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Maro Vlachopoulou, Fotis Kitsios, Maria Kamariotou

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OR in the digital era - ICT challenges

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Editors:

Maro Vlachopoulou
Department of Applied Informatics
University of Macedonia

Fotis Kitsios
Department of Applied Informatics
University of Macedonia

Maria Kamariotou
Department of Applied Informatics
University of Macedonia

University of Macedonia, Thessaloniki, Greece

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GR-546 36 Thessaloniki,
Greece

Introduction and conference overview

Maro Vlachopoulou

Fotis Kitsios

The 6th International Symposium and 28th National Conference on Operational Research (HELORS 2017) held in Thessaloniki, Greece, in June 2017. In this introductory paper the editors provide an overview of the conference, summarize the most important presentations, and offer some reflections on the conference outcomes. The key objective of the HELORS 2017 was to disseminate recent scientific advances in the field of Operational Research (OR) and Management Science in Greece and to promote international co-operation among researchers and practitioners working in the field. The specific aim of this year's Conference was to highlight the role and importance of OR in the digital era and the underlying ICT challenges ("OR in the Digital Era – ICT Challenges"). The main topics of the conference were: Multicriteria Decision Making; Metaheuristics; Data Envelopment Analysis; Logistics Optimization; OR in Finance & Economics; Strategy & Analytics; Supply Chain Optimization; Digital Economy & Digital Enterprise; Forecasting & Maintenance Optimization; Agricultural Management; OR & ICT; Statistics & Data Mining; Business Process Management; OR in Construction; Environmental Management; and OR in Health.

Prof. Maro Vlachopoulou

Professor, Department of Applied Informatics, School of Information Science
University of Macedonia
156 Egnatias str., GR-546 36 Thessaloniki, Greece
E-mail: mavla@uom.gr.

Prof. Fotis Kitsios

Assistant Professor, Department of Applied Informatics, School of Information Science
University of Macedonia
156 Egnatias str., GR-546 36 Thessaloniki, Greece
E-mail: kitsios@uom.gr.

The 6th International Symposium and 28th National Conference on Operational Research took place on Thessaloniki, Greece, on 8-10 June 2017. It attracted about 197 delegates from 10 countries. The conference was organized by the Department of Applied Informatics of the University of Macedonia and the Hellenic Operational Research Society (HELORS).

Keynote speakers were Professor Panos M. Pardalos from the University of Florida, Professor Georgios Doukidis from Athens University of Economics and Business and Professor John N. Tsitsiklis from the Massachusetts Institute of Technology.

In his presentation, 'Quantification of Network Dissimilarities and its Practical Implications', Professor Panos Pardalos concentrated on the qualification of network dissimilarities and discussed the implications of network dissimilarities.

In his presentation, 'Data-driven Innovations in the Retail Supply-Chains: From Digital to Business Transformation', Professor Georgios Doukidis focused on Business Analytics and Shopper Centricity in Retail. He highlighted alternatives of customers' satisfaction increase, and the improvement of major KPIs in stores. He presented the business transformation in order to increase basket size and customer satisfaction using Business Analytics. Furthermore, Professor Doukidis discussed the eight waypoints for data-driven supply chain collaboration.

In his presentation, 'Dynamic Programming: an eclectic overview', Professor John Tsitsiklis described the Dynamic Programming problem, the computational lens, limits and problemsand heavy-duty methods. Professor Tsitsiklis highlighted that dynamic programming is a mature field, but researchers have not seen the end of it. Also, it involves ideas from OR, Applied Mathematics, Control Theory and Artificial Intelligence. He concluded by arguing that even when theory is not relevant in a literal/exact sense, it is still the source of guiding principles.

Session 1: Multicriteria Decision Making

Spyridakos et al presented an adaptation of the UTA methods which on the one hand can solve the above mentioned issues but on the other require additional preferential information by the Decision Makers (DMs), concerning the strength of preferences of the DMs. Also, a visual technique was presented which allows to acquire with an easy and comprehensive way the required preference information using the pre-ranked alternative actions of the reference set. The proposed approach leads to the estimation of preference models with higher robustness and on the same time functioned in cases with limited alternative actions.

Vavatsikos and Anastasiadou initiated a framework that examines both criteria and the constraints implementation into the wind farms site suitability problem. Both criteria and constraints form an objectives' tree through their classification into three main criteria categories which namely are: environmental, socio-economical and design considerations. At the first step absolute suitability analysis aims to identify candidate siting locations that satisfy all the examined constraints by performing Boolean operators. Then, relative suitability analysis was implemented in order to rank efficient locations using suitability measures in GIS environment. The proposed analysis was presented in a real case study in Eastern Macedonia and Thrace region, while multicriteria evaluation was implemented using TOPSIS and VIKOR decision models.

Vryzidis and Spyridakos argued that the evaluation of project success is characterized by complexity, diversity and ambiguity concentrating the strong interest of academics and business managers over the last decades. The proposed PROMITHEAS approach (PROject Multicriteria Interactive Tool for Holistic Effectiveness ASsessment) for the project success evaluation concluded to the estimation of a value system based on the selection criteria combining the disaggregation - aggregation multicriteria decision aid UTA methods and the Multi-Objective Linear Programming Techniques. Through this approach the following main objectives were achieved: 1) the evaluation of the projects' success according to the strategic goals of an organisation, 2) the use of a consistent family of criteria in the analysis taking into account the relative importance of the criteria and 3) the consideration of different stakeholders in all stages starting from the selection process of the projects' portfolio to the final evaluation of project success. The value system estimated by this approach can lead to the analysis of the success or failure of the projects by deducting differences from the initial strategic planning. The PROMITHEAS approach is illustrated through a real world case study concerning the evaluation of Post Graduate Educational Programmes of a higher Educational Greek Business School.

Kitsios and Sitaridis aimed to use methods of operational research, to provide decision makers with a straightforward way of ranking a set of entrepreneurial ecosystems, depending on a common set of criteria. For over 15 years the Global Entrepreneurship Monitor (GEM) releases an annual report on Entrepreneurship, including data from more than 100 countries. The data were collected by national experts and cover two basic elements, namely the entrepreneurial behavior and attitudes among the population and the entrepreneurial ecosystem. Moreover, explanatory national reports were written for each country by a panel of experts, but comparative studies are more rare. Authors applied multi-criteria decision methods in order to assess the entrepreneurial ecosystem of selected countries. They used data from the National Expert Survey (NES), indicating multiple facets of the economic and social environment, as input criteria and they examined each country as a different alternative. The multi attribute decision method used was based on Perron-Frobenius theorem on primitive matrix properties. The method produces a primitive comparison matrix based on pair comparisons of alternative cases on each criterion. Only the win-tie results of each comparison were taken in account and not the magnitude of the difference. Finally a

ranking vector was extracted based on the spectral radius and the corresponding eigenvector. The main benefit of the method is that it does not require experts' assigned weights for the criteria used and it has reduced computational burden. Finally, the ranking results were compared to those of some popular MADM methods.

Session 2: Decision Making Applications

Milenković et al presented the results of a case study based on a cooperative single wagonload transport planning between rail freight operators in different and interconnected service networks. Cooperative planning approach wass based on Distributed Model Predictive Control (DMPC) for managing the freight wagon flows by a number of rail freight operators in their subnetworks in order to minimize the total freight wagon management cost. Augmented Lagrangian formulation of the planning problem wass decomposed into sub problems cooperatively solved by rail freight transport operators.

Dimitriou et al identified the key factors affecting decision making and management towards effective use and allocation of resources in the hotel industry, focused on medium size resort hotels that are the majority in Mediterranean region. By adopting a System of System concept a multi-agent decision framework for the hotel industry was presented development, highlighting the key decision objectives, variables and stakeholders. Based on functional analysis approach, the taxonomy for an effective capability driven DSS system relevant for medium-size resorts was discussed and the data driven functions were presented. The results of a gap-analysis for the hotel-resorts in Alexandroupolis region in Northern Greece were discussed, providing key messages to planners, decision makers and managers towards tourism sector resilience and productivity.

Manolis et al investigated via realistic traffic-flow simulations and discussed L4GCAO (Local for Global Cognitive Adaptive Optimization), a novel model-free optimization approach aiming at maximizing global performance of a given control system by calibrating its control parameters through decentralized self-learning elements that periodically share a single piece of information, which is the overall system performance. L4GCAO performance was also compared against CAO (Cognitive Adaptive Optimization), its centralized counterpart developed and successfully applied in the past, and the results indicated its ability to achieve a performance close to the performance achieved by the centralized CAO approach, albeit with significantly less computational effort.

Michopoulou and Giannikos discussed that the process of finding appropriate locations (sites) implies a long term investment, since it typically includes land property costs and high construction expenses, while it also functions as an indicator of the customers' preferences for the particular sites that are chosen. Thus, locating facilities could have a huge impact on the effectiveness, competitiveness and vitality of any firm or organization. Typically, covering models do not take into account the quality of the services provided as a feature of the facility or the interaction between facilities and demand. Authors examine several reformulations of the basic models that may incorporate the quality of services provided by each facility and the ability to meet demand after multi-site co-operation. These formulations were tested on a series of instances from the 40 problems in OR Library (Beasley 1990). In particular, the computational times and the quality of the solutions were examined in a variety of problems with different number of customers and different topological features.

Session 3: Logistics Optimization

Konstantakopoulos et al presented a methodology for classifying the literature of the Vehicle Routing Problem (VRP) for urban freight transportation and a review of the latest bibliography.

The fact that the variants of the VRP have grown and similarly have their practices and applications, made the VRP popular in the academic literature. Hence, the number of articles published, is constantly increasing and it is difficult to monitor developments. In this paper, after considering existing research papers, a review from Scopus scientific database was presented. The taxonomy of the last decade's literature of the VRP for urban freight transportation was given and critical insights were discussed. After the categorization of the articles, the trends of the VRP for urban freight transportation were featured and analyzed. This knowledge and analysis will be used in a research project in order to support through an algorithms approach, the functionality of a vehicle routing and scheduling information system, and lead to an operational solution.

Session 4: OR in Finance & Economics

Pavlou and Doumpos argued that the selection of investment portfolios is a major topic in financial decision making with many portfolio optimization models available in the literature. These models extend the traditional mean-variance framework using a variety of other risk-return measures. Existing comparative studies of such models have adopted a rather restrictive approach focusing solely on the minimum risk portfolio without considering the whole set of efficient portfolios, which are also relevant for investors. Authors tried to move a step forward, focusing on the performance of the whole efficient set, rather of a single portfolio. To this end, they examined the out-of-sample robustness of efficient portfolios derived by popular optimization models, namely the traditional mean-variance model, mean-absolute deviation, conditional value at risk, and a multi-objective model. Tests were conducted using data for S&P 500 stocks, over the period 2005-2016. The results were analyzed through novel performance indicators representing the deviations between historical (estimated) efficient frontiers, actual out-of-sample efficient frontiers, and realized out-of-sample portfolio results.

Avgeris et al investigated and measured the reciprocity between human (economic) relations. In particular, that is if people are possessed by feelings of reciprocity or opportunism. In other words, authors attempt to provide answers regarding the battle between the two kinds of economic people in experimental economics, Homo Economicus versus Homo Reciprocans. The two well-known games of Game Theory, Ultimatum Game and Dictator Game were used and applied for this reason. Authors presented the findings of a combined research conducted with undergraduate students at the University of Patras, in the Departments of Business Administration of Food & Agricultural Enterprises and of Environment & Natural Resources Management, based in Agrinio.

Tsianaka et al indicated that he real estate business environment since 2008 has changed dramatically. Changes have been located in the evaluation price of real estates, the reduction of demand on real estate market, over taxation, the lack of bank finance etc. Real estate properties are part of the economic capital and first authors explored how they tariff properties when the holder is a natural person (individual) and second how they tariff properties when the holder is a legal entity.

Session 5: Strategy & Analytics

Misirlis et al reported on the following research issues regarding several social media types, social media analytics and social media tools in precise definitions and categories, based on literature review and Internet search. How to render actionable the large datasets from social media? How to classify all the relevant techniques? How to capitalize all the existing information? Authors analyzed social media on marketing and its research options. Furthermore, they performed a full report of social media landscape, presenting four main classification suggestions for social media.

Kyriakopoulou and Kitsios focused on their experiences in examining the impact of social media on consumers' behavior. They concluded that online social networking has become one of the most popular online activities that more and more people preferably spend their free time on. The high rate of data transmission combined with the hectic everyday lifestyle that the actual society imposes, have raised the necessity of time-saving solutions. As a result, consumers search for direct and quick alternatives for their purchases, in order to cover their needs. Also, the most important role of social media is that it has changed the way of how consumers and marketers communicate. Social media is a great communication tool that people use to connect to others or communicate with organizations. Social networking platforms as a part of everyday life are virtual places where people as users, share their opinion, warnings, experiences and information. The consumers' social and commercial experience on the internet has been enriched through the daily use of social media. On the other hand, companies benefit from this state and try to provide their products through a "friendly" environment such as social networks, less direct to the consumers, aiming to maximize the customers' experience.

According to Kamariotou and Kitsios, Strategic Information Systems Planning (SISP) supports business goals and business strategy, through the use of Information Systems (IS). Findings from previous surveys indicate that many managers make too much effort to SISP process while others too little. When managers invest too much effort, the process could be confusing, delayed or its implementation could be prevented. When managers avoid investing too much time to the process, the implemented plans could be inefficient so the objectives could not be achieved. Consequently, the assessment of the process is significant because managers can reduce these unsatisfactory results. Findings conclude that managers concentrate more on Strategy Conception and Strategy Implementation and they do not invest time on Strategic Awareness and Situation Analysis. As a result the implemented plans are not effective, successful and they do not meet the objectives. Many factors which influence SISP process could be taken into consideration in order to explain these results. Almost 80% of businesses have been highly influenced by the financial crisis. So, more attention is needed to be payed to Small-Medium Enterprises (SMEs) and how they use IS and strategic planning in order to deal with the crisis. Despite the fact that family businesses focus on business's long-term sustainability, they do not develop strategic planning. The results of a survey in Greek SMEs indicate that executives should pay attention to implementing Situational Analysis with greater meticulousness, so they can apply Strategy Conception and Strategy Implementation Planning with greater agility rather than now.

Georgakalou et al described the measures in order to investigate and measure the degree of a person's strategic thinking, mainly focusing on leaders. These measures concern: (a) the measure of risk taking (which is actually a score) and (b) the measure of (visionary). Authors found that leaders establish and share the values, develop and communicate the vision, determine the mission and formulate and implement the strategy. Apart from being determined, the leader should be able to present his vision and to stir up his audience and envisage them. Additionally, he should be determined to undertake risks. Previous researches have examined the link between their personal characteristics and planning system, the human capabilities of leaders and the effect of organizational characteristics. The Leadership Excellence Model which has been studied by many researchers contains these elements but they cannot be measured directly.

Session 6: Supply Chain Optimization

Makris et al proposed a fairness-informed modelling extension to the existing single-airport slot scheduling models by introducing and modelling the notion of "marginal schedule displacement", which can be defined as the incremental schedule displacement caused by each slot request. The proposed model aimed to ensure that each airline absorbs its "fair share" of the total marginal schedule displacement exerted onto the system. In doing so, authors enriched previous, single-

objective modelling formulations aiming to minimize total schedule displacement with a fairness constraint ensuring a fair allotment of marginal schedule displacement.

Drakaki et al focused on the logistical aspects of a community based social partnership in Greece, and the contribution of this partnership to community resilience. In such a context, logistical activities were performed by the membership base of various non-governmental organisations in a manner of "collective action" rather than the commercial sector. Authors focused on self-organisation, and a resultant community based social partnership (CBSP) in Greece, with members from the private, public and civic sectors, in the midst of a financial crisis. In the context of logistics, a conceptual model had been developed linking the partnership with self-organisation, social capital building, and community resilience.

Yakavenka et al proposed a decision-making framework that assigns aspects of business ethics to the sustainable management of the supply chain of perishable products, and involve the provision of fresh, price and environmentally friendly products to the consumers. In order to address this issue, authors developed and employed multi-criteria (cost, time and emissions minimization) mixed integer linear programming (MILP) model, and applied it in a realistic case study for deriving managerial insights.

Tziantopoulos and Madas evaluated the impact of Additive Manufacturing (AM) adoption on drug tablet production and the supply chain reconfiguration opportunities under different AM production cost scenarios. For this purpose, authors proposed a MILP model formulation which aims to minimize a total cost function consisted of AM facility investment costs, production costs for primary and secondary manufacturing, as well as transportation costs, subject to network connectivity, production capacity, demand fulfillment, and flow conservation constraints. The proposed model was demonstrated at a small problem instance involving a 4-echelon pharmaceutical supply chain network for theophylline Active Pharmaceutical Ingredient (API) tablets.

Session 7: Digital Economy

Roussou and Stiakakis presented the results of the first online academic survey about the actual use of digital currency by companies and freelancers globally, with an emphasis in the European Union, where Greece belongs. Considering digital currency as a pioneering technological innovation, a combination of Diffusion of Innovations (DOI) Theory (mainly Innovation Decision Process Model - IDPM) and Technology Acceptance Model (TAM) had been applied. The goal of the survey was to investigate the actual use of digital currency, as a means of transaction by companies and how it is affected by the constructs of Perceived Ease of Use, Perceived Usefulness, and Perceived Security directly and other constructs indirectly, according to the research model. Based on the responses provided by 254 companies and freelancers the results exhibited that the penetration of digital currency usage is in increasing progress.

Nanos et al reflected on the relationship between cloud computing and e-government, to highlight the importance of cloud computing adoption in public administration and to offer insights on the way that cloud computing can contribute to the successful deployment of e-government services. Through the study of relevant theoretical models and frameworks, enabling and inhibiting factors for cloud computing adoption in the public sector were identified, classified and analyzed. Furthermore, initiatives that have taken place so far in Greece in the area of cloud computing and e-government were presented.

Andreopoulou et al studied the Internet market of mushrooms and truffles in Greece. Their research focus on registration and assessment of SMEs located in Greece and operating in field of

mushrooms and truffles, with emphasis on the classification of their business websites in groups according to their marketing and digital characteristics and functions. The findings show that mushrooms and truffles are found in normal diets since antiquity and also as a delicacy, because of their texture and highly desirable taste and aroma. During the last ten years, the need of the production of cheap nutritious food, led to the fast development of the mushroom and truffle cultivation sector. The Internet provides a stable communication infrastructure to citizens and businesses and has augmented business opportunities.

Session 8: Forecasting & Maintenance Optimization

Kouziokas et al focused on the application of Artificial Intelligence for developing neural network forecasting models in order to predict the final energy consumption which covers the energy consumption in industry, transport, households, public administration, commerce and other sectors. The energy consumption forecasting can be very valuable in adopting management practices regarding the energy management and also in designing and planning national energy strategies. Several topologies were examined in order to develop the optimal artificial neural network forecasting model. The results showed that the proposed methodology can provide energy consumption predictions with a very good accuracy, which can be very valuable in public and environmental management, since they can be used in order to help the authorities at adopting proactive measures in energy planning and management.

Kouziokas investigated the use of Artificial Neural Networks for building forecasting models in order to predict unemployment. A Feedforward Neural Network structure was used since it is considered as the most suitable in times series predictions. In order to develop the best artificial neural network forecasting model, several network topologies were examined regarding the number of the neurons and also the transfer functions in the hidden layers. Several economic factors were taken into consideration in order to construct the neural network based prediction models. The results had shown a very precise forecasting accuracy regarding the unemployment.

Session 9: Agricultural Management

Tarnanidis et al used the methodology of PROMETHEE II multicriteria decision-making approach for the comparison of agricultural productivity and ranking the seven prefectures of Central Macedonia in Greece, based on productivity indicators of agricultural resources, like the gross return produced in each region. Data was collected for the period of 2013 to 2014. The results revealed that the prefecture of Pella surpasses on productivity the remaining six, while in the second and third place the prefectures of Imathia and Pieria follow.

Dragoslis et al considered the development of a DSS for the support of decision making for spatial tillage allocation. The developed DSS integrated the weights' estimation methodology of revised Simos with the VIKOR and AHP multicriteria analysis methods and can be used to solve complex decision problems that have alternative solutions and are evaluated by using conflicting qualitative and quantitative criteria. Using the AHP and the Revised Simos modules, stakeholders can calculate the relevant weights for the evaluation criteria needed for VIKOR's application on data. The outcome was a ranking of the alternatives and a suggestion of the best compromise solution. The DSS was applied experimentally on a set of seven crops.

Mantzaropoulou et al discussed the management options that may have a Nexus approach on the management of water, soil and waste, in order to enhance the sustainable intensification of agriculture, and contribute to the socio-economic development. Authors also examined various economic assessment methods which were used in the management process and decision making

in the framework of sustainable development. Finally, the most appropriate operational research models and applications were proposed that promote the decision making in Nexus systems.

Session 10: OR & ICT

Geranis et al presented the results of an exploratory survey on the factors which affect Internet users' intention to use a price comparison site. Results showed that the perceived website image, as well as the users' overall satisfaction with the site, had a positive impact on their intention to use a price comparison site.

Karagiorgou et al explored issues relating to the level of IT knowledge of Financial Accounting students in Greece. Authors investigated the kind of IT knowledge and skills that accountants need and the entry-level IT skills and knowledge that educators should provide.

Balasas et al illustrated a comparative analysis of the characteristics and the metrics of dynamic routing protocols. Authors also compared the performance of different Interior Gateway routing protocols, like EIGRP, OSPF and RIP, in real-time applications Big Data, Video conferencing and VoIP, based on end to end packet delay, network convergence duration, packet delay variation and Jitter of VoIP by using Riverbed Modeller simulator. Authors aimed to show how dynamic routing protocols perform in real time applications while some failures happen on different network links.

Session 11: Statistics & Data Mining

Ismyrlis and Moschidis discovered the most important factors that influence happiness (H) and life satisfaction (LS) and whether H and LS had the same impact on other variables. The final results emerged from this study, seemed to prove that LS and H had the similar attitude with most variables of the study. Moreover, it was deduced that income was not the most important determinant of SWB, as many other variables had demonstrated almost the same attitude.

Nikolopoulou et al proposed a method which was based on some constraint statistical analysis, like the mean solution of each constraint, in order to identify a significant number of redundant constraints, in comparison with other methods in non-negative LP problems. The proposed algorithm suggested that the constraint that had the maximum lower bound of the confidence interval among the lower bounds of the other constraints had the higher probability not to be redundant. The classification rule had a significant overall percentage of correct prediction and an almost accurate percentage of correct prediction of redundant constraints.

Session 13: Business Process Management

Papadopoulos et al identified and explored business process management issues in the construction industry, using business process modeling methods and tools which integrate the risk management perspective. Authors discussed the benefits gained for the case company while demonstrating examples of the created business process models. Business process models integrate all of the systems, data, and resources within the construction company, they can form a protective wall against the risks to which the company is exposed. They also had a direct impact on the attractiveness and the quality of the provided services inside a really competitive market.

Session 14: OR in Construction

Tegos and Aretoulis discussed that the development of a reliable Decision Support System with respect to the selection of the type of Concrete highway bridges is an important research

objective, for which only fragmentary efforts have been made worldwide so far. Through the application of this method, the respective optimal selection of the bridge type was achieved, among a number of potentially suitable alternatives.

Tarnanidis et al presented the results of the calculating algorithm of entropy budgets that attempts to examine the significance of unanticipated cost and time of construction projects. They identified that the main problem was a major gap in the understanding of how entropy can be used more effectively in the construction industry, in order to foresee non deterministic situations that influence the budgeting process.

Seira and Katsavounis reported on the effectiveness of several distribution patterns, learning curve shapes, Skewness and kurtosis in order to monitor a project's plan baseline schedule and the ongoing progress. The results from two large scale case studies using Primavera P6 Professional v15.2 for planning and scheduling while Monte Carlo method were used from Primavera Risk Analysis for schedule's risk and "what-if" scenarios simulation.

According to Vavatsikos et al the continuously developments with respect to modern GIS software packages and the contribution of programming languages leads to the creation of scientific automatization tools that can deal with a huge amount of information fast, efficiently and accurately. In that context Land-Use Suitability mapping and analysis can are expanded to the consideration of decision criteria to evaluate spatially related decision problems. On the other hand PROMETHEE methods enrich the analysis with their ability to a/ simultaneously deal with qualitative and quantitative criteria and b/ manage uncertain and fuzzy information provided by the decision makers. Authors developed modules which can be considered fast while in the same time they capable to manage big amount of data and information.

Session 15: Environmental Management

Kazana et al explored and evaluated the multi-criteria decision process for SFM assessment. Authors presented the results of a survey conducted in in the forests of Eastern Macedonia & Thrace Region. The "business as usual" OFSPI value showed that continuation of the present management policy of the Region's forest areas will diminish the Region's forest sustainability performance in the following 10 years. The SFM policy option concerning the improvement of the Region's wood stock for technical wood, firewood and pulpwood production will contribute the most to the Region's forest sustainability and therefore it should constitute a first priority management objective for the Region's forests should the forest authorities decide to improve the Region's forest sustainability.

Georgiou and Karpouzos developed an optimization model to determine the optimal allocation of irrigation water to multiple crops in irrigated agriculture under deficit irrigation. The model used as a decision support tool for irrigation scheduling while it indicated cases where a deficit irrigation can lead to notable water savings with limited decrease of economic profit.

Session 16: OR in Health

Stefanakakis et al investigated the characteristics of an appointment system of a Greek hospital in Thessaloniki based on Kano's satisfaction model, and provide data for future improvement of the system based on the users' needs. Authors examined the following criteria; website quality, perceived ease of use, perceived usefulness and service quality. The providers of the service should improve the performance of some of the characteristics so as user satisfaction is increased more.

Syngelakis and Kitsios evaluated the occupational stress of non-hospital Greek NHS dentists, during the current economic crisis and public sector reform, by using Effort – Reward Imbalance (ERI) questionnaire, a contemporary research instrument strongly linked to labour market conditions. A relative imbalance between efforts given and rewards received was found in non-hospital (primary care) Greek NHS dentists at the time of research. Therefore, authors argue that well designed interventions should be implemented to address occupational stress, which is expected to increase during the ongoing crisis. Additionally, targeted policies by the Greek government aiming to improve the Public Dental care System in the Greek NHS would also be necessary.

Nikoloudis et al developed a multi-criteria decision-making model in order to analyze the criteria used by investors (venture capitalists and angel investors) to evaluate startup funding. Their paper makes an attempt to list and describe what investors do, and other stakeholders see when evaluating a startup in the early stage (pre-seed and development) during a business ideas competition. Their results comparing all the registered business ideas of startups, showed that the proposed multi-criteria model could be used for evaluating the pre-seed (business idea) stage of startups, and that offers promising new perspectives in this field of research.

Reflections

At 6th International Symposium & 28th National Conference on Operational Research, recent scientific advances in the field of Operational Research (OR) and Management Science in Greece were discussed. The aim was to promote international co-operation among researchers and practitioners working in the field. The impact of Information and Communication Technologies (ICT) in the field of OR, was the key issue that dominated the presentations.

Papers satisfy many research areas, such as strategy, supply chain, logistics, digital economy, data mining and health. Authors examined the combination of ICT and OR methodologies in these areas. Researchers might either experiment with new methodologies regarding OR or apply the existing in order to provide conclusions concerning their implications in ICT era. Authors presented new frameworks, case studies applications using a variety of OR methodologies and methodologies for Information Systems development.

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Nanos, I., Misirlis, N., and Manthou, V. ‘Cloud Computing Adoption and E-government’.

Andreopoulou Z., Kalfagianni A., Tsiaras S., and Tsekouropoulos G. ‘Assessment of the Internet market in Greece; The case of Mushrooms and Truffles’.

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Hellenic Operational Research Society

Email: eeee [at] otenet.gr

Tel: +30 210 3807532, Fax: +30 210 3807807

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Contents

Robustness Improvement in UTA methods through the elicitation and exploitation of strength of preference information 1

Distributed model predictive single wagonload control 7

Vehicle Routing Problem for Urban Freight Transportation: A Review 14

Wind Farms Suitability Analysis Using TOPSIS and VIKOR Approaches: A Case Study in Thrace Region 22

Utilising Multicriteria Decision Aid for the measurement of Project Success. The PROMITHEAS methodological frame. 29

An application of non weight MCDM for the evaluation of GEM entrepreneurial ecosystems 35

The Robustness of Portfolio Optimization Models: An Empirical Comparative Analysis 40

Reciprocity in Trade: An Empirical Investigation Using Experimental Economics Methods Under Real Circumstances 46

Income taxation from Real Estate property (physical and legal persons) 52

A Roadmap to Social Media Analytics 57

The influence of social media on consumers' behavior 62

An Empirical Evaluation of Strategic Information Systems Planning Phases in SMEs: Determinants of Effectiveness 67

Measuring Leaders' Strategic Thinking 73

Taxonomy for effective decision making in medium size tourist resorts 79

Simulation study of an adaptive decentralized approach for the optimization of traffic control systems 85

Demand Covering Problems with Facilities' Interaction..... 91

A fairness-informed modelling extension to the single-airport slot scheduling problem 97

The logistics role in community resilience: a case example of a community based social partnership in Greece 102

A Decision-Making Framework for Sustainable Supply Chain Management of Perishable Goods . 108

The Impact of Additive Manufacturing on Pharmaceutical Supply Chain Network Configuration .. 113

Adoption of Digital Currencies: The Companies' Perspective 120

Cloud Computing Adoption and E-government 128

Assessment of the Internet market in Greece; The case of Mushrooms and Truffles……135

Neural network based methodology for predicting energy consumption in public and environmental management 140

Feedforward Neural Network Model in Unemployment Rates Forecasting in Public Administration 146

Evaluation of agricultural productivity by using multicriteria analysis: A case study in Central Macedonia in Greece..... 151

Software design and development for spatial tillage allocation using the Revised Simos methodology combined with the Multicriteria Analysis Methods AHP and VIKOR 157

A Nexus approach for Agricultural Sustainable Management 164

Internet users' perceptions towards price comparison sites in greece..... 170

Accounting information systems in higher education: Assessment of graduate students' level of knowledge regarding IT technology and its applications. 176

Performance Evaluation of Routing Protocols for Big Data applications 183

Subjective well-being in Europe: a multidimensional statistical analysis of ESS data 190

Redundant constraints identification in linear programming using statistics on constraints 196

Business Process Management Integrated with Risk Management in Construction Industry 202

Proposal for an effective Decision Support System for the Pre-Selection of the Type of Concrete Highway Bridges 208

The Concept of Entropy in the Management of Construction Projects: A decision-making model of risk uncertainty 213

Scheduling and Risk Analysis in Large Construction Projects using Learning Curves Approach..... 219

A Combined Use of GIS, PROMETHEE and Monte Carlo Simulation Methods for Major Transportation Infrastructure Impacts Evaluation 227

A multi-criteria fuzzy AHP approach for assessing forest management sustainability: A Greek case study 233

Optimization Model for Irrigation Water Management under Deficit Irrigation 239

Analyzing quality characteristics: The case of an e – health application 246

Evaluating occupational stress and job satisfaction in health sector during the austerity: the case of Greek NHS dentists 252

Applying the multi-criteria method Promethee II for the startup ranking during a business ideas competition 257

Robustness Improvement in UTA methods through the elicitation & exploitation of strength of preference information

Athanasios Spyridakos
Piraeus University of Applied Sciences
Business Administration Department
tspyr@puas.gr

Nikolaos Tsotsolas
Piraeus University of Applied Sciences
Business Administration Department
ntsotsol@puas.gr

Isaak Vryzidis
University of Athens
Department of Primary Education
Isaak.Vryzidis@gmail.com

Abstract

UTA methods concludes to the assessment of additive value preference models based on Decision Makers (DMs) global preferences expressed by rank ordering of a limited set of the alternative actions evaluated into a consistent family of criteria. An adaptation of UTA methods is presented in this research work which utilizes additional information concerning the global preferences of the DM. The strengths of preferences among the successive alternatives of the reference set, sorted by their ranking, are derived. The DM is asked to provide ranges of values [zmin, zmax], through visual techniques, expressing the degree he/she prefers an alternative action from the next one in the ranking. By this way n-1 ranges of indices concerning the strength of preferences among the successive alternatives of the n alternative actions of the reference set are embedded into the UTA methods. Adaptations of the linear program of UTA method leads to the estimation of a more robust additive value model corresponding to more rich representation of DM's preferences. The proposed adaptation of UTA methods can be used a priori during the initial expression of DM's global preferences or a posteriori in the frame of post optimality and robustness analysis, constituting a new feedback of UTA methods. The above approach is presented and evaluated through an illustration case study.

KEYWORDS

Multicriteria Decision Aid, Robustness Analysis, Disaggregation Aggregation Approach

1. INTRODUCTION

Multicriteria Disaggregation - Aggregation (D-A) approaches (Jacket-Lagreze and Siskos 1982, Siskos and Yannacopoulos, 1985, Siskos 1t al, 1999) leads to the assessment of additive value models described in the following formulae:

$$U(g) = \sum_{i=1}^{n} p_i u_i(g_i), \quad u(g_{i*}) = 0, u(g_i^*) = 1, for\ i = 1,2,..,n$$

$$\sum_{i=1}^{n} p_i = 1, \qquad p_i \geq 0, \qquad for\ i = 1,2,..,n$$

where g = (g1, g2, ..., gn) is the evaluation vector of an alternative action on the n criteria, gi* and gi* are the least and most preferable levels of the criterion gi respectively and ui(gi), pi are the value function and the relative weight of the i-th criterion. The assessment of this additive value modes is achieved based on: a) the evaluation of the alternative actions into a consistent family of criteria, b) the DM global preferences expressed by rank-ordering of a limited set of alternative actions (reference set), c) Linear Programming techniques where the parameters of the additive value model are estimated so as to reproduce, as close as possible, the initial global preferences of the DMs and d) utilisation of interactive structured or unstructured

dialogues with the DM where a set of feedbacks can be used triggered by the analysis of the estimated value preference model.

The utilisation of UTA methods in real world case studies inspired many researchers the last 30 years as well for the development of extensions and adaptations from the first presentation of the method UTA (Jacket-Lagreze and Siskos 1982). Two significant issues which preoccupied the researchers are the need for Robustness as far the estimated preference model is concern and the selection of the reference set of the alternative actions. The estimation of the additive value models based on the DM's global preferences expressed through the pre-ranking of the alternatives actions of the limited reference set leads, in many cases, to the estimation of infinitive sets of preference models (Low Robustness). The robustness of the estimated value prefernce model can me measured with the Avarage Stability Index (ASI) (Grigoroudis and Siskos, 2010) varying from in the range [0,1] where 1 corrsponds to total robustness. Another issue concerning the consistency and the robustness of the estimated additive value preference model is oriented to the selection of the reference set, which ought to be representative of the total set of the alternative actions and familiar to the DM so as to be able to express reliable global preferences. In order to handle the above mentioned issues leads to the selection of polulated reference sets and are created perversion to use the D-A approach in cases with limited alternative actions.

This research work presents an adaptation of the UTA methods which on the one hand can solve the above mentioned issues but on the other requires additional preferential information by the DMs concerning the strength of preferences of the DMs. Also, a visual technique is presented which allows to acquire with an easy and comprehensive way the required preference information using the pre-ranked alternative actions of the reference set. The proposed approach can leads to the estimation of preference models with higher robustness and on the same time to be functioned in cases with limited alternative actions.

The paper includes the introduction and three more sections. In the second section the utilization of information concerning strength of preferences is presented and the above mentioned visual approach is described. Following an illustration example is used in order to provide the main features of the proposed approach. Finally conclusions and the potential exploitation of the proposed approach is presented in the last section.

2. VISUAL TECHNIQUES FOR ACQUIRING STRENGTH OF PREFERENCES

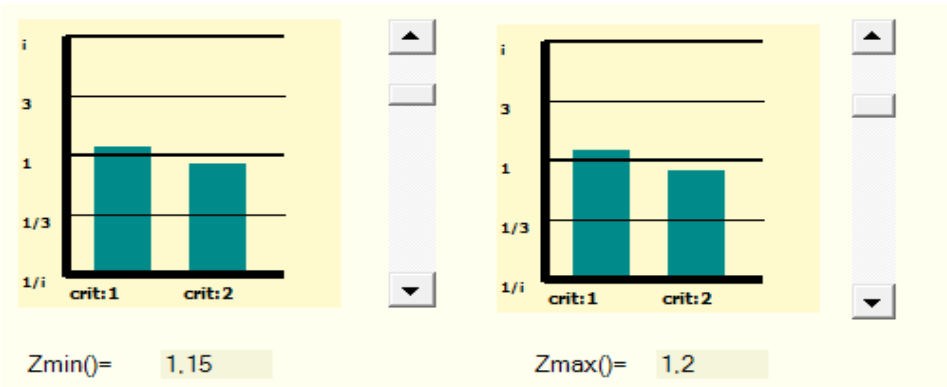
One of the crucial features of the UTA methods is the capability to lead to the estimation of an additive value model (preference model) based on a pre-ranking of the alternative actions of a limited reference set, instead of other MCDA methods which require rich preferential information by the DMs increasing the complexity. This pre-ranking can be easily and efficiently acquired by the DM's capturing the priorities of the DMs as far as their global preferences is concerned. The number of alternatives used into the reference set as well as the representation of the decision space constitute a crucial points for the effectiveness of the D-A approach. Thus, the reference set ought to include enough alternative actions but not too many so as the DM to be able to express his/her preferences covering the different aspects of the total set of alternative actions. Quality of preference information concerning how much more the DM prefers an alternative action a_i from another action a_j ranked in a way that a_j follows the a_i cannot easily expressed by the DM. It is more complicated to ask the DM to compare the alternative actions of the reference identifying the level or the degree he/she believes that an alternative is better from another. Strength of Preferences (SoP) concerning a pair of alternative actions can be acquires directly or indirectly. A qualitative scale can be used in the form of indifference, low preference, preference, strong preference and very strong preference. In this case it is difficult to translate this qualitative preference information to a quantitative scale. Also, a qualitative preference information doesn't mean the same for every DM due to the subjectivities. The utilization of the pair wise comparison approach used in AHP (Saaty, 1980) with the 9 levels of prioritization and the assessment of the vector of priorities using the eigenvector technique comes with strong assumptions and inconsistencies (Costa and Vasnick, 2007) and cannot be used effectively in cases which require a precise and consistent preference information related to the DM's SoP. Preference information can be also acquired through the MultiAttribute Utility Theory techniques (Keeney and Raifa, 1976) but the demanding of the interactive approaches increases the complexity of the dialogues between the DM and the Decision Analyst.

The main issue of the proposed approach is to identify the index Z where $U(a_i) = Z \times U(a_j)$ expressing how much the DM prefers a_i from a_j ranked in k and k+1 positions correspondently. There are two main issues concerning this pair wise comparison of two alternatives: a) The DM cannot give you an exact value. It is more easy for them to give you a value range. b) The DM can more easily interact through a visualization process, expressing how much he believes that an alternative action is better than the other. The above two issues lead to the incorporation of the following in our effort to utilize SoP in the implementation of D-A approaches:

a) The DM is asked to give a value range as far as the Z index is concerned (**$Z_{min} \leq Z_r \leq Z_{max}$**) which is translated to the following two conditions **$U_a - Z_{min}U_b \geq 0$** and **$U_a - Z_{max}U_b \leq 0$**. So, it is asked to give a magnitude of his/her SoP for every pair of successive alternative actions of the reference set sorted by the pre-ranking.

b) The utilization of visual techniques providing and easy and comprehensive way for the DM to express his/her SoP for every successive pair of alternative actions of the sorted by the ranking reference set. Actually, using scrollbars the DM can visualize through bar diagrames and finally identify the magnitude of the difference in total values that he/she believes there is between the two alternative actions(Fiigure 1)

Figure 1 Visual technique for identifying the range of strength of preferences for a pair of successive alternative actions of the sorted reference set



The ranges of the Zi indices can enrich the conditions of the linear program while every condition concerning only priorities of preferences coming by the ranking is now replaces by two ones comming from the minimium and maximum values of the range values of the Z index. The modification of the linear programm for the assessment of the additive value model is described by the following formulas.

Alternatives ai are re-arranged so as $a_i P a_{i+1}$ or $a_i \, I \, a_{i+1}$.(see Jacquet-Lagreze and Siskos, 1982 or Siskos, 1980).

$$[\min]F, \quad F = \sum_{i=1}^{k} (\sigma^+(a_i) + \sigma^-(a_i))$$

s.t.

If $a_m \, P \, a_{m+1}$

$$\sum_{i=1}^{n} p_i u_i[g_i(a_m)] + \sigma^+(a_m) - \sigma^-(a_m) - \mathbf{Z_{minm}}[\sum_{i=1}^{n} p_i u_i[g_i(a_{m+1})] + \sigma^+(a_{m+1}) - \sigma^-(a_{m+1})] \geq 0_r$$

$$\sum_{i=1}^{n} p_i u_i[g_i(a_m)] + \sigma^+(a_m) - \sigma^-(a_m) - \mathbf{Z_{rmaxm}}[\sum_{i=1}^{n} p_i u_i[g_i(a_{m+1})] + \sigma^+(a_{m+1}) - \sigma^-(a_{m+1})] \leq 0$$

If $a_m \, I \, a_{m+1}$

$$\sum_{i=1}^{n} p_i u_i[g_i(a_m)] + \sigma^+(a_m) - \sigma^-(a_m) - [\sum_{i=1}^{n} p_i u_i[g_i(a_{m+1})] + \sigma^+(a_{m+1}) - \sigma^-(a_{m+1})] = 0$$

for m=1 , 2, ..., k-1

$\sum_{i=1}^{n} p_i = 1$, $p_i \geq 0$, For i=1, 2,..., n,

$\sigma^+(a_j) \geq 0$, $\sigma^-(a_j) \geq 0$, for j = 1,2, ..., k

Also, the same modifications are embedded in the post optimality analysis where 2n Linear programs are solved and the weights of every criterion p_i is maximized and minimized with one more condition concerning the summation of the over-under-estimation errors.

3. ILLUSTRATION EXAMPLE

For the illustration of the method a real world example will be used concerning a previous published research work for the job evaluation (Spyridakos et al, 1999). In this case the UTA II method and the system MIIDAS (Siskos et al, 1999) was used. In the original case study a reference set of 13 alternatives was used from the total set of 26 alternatives actions evaluated into 6 criteria and concludes to the estimation of an additive value preference models with quite high ASi Index equal to 0,85. For the illustration of the proposed approach 6 alternatives of the reference were selected of the original reference and the same ranking was used. Also, the same marginal values with the original case were used. Table 1 includes the alternatives action of the limited reference, the ranking and the evaluation of the alternatives on the family of the criteria.

Table 2 Reference Set

Alternative Actions	RANKING	cr1	cr2	cr3	cr4	cr5	cr6
p-3	1	15	1	5	5	3	4
p-7	2	17	2	5	3	5	5
p-22	3	16	2	3	5	4	4
p-10	4	16	3	4	3	3	5
p-18	5	14	1	3	4	4	4
p-19	6	13	3	2	2	2	2

The pair wise comparison of the 5 pairs of the successive alternatives of the reference provides the following ranges for the Z indices which are presented in Table 2.

Table 2 Value ranges of the Z indices expressing the SoP

Pairs of Successive Alt. Actions	Zmin	Zmax
p-3 , p-7	1,15	1,2
p-7 , p22	1,25	1,3
p-22 , p-10	1,3	1,4
p-10, p-18	1,1	1,25
p-18, p-19	2,1	2,9

The adaptation of the UTA II linear Programme was used for the estimation of the additive value model and the post optimality analysis. The minimum, maximum and the barycenter of the weights of the criteria estimated by the post optimality analysis are presented in table 3. Also in table 4 the same results concerning the weights of the criteria are presented using only the ranking of the six alternatives of the reference set.

Table 3 Minimum - Maximum - Barycenter of the estimated weights utilising the SoP into L.P.

	cr1	cr2	cr3	cr4	cr5	cr6
BaryCneter	0,075993	0,074528	0,406023	0,294351	0,139063	0,010043
Min	0,000000	0,000000	0,350237	0,268765	0,103751	0,000000
Max	0,169559	0,207470	0,465382	0,313665	0,173528	0,038799

Table 4 Minimum - Maximum - Barycenter of the estimated weights using only the Ranking.

	cr1	cr2	cr3	cr4	cr5	cr6
Barycenter	0,128534	0,128336	0,315520	0,238845	0,094883	0,093882
Min	0,000000	0,000000	0,028807	0,137466	0,000000	0,000000
Max	0,664687	0,602563	0,719275	0,480992	0,309132	0,729244

The examination of the above estimated preference models shows the utilsation of the proposed approach. First the ASI index for the preference model estimated using Sop is 0,8909 wjhile for preference model estimated using only ranking is 0,47. Also, this robustness is higher from the orginal case where 13 alternatives were used in the reference set utilising only ranking. Also, using visual techniques and ranges of values for the identification of the Z indices expressing the SoP were quite easy to be acquired by the DM providing flexibility withoout the need to use well populted reference set.

4. CONCLUSIONS

The proposed methodological approach for the acquisition of DM's SoPs and utilisation n UTA methods has advantages and disadvantages. The main advantages is that this approach can be used in cases with limitation to the numbers of alternative actions in the reference set and the capability to lead to additive value models with higher robustness. The disadvantages are related to the complexity raised in cases with a large numbers of alternatives into the reference. The use of the indices Z make difficult and tiring to interact with the DM and arguments can be emerged concerning the quality and the precision of the preferential information acquired.

The prosposed method can be used: a) for the direct assessment of the additive value models in cases with limitations to the number of alternatives used into the reference set and b) in cases where the estimated additive value models presents low robustness. In the latter case this approach can be used as a new feedback for the increasement of the robustness. Using the SoP in some of the pairs of allternatives can enrich the Linear Programme and so to lead to preference models of higher robustness.

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Distributed model predictive single wagonload control

Miloš Milenković
Zaragoza Logistic Center, C/Bari 55, Edificio Náyade 5, 50197 Zaragoza, Spain & The Faculty of Transport and Traffic Engineering, University of Belgrade, Vojvode Stepe 305, 11000 Belgrade, Serbia

Susana Val
Zaragoza Logistic Center, C/Bari 55, Edificio Náyade 5, 50197 Zaragoza, Spain

Nebojša Bojović
Division for Management in Railway, Rolling stock and Traction, The Faculty of Transport and Traffic Engineering, University of Belgrade, Vojvode Stepe 305, 11000 Belgrade,

Abstract

Single wagonload transport is one of the essential components of rail freight transportation system. However, on many European railways single wagonload transport faces with profitability and quality issues and has difficulties to keep pace with changing market requirements. This paper considers cooperative single wagonload transport planning between rail freight operators in different and interconnected service networks. Cooperative planning approach is based on Distributed Model Predictive Control (DMPC) for managing the freight wagon flows by a number of rail freight operators in their subnetworks in order to minimize the total freight wagon management cost. Augmented Lagrangian formulation of the planning problem is decomposed into sub problems cooperatively solved by rail freight transport operators. A case study illustrates the potential of the proposed cooperative planning approach.

KEYWORDS

Single wagonload transport, railway, distributed model predictive control

1. INTRODUCTION

Single wagonload (SWL) transport represents very complex railway market segment where a number of different factors confluence making the SWL service more or less competitive. Besides some less controllable factors like the decrease of transport volumes on relevant markets or imperfect regulative policy, poor utilization of freight wagons represents one of the most important controllable factors which leads to low service quality - low reliability and flexibility, high lead time and cost of the service and consequently to low customer satisfaction. Developing and full utilization of IT supported rail freight wagon management approaches may change this situation and significantly improve the current status of SWL service.

A number of approaches for freight wagon management has been proposed in previous period. Dejax and Crainic (1987), Cordeau et al. (1998) and Milenkovic et al. (2015) made an extensive assessment of optimization techniques for rail freight wagon management problem. In this paper the rail freight wagon allocation problem is solved by applying the distributed model predictive control. The overall optimization problem is divided into subproblems which consider the freight wagon allocation decisions on their own territory. Each decision making unit or controller solves its own local problem using the model covering only its part of railway network. Local problems are solved using the model predictive control (MPC). These regional decision making units or controllers are mutually connected by interconnecting links - railway lines on which the empty and loaded freight wagon flows between regions are interchanged. That means that the local problems are not isolated but depend on the solution of the MPC problem of the surrounding controllers. For the purpose of cooperative distributed model predictive control solving the Augmented Lagrangian relaxation method is applied. Each of the problems considers homogeneous freight wagon fleet. The demand is considered to be deterministic. The paper is organized as follows. The second chapter contains

detailed problem description, model formulation and solution mechanism. Numerical experiments in third chapter contain validation of proposed approach. The fourth chapter is devoted to concluding remarks.

2. DISTRIBUTED MODEL PREDICTIVE CONTROL APPROACH FOR SINGLE WAGONLOAD TRANSPORT PLANNING

Freight wagon system represents a large scale system composed from a number of interacting subsystems. More specifically, railway network is divided on regions and each region can be further divided into districts. Freight wagon flows are managed by local agents (controllers) responsible for efficient freight wagon management. Despite the development of operations research and high speed computers it can be difficult to control these subsystems with a centralized control structure. Besides computational complexity, there are also issues related to reliability of data exchanged and communication limitations. On the other side, in completely decentralized control there is a problem of control and lack of interaction leading to suboptimal freight wagon control actions. Solution in this case may represent a cooperative distributed control where local agents (controllers) optimize flows on their subnetworks having some knowledge on the freight wagon flows from other subsystems. This solution is also aligned with cooperative strategies for improving the SWL market segment on EU railway market.

2.1 Problem description

Cooperative freight wagon planning can be established between a set of railway operators N_{sub} in a railway transport network $M(N,L)$, where $N = \bigcup_{s=1,\dots,N_{sub}} N_s$ and $L = \bigcup_{s=1,\dots,N_{sub}} L_s$ represent all stations and railway lines on considered rail network. Every railway operator controls freight flows on its subnetwork which does not contain common nodes and links with any other subnetwork, $N_s \cap N_k$, $L_s \cap L_k$, $\forall s,k = 1,\dots,N_{sub}$. Railway subnetworks mutually interact through interconnecting lines. Railway operator s plans freight wagon flows on subnetwork s by solving the optimal freight wagon allocation problem over P periods of the planning horizon:

$$J_s = \frac{1}{2} X_s(P)^T \Gamma_s(P) X_s(P) + \frac{1}{2}\sum_{n=0}^{P-1} [X_s(n), U_s(n)]^T \left[\begin{array}{c|c} A_s(n) & L_s \\ \hline L_s^T & B_s \end{array}\right] \begin{bmatrix} X_s(n) \\ U_s(n) \end{bmatrix} \tag{1}$$

subject to system dynamics and planning constraints:

$$X_s(n+1) = F_s(n) X_s(n) + G_s U_s(n) + \Phi_s d_s(n), \quad n = 0,1,\dots,P-1 \tag{2}$$

$$D_s X_s(n) \le K_s \tag{3}$$

$$X_s(n), U_s(n) \ge O \tag{4}$$

Objective functional and constraints are derived from linear discrete time rail freight wagon fleet sizing and allocation model developed by Milenkovic et al. (2015). Objective functional (1) minimizes quadratic costs of owning and distributing empty and loaded freight wagons on a considered subnetwork. First term represents the cost of freight wagon system for the last period P and the second is the sum of costs over $P-1$ periods of planning horizon. Constraint (2) represents dynamic model of the system. It incorporates following state and unmet demand relations:

$$\begin{aligned} S_{is}(n+1) = S_{is}(n) &+ \sum_{j=1}^{N} \sum_{m<n+1} (F_{jis}(m) \cdot \theta_{jis}(m,n+1) + E_{jis}(m) \cdot \alpha_{jis}(m,n+1)) \\ &- \sum_{j=1}^{N} (F_{ijs}(n+1) + E_{ijs}(n+1)) \end{aligned} \tag{2.1}$$

$$V_{ijs}(n+1) = V_{ijs}(n) + D_{ijs}(n+1) - F_{ijs}(n+1) \tag{2.2}$$

Relations (2.1) are conservation of flow constraints for freight wagons at each station in each time period which include the effects of travel times for wagon movements through the θ and α terms. Relations (2.2) ensure that all demand is accounted for. Station capacity constraints limit the number of freight wagons in

each station (3). For each period $n=0,1,...,P-1$ control actions and system state are assumed to be nonnegative (4).

2.2 Cooperative model predictive control for freight wagon flow planning

Every railway operator employs model predictive control to determine which actions to take. Optimal actions for each subnetwork are determined over a prediction horizon of P time steps according to objective functional subject to a model of the subsystem as well as behavior of the surrounding railway systems and additional constraints. Therefore, the cooperative freight wagon planning can be formulated as following cooperative model predictive control problem:

$$\min \sum_{s=1}^{N_{sub}} J_s(X_s(n+1),U_s(n),d_s(n)) \tag{5}$$

for $s=1,...,N_{sub}$ subject to

$$X_s(n+i+1)=F_s(n)X_s(n+i)+G_sU_s(n+i)+\Phi_s d_s(n+i), \quad \mathrm{i}=0,1,...,P-1 \tag{6}$$

$$\overline{D}_s\overline{X}_s(n)\le\overline{K}_s \tag{7}$$

$$\overline{X}_s(n),\overline{U}_s(n)\ge O \tag{8}$$

$$\overline{v}_{in,s}(n)=\overline{K}_{in}(s)\overline{U}_s(n) \tag{9}$$

$$\overline{v}_{out,s}(n)=\overline{K}_{out}(s)\overline{U}_s(n) \tag{10}$$

$$\overline{v}_{in,k,s}(n)=\overline{v}_{out,s,k}(n),\ \forall k\in N_s^{nei} \tag{11}$$

Objective functional (5) integrates total costs of owning and distributing empty and loaded freight wagons over the entire cooperative freight wagon network. Equation (6) represents the dynamics of subnetwork s. Inequality (7) is a station capacity constraint within each subnetwork s. $\overline{D}_s$ and $\overline{K}_s(n)$ represent matrices that contain lengths of freight wagons and capacity of each station for whole prediction horizon P. Network state and control vectors over the prediction horizon are denoted as $\overline{X}_s(n)=[\overline{X}_s(n),...,\overline{X}_s(n+P)]^T$ and $\overline{U}_s(n)=[\overline{U}_s(n),...,\overline{U}_s(n+P-1)]^T$ respectively. Non negativity of state and control actions is stated in constraints (8). Constraints (9) and (10) represent input and output loaded and empty freight wagon flows on interconnecting railway links in the model predictive control problem of operator s. Input and output loaded and empty freight wagon flows on interconnecting lines for subnetwork of operator s with respect to operator $k\in N_s^{nei}$ in the prediction horizon P are represented as $\overline{V}_{in,s}(n)=[V_{in,s}(n),...,V_{in,s}(n+P-1)]^T$ and $\overline{V}_{out,s}(n)=[V_{out,s}(n),...,V_{out,s}(n+P-1)]^T$ respectively. $\overline{K}_{in}(s)$ and $\overline{K}_{out}(s)$ represent zero-one matrices aimed to select input and output empty and loaded freight wagon flows on interconnecting links between neighboring subnetworks for the prediction horizon. Constraints (11) represent interconnecting constraints between freight wagon flows that enter or leave subnetwork s from or to its neighboring subnetwork k.

2.3 Distributed model predictive freight wagon flow control

Coupling constraints (11) are related to neighboring subnetworks and thus prevent independent problem solving by the operators. Therefore, the solution of MPC problem for one network depends on the solution of the MPC problem of surrounding MPC controllers. That means that MPC problems of the controllers have to be solved in a cooperative way by enabling communication between railway operators. Solution scheme for this problem is obtained by parallel augmented Lagrangian relaxation algorithm which represents a combination of augmented Lagrangian formulation and auxiliary problem principle (Li et al., 2016). In the first step interconnecting constraints are relaxed and added to the objective functionals of different controllers:

$$\min_{u_s(n),s=1,...,N_{sub}} J_s(x_s(n+1),u_s(n),d_s(n))+\sum_{k=1}^{N_s} J_{\mathrm{inter},k}(\overline{v}_{in,k,s}(n),\overline{v}_{out,s,k}(n),\lambda_{in,k,s}(n)) \tag{12}$$

$J_{\mathrm{inter},k}$ is the cost associated with coordination between controllers s and k:

$$J_{\mathrm{inter},k}=\lambda_{in,k,s}^T(n)(\overline{v}_{in,k,s}(n)-\overline{v}_{out,s,k})+\frac{\theta}{2}\left\|\overline{v}_{in,k,s}(n)-\overline{v}_{out,s,k}(n)\right\|_2^2 \tag{13}$$

Where $\lambda_{in,k,s}(n)$ and θ represent Lagrangian multipliers related to interconnecting constraints and the penalty parameter. However, this formulation contains non-separable quadratic term involving the difference between input $\bar{v}_{in,k,s}(n)$ and output $\bar{v}_{out,s,k}(n)$ empty and loaded rail freight wagon flows between subnetworks. For this purpose parallel DMPC scheme based on auxiliary problem principle for decoupling quadratic terms in augmented Lagrangian is applied. Auxiliary problem principle enables simultaneous solving a sequence of auxiliary problems by all operators. Operators solve problem (12) using the following additional objective functional term for interconnecting constraints:

$$J_{\text{inter},k} = \lambda_{in,k,s}^{T}(n)(\bar{v}_{in,k,s}(n) - \bar{v}_{out,s,k}) + \frac{\theta}{2}\left\|\begin{bmatrix} \bar{v}^{\ell}_{in,s,k}(n) - \bar{v}_{out,k,s}(n) \\ \bar{v}^{\ell}_{out,s,k}(n) - \bar{v}_{in,k,s}(n) \end{bmatrix}\right\|_2^2 + \frac{\upsilon - \theta}{2}\left\|\begin{bmatrix} \bar{v}_{in,k,s} - \bar{v}^{\ell}_{in,s,k}(n) \\ v_{out,k,s} - \bar{v}^{\ell}_{out,k,s}(n) \end{bmatrix}\right\|_2^2 \tag{14}$$

ν represents positive scalar.

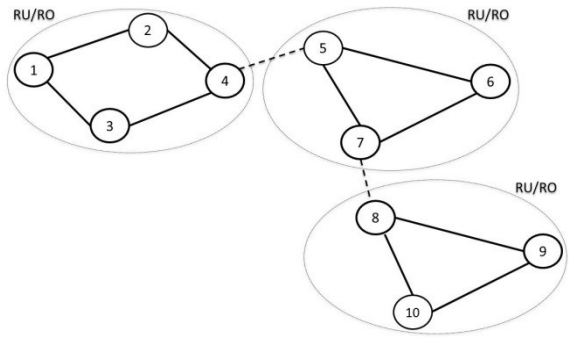
Distributed MPC algorithm can be summarized as follows:

1. For time interval n, every operator s assess current state of the rail freight wagon subsystem $x_s(n)$ and estimates the expected disturbance $d_s(n)$ for $n = 0,\ldots,P-1$.
2. Initialization phase includes setting the iteration counter ℓ to 1 and initializing Lagrange multipliers, control actions and interconnecting variables.
3. Iteration process includes simultaneous optimization of local MPC problem (12) subject to subnetwork dynamics and planning constraints (6)-(11). Adjacent controllers send $\bar{v}^{\ell}_{in,k,s}(n)$ and $\bar{v}^{\ell}_{out,k,s}(n)$ receive $\bar{v}^{\ell}_{in,s,k}(n)$ and $\bar{v}^{\ell}_{out,s,k}(n)$.
4. Operators update Lagrange multipliers using following expression:
   $\lambda^{\ell+1}_{in,k,s} = \lambda^{\ell}_{in,k,s} + \upsilon(\bar{v}^{\ell+1}_{in,k,s}(n) - v^{\ell+1}_{out,s,k}(n))$
5. The distributed MPC iterations terminate when $\left\|\lambda^{\ell}_{in,k,s} - \lambda^{\ell-1}_{in,k,s}\right\|_\infty \le \varepsilon$, where ε is a specified tolerance and $\|\cdot\|_\infty$ denotes the infinity norm.
6. The output: $\bar{u}_s, v^{\ell}_{in,k,s}(n), v^{\ell}_{out,k,s}(n), \lambda^{\ell}_{in,k,s}, s = 1,\ldots,N_{sub}, k \in N_s^{nei}$. Controllers implement freight wagon actions until the beginning of the next planning period.
7. The next time period is started.

3. NUMERICAL EXAMPLE

This section describes an application of proposed cooperative freight wagon planning model. On a considered railway network three operators cooperatively manage freight wagon allocation problem. Railway network consists of ten railway nodes that belong to three subnetworks in each of which a railway undertaking (RU) or railway operator (RO) manages railway freight transport services (Figure 1.).

Figure 1 Railway network



Rail freight operations are performed by one freight wagon type. The planning horizon is composed from $P=4$ days where each day represents one decision period.
Centralized planning involves a QP optimization problem given by objective functional (5) and linear dynamic constraints (6)-(8) which is solved using the interior-point-convex algorithm (MathWorks Inc., 2012). In the next phase we applied DMPC approach for cooperative freight wagon planning. Experiments are performed with a laptop computer with an Intel® Core i7-5600 CPU with 2.60 GHz and 8GB RAM.
The total freight wagon planning cost obtained on centralized level is 7.03×10^6. Proposed distributed MPC approach obtains the same total delivery cost. Required fleet of freight wagons is 412. However, DMPC approach differs from centralized in terms of communication cost and computation time. The total number of iterations and total communication cost per period in planning horizon are given in next table (Table 1).

Table 1 Distribution costs, communication costs and computational time of DMPC approach

DMPC	Cost of loading and empty freight wagon allocation	Period	Total communication cost per period			Computation time (min) per period
			$N_{iteration}$	$I_{iteration}$	J_{cost} (floats)	
Operator 1	2.63×10^6					
Operator 2	2.39×10^6	1	13322	256	3.41×10^6	36.50
Operator 3	2.01×10^6	2	4524	256	1.15×10^6	9.03
Total	7.03×10^6	3	9974	256	2.55×10^6	20.59

In order to illustrate the cooperative process of the distributed freight wagon model predictive control we present the evolution of the differences between interconnecting variables. These variables denote empty and loaded freight wagon flows between subnetworks 1 and 2 in the first planning period. Figure 2 shows the evolution of the differences between the output interconnecting variable of operator 1, $v^l_{out,2,1}(m+n)$ and the corresponding input interconnecting variable of operator 2, $v^l_{in,1,2}(m+n)$, for period $m=1$ over a prediction period $n=1,\ldots,P-1$. Figure 3 presents the evolution of Lagrangian multipliers associated with interconnecting variables $v^l_{in,1,2}(m+n)$ and $v^l_{out,2,1}(m+n)$ for time interval $m=1$. Maximum allowed computation time for operators is 60 min. Cooperation parameters are $\theta=0.9$, $\nu=2\theta$ and $\delta=5\theta$ The iteration stopping threshold is $\varepsilon=10^{-3}$.

Figure 2 Evolution of the differences in interconnecting loaded flows between railway operator 1 and operator 2

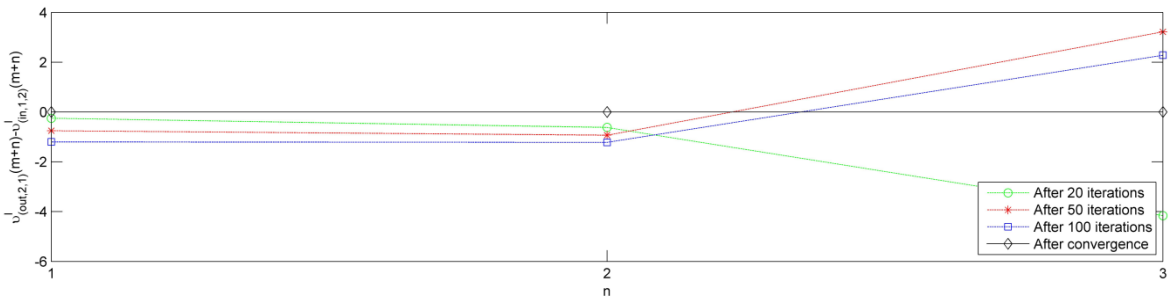
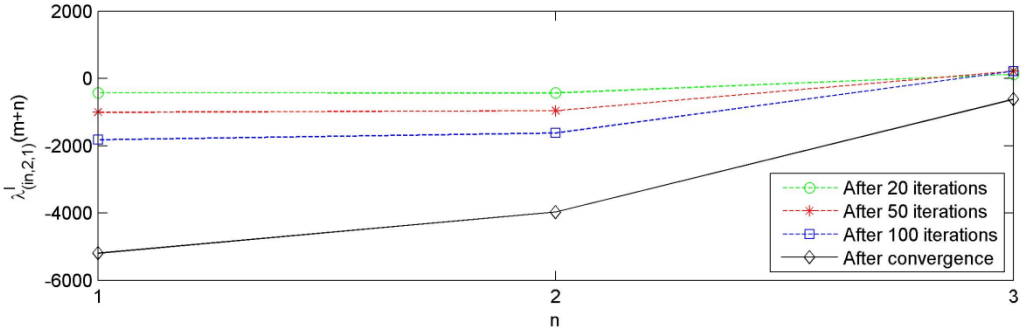


Figure 3 Evolution of Lagrange multipliers (loaded flows) for operator 1 for time interval $m=1$ over the whole prediction period $n=1,\ldots,P-1$



The control actions as well as the unmet demand are the same as control actions from centralized approach (Table 2).

Table 2 Control actions and unmet demand

Route	Period 1			Period 2			Period 3		
	Loaded flows $F_{ij}(1)$	Empty flows $E_{ij}(1)$	Unmet demand $U_{ij}(1)$	Loaded flows $F_{ij}(2)$	Empty flows $E_{ij}(2)$	Unmet demand $U_{ij}(2)$	Loaded flows $F_{ij}(3)$	Empty flows $E_{ij}(3)$	Unmet demand $U_{ij}(3)$
1-2	17.54	8.45	7.85	17.56	4.58	7.48	16.60	3.39	0.49
1-3	19.09	8.37	10.31	19.20	4.06	10.29	17.92	3.24	0.00
2-1	16.74	10.83	4.19	15.68	6.98	3.12	14.65	6.91	2.30
2-4	14.18	8.72	6.01	12.78	4.30	3.45	11.06	3.89	2.01
3-1	16.59	10.10	6.81	13.63	7.37	0.00	11.43	7.13	4.41
3-4	18.83	10.12	6.56	16.19	5.86	6.19	15.07	5.22	0.97
4-2	14.37	3.65	6.12	16.02	5.14	8.83	18.38	6.23	1.33
4-3	13.83	4.37	8.18	16.27	5.84	3.88	12.06	7.59	0.00
4-5	16.97	5.33	3.53	12.09	0.78	9.17	6.70	0.56	17.36
5-4	19.24	9.20	3.91	14.30	1.37	8.97	9.69	0.97	11.25
5-6	20.83	5.33	5.51	20.13	4.16	5.56	15.84	5.01	0.00
5-7	15.52	5.61	2.48	13.76	4.19	0.52	13.21	3.07	2.22
6-5	23.27	10.12	0.00	13.03	4.80	0.00	10.02	7.59	0.00
6-7	24.72	4.79	0.54	15.31	0.04	0.27	14.28	1.38	0.00
7-5	23.90	6.90	0.00	10.67	0.67	0.00	14.78	0.78	0.00
7-6	26.60	4.60	0.00	11.44	0.45	0.00	10.52	0.52	0.00
7-8	16.70	8.00	0.75	16.08	1.84	0.00	12.39	0.89	0.00
8-7	20.17	8.38	0.74	11.30	0.90	0.33	7.22	0.36	4.47
8-9	16.00	5.41	1.93	11.65	0.98	2.64	13.38	2.62	2.83
8-10	18.03	5.54	1.89	14.25	0.44	6.00	16.58	0.83	0.00
9-8	19.03	4.66	6.50	15.64	0.81	2.67	12.73	0.82	3.76
9-10	15.90	13.17	0.00	10.98	5.32	9.61	13.57	1.59	11.66
10-8	15.68	5.11	3.92	11.99	1.23	3.15	11.41	1.41	3.50
10-9	15.52	4.98	5.18	14.21	3.41	3.88	13.39	3.65	1.06

4. CONCLUSIONS

Efficient utilization of freight wagons contributes to decreased costs through improved utilization of trains, lower rail freight wagon fleet required and increased customer satisfaction through shorter transport times. In this paper we proposed a cooperative distributed model predictive control approach of a linear, dynamic, discrete time rail freight wagon fleet system which consists of coupled subsystems. Each of the cooperating controllers minimizes a quadratic objective functional subject to state, control and station capacity constraints. For the cooperative freight wagon planning problem considered it is concluded that the proposed approach attains the same cooperative performances as that of the centralized decision making. Proposed approach is also aligned with actual EU initiatives for recovering the single wagonload market segment.

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Vehicle Routing Problem for Urban Freight Transportation: A Review

Grigorios D. Konstantakopoulos
National Technical University of Athens, School of Mechanical Engineering, Sector of Industrial Management and Operational Research
mc12040@central.ntua.gr

Sotiris P. Gayialis
National Technical University of Athens, School of Mechanical Engineering, Sector of Industrial Management and Operational Research
sotga@central.ntua.gr

Ilias P. Tatsiopoulos
National Technical University of Athens, School of Mechanical Engineering, Sector of Industrial Management and Operational Research
itat@central.ntua.gr

Abstract

This paper presents a methodology for classifying the literature of the Vehicle Routing Problem (VRP) for urban freight transportation and a review of the latest bibliography. The fact that the variants of the VRP have grown and similarly have their practices and applications, made the VRP popular in the academic literature. Hence, the number of articles published, is constantly increasing and it is difficult to monitor developments. In this paper, after considering existing research papers, a review from Scopus scientific database is presented. The taxonomy of the last decade's literature of the VRP for urban freight transportation is given and critical insights are discussed. After the categorization of the articles, the trends of the VRP for urban freight transportation are featured and analyzed. This knowledge and analysis will be used in a research project in order to support through an algorithms approach, the functionality of a vehicle routing and scheduling information system, and lead to an operational solution.

KEYWORDS

Vehicle Routing Problem, Urban Freight Transportation, Literature Review

1. INTRODUCTION

Clarke and Wright (1964) [1] generalized the "Truck Dispatching Problem", which was introduced by Dantzig and Ramser (1959) [2], to the "Vehicle Routing Problem" (VRP). It is still encountered in our days, mainly in the domain of logistics and transport and it is one of the most widely studied topics in the field of Operational Research. In the VRP, *m* vehicles, with identical capacities (Q), initially located at a central depot, are to deliver discrete quantities of goods to *n* customers, which are geographically diffused around the central depot. Concurrently, the aim of the VRP, beyond serving customers, is to minimize the travelled distance.

Due to the difficulty the VRP presents and because of its practical applications, many models have been created for solving the problem and many variants of the basic VRP have been compiled, with different parameters, leading to a different structure of the basic VRP. Firstly, the classical VRP is equivalent to the Capacitated VRP (CVRP) in which, the capacity of the vehicle must not be exceeded [3]. However, there is another possibility, the vehicles do not have the same capacities which leads to the Heterogeneous Fleet VRP (HVRP).

Another important variant which was created a decade after the classical VRP (1969) was the Multi Depot VRP (MDVRP) in which, the company has several depots from which it can serve its customers, while the objective is still to service all customers and minimize the number of vehicles and distance travelled [4]. At the same period, the Stochastic VRP (SVRP) was created, where, the customers, the demand of each customer or service and travel times are random.

In addition, in the VRP with Pick-up and Delivering (VRPPD), goods are transported, not only from the central depot to customers, but in the opposite direction too. Hence, in VRPPD it is necessary to take into account that the total delivery load and the total pickup load should both fit into the vehicle [5]. Furthermore, due to

the need for specific arrival time information and for better customer services, an extra restriction to the VRP was added, time windows. The VRP with Time Windows (VRPTW) is the same with the classical VRP but constrained by a time interval within which the customers have to be supplied [6].
Another variant worth mentioning is the Dynamic VRP (DVRP) in which customer requests, that are trips from an origin to a destination, appear dynamically [7] or when data and information regarding to the VRP such as travel time, change dynamically. Another significant variant which takes into account time, is the Time Dependent VRP (TDVRP) in which travel times change as time passes. The reason why this happens is due to traffic congestion. The factors which affect travel times are: (i) the location, and (ii) the time of the day [8].
During the last decade, many researchers have tried, while solving the VRP, to minimize carbon (or fuel emissions) as carbon dioxide (CO_2) emitted by trucks is the main greenhouse gas. In addition, the Green VRP has been strengthened due to the technical developments and the road traffic information which allows planning vehicle routes and schedules and taking time-varying speeds into account [9], [10]. In the same field belongs the Hybrid VRP where vehicles can work both electrically and with traditional fuel [11].
VRP has numerous practical applications in the industry. Solving the vehicle routing problem can assist companies in reducing their costs, as a big part of a product's price originates from transportation. Companies are trying to adopt VRP software solutions with appropriate algorithms in order to reduce transportation costs, mileages and time spent while increasing customer services. Maybe the most challenging issue for companies is urban transportation, as traffic congestion often hinders the delivery of products on time. The scope of the paper is to review and categorize research papers in the field of VRP for urban freight transportation and to provide a methodology for the analysis of the VRP research field and the categorization of the research papers. The results and methodology of the review can assist researchers in studying the research field, as well as practitioners in understanding the various aspects of the VRP in order to support the design of software solutions.
In the remainder of this paper, we first record the papers which are related to the VRP for urban freight transportation through a specific research process in Section 2. Section 3, introduces the research methodology followed and presents the survey's main topics and some numerical results. In section 4, we feature the trends of the VRP since the present paper will be used as an analysis for a research project of a Vehicle Routing and Scheduling Information System.

2. RESEARCH PROCESS

The current paper followed a systematic literature review adopted from the work of [12], [13], [14] . After the need for a review is identified, a research protocol is appointed, selection and de-selection criteria defined, and then papers assessed and outcomes composed. It aims at an efficient and well recorded coverage which will include only necessary variants and may lead to potential developments and applications.
The Scopus database was used for an advanced search in accordance with Table 1. The aim of the present paper is to identify papers relevant to the VRP for urban freight transportation which will be analyzed for featuring the last decade's trends. Every paper will be studied thoroughly in order to achieve the right categorization which will lead to an established statistical analysis.

Table 3 Research Protocol

Research protocol	Title: set of "Vehicle Routing Problem" or "VRP"

Research variable	Description
Databases	Scopus: This is an international database, covering a wide range of peer-reviewed academic publications, estimated at 20.000.
Publication type	Peer-reviewed papers only: These represent work at a final stage of completion.
Language	English-only: This provides wide coverage, and there was no translation capacity
Data range	The limits were set from 2006 till the first quarter of 2017, in order to include papers published at least in the last decade
Search fields	Search terms were applied to Titles, Abstracts and Keywords only
Search terms	(TITLE-ABS-KEY("Vehicle Routing Problem" or "VRP" or "Vehicle Routing") AND PUBYEAR > 2006) AND ("urban freight transport*" OR "urban freight" OR "goods movement" OR "urban logistics" OR "city Logistics") AND (LIMIT-TO (SRCTYPE,"j ") OR LIMIT-TO (SRCTYPE,"k ") OR LIMIT-TO (SRCTYPE,"b ")) AND (LIMIT-TO (DOCTYPE,"ar ") OR LIMIT-TO (DOCTYPE,"ch ") OR LIMIT-TO (DOCTYPE,"re ") OR LIMIT-TO (DOCTYPE,"bk ")) AND (LIMIT-TO (SUBJAREA,"COMP ") OR LIMIT-TO (SUBJAREA,"ENGI ") OR LIMIT-TO (SUBJAREA,"DECI ") OR LIMIT-TO (SUBJAREA, "BUSI ")) AND (LIMIT-TO (LANGUAGE,"English "))
Deselection Criteria: Relevance to the research problem	The primary search terms are the phrases “Vehicle Routing Problem”, “VRP” and “Vehicle Routing”. After the first phase, the terms “urban freight transport”, “goods movement”, “urban logistics”, “urban freight” and “city logistics” are added, and the papers are limited to those whose subject area is Computer Science, Engineering, Decision Sciences or Business Management, excluding Mathematics as the paper is focused in information systems and not to mathematical formulations. The former queries are applied to acclaimed document sources such as Article, Book Chapter or Review and their Source type limited to Journal, Book Series or Books. The deselection criterion is relevant to the research question. Some papers are clearly irrelevant based on the title or the abstract while others are also deemed irrelevant after a more thorough review, as they refer to waste collection, cash in transit, truck and trailer, battery swap stations, location routing, food distribution and parcels and documents. For the remaining papers, the full text was reviewed in order to achieve a detailed categorization.

The full list of papers extracted from the Scopus database, applying the search terms of Table 1 can be found in the following link (178 papers): https://goo.gl/1eRBfw

Following the described process 111 documents are selected and categorized according to the methodology proposed in the following section. This methodology produces a credible and essential data to an upcoming research project about VRP systems for urban freight transportation.

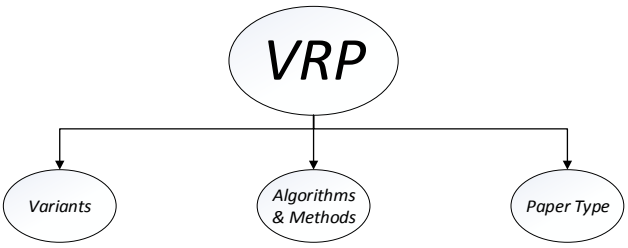
The final list of papers presented in this literature review, after the application of deselection criteria of Table 1 can be found in the following link (111 papers): https://goo.gl/yoVrKQ

3. METHODOLOGY AND RESULTS

The VRP is a largely analyzed problem, which finds significant application in urban freight transportation. The delivery of products from distribution centers to several drop points within the cities, face difficulties such as traffic congestion, which lead to delays in the scheduled routes of vehicles. Hence, companies are seeking for software and systems which can reduce or ideally eliminate the obstacles, and schedule reliable routes, taking simultaneously more than one parameters of the classical VRP into account. Besides software solutions, mainly research papers propose and develop algorithms for solving specific variants of the VRP, without offering complex solutions. The evaluation, primarily of software and secondarily of individual algorithms, is important to be implemented through case studies as they help in understanding real systems and taking reliable outcomes.

Consequently, the conducted survey will be exhibited in 3 dimensions. The first dimension includes the various variants of the VRP, the second dimension consists of the algorithms used for the solution of the different variants of the VRP and the third dimension, the paper type.

Figure 1 Methodology for studying the VRP Research Field



The above three dimensions are appropriate for a systematic analysis of the research field of the VRP, in cases of applied projects for the design of specifications of VRP software, its development and implementation. Software solutions for VRP usually need adaptation and additional development in order to meet a specific company's needs. The proposed methodological approach and the research results can assist such projects in defining the VRP, selecting appropriate algorithms and assessing the suitability of applied methods in similar cases. The three dimensions of the methodological approach are described in the following sections.

3.1 VRP Variants

Firstly, besides the VRP variants presented in the introduction, which are the most common, there are few more that have not yet been presented. The Two-Echelon VRP, originating from the Multi-Echelon VRP, involves two levels of routing problems, as satellites are supplied from the depot and the customer demands are transported from satellites. This problem is similar to the VRP with Satellite Facilities (VRPSF) [15].
A VRP which is interesting, especially for city logistics, is the Multi-Trip (MTVRP), where each vehicle can go back to the depot, be reloaded and commence another trip, making several trips during the working day [16].
A very important variant which is close to the TDVRP is the Real-Time VRP where a re-optimization procedure runs in order for new routes to be identified, every time, travel time between a pair of nodes is updated [17]. Furthermore, Real-Time Traffic Data can be used to develop routing strategies that tend to minimize the time spent due to traffic congestion and consequently costs, while maximizing customer services [18].
In the Periodic VRP (PVRP) a set of customers has to be visited on a given time horizon, once or several times [19]. In the Split Delivery VRP (SDVRP), the assumption that a customer must be visited by one vehicle only is relaxed and the objective is still to find the routes which minimize the cost [20]. Finally, the Open VRP differs from the classical VRP, as vehicles are not required to return to the depot after the end of the route [21].

3.2 Solution Methods

Many researchers have faced most of the presented VRP variants in search of a solution. The methods they propose are Heuristic, Metaheuristic, Exact and Simulation. Exact optimization methods may guarantee finding an optimal solution but due to the fact that the VRP is an NP Hard Problem only a few problems can be solved. On the contrary, heuristic and metaheuristic optimization methods may not guarantee that an optimal solution is found, but they provide an adequate solution that guides the search for the immediate goals, in less time [22]. Simulation methods, use what-if analyses, for generating multiple scenarios, selecting the best one and using these in the main algorithms [12].

3.3 Paper Type

Besides the VRP variants and the kind of methods researchers present, it is important to estimate the number of papers (i) conducting a literature review or survey which means broader theoretical knowledge, (ii) the papers proposing and developing algorithms or even these which describe or present another existing algorithm or any other solution, (iii) the papers which have computational results and test data and (iv) the papers which present or work on software and systems which is a focal point in our research.

3.4 Research Results

According to the categorization of 111 papers, the CVRP proves to be the most common variant of the VRP, followed by the VRPTW. Many of the other VRP variants have lately been studied such as the Green and Hybrid VRP due to the need for minimization of carbon and fuel emissions or the TDVRP, the DVRP and the Real Time VRP, where new technologies offer better feasible solutions. In the research of [14], conducted for articles published till the middle of 2015, it is crucial to stress that the MEVRP and the VRPSF were not included, but have since attracted research interest. Other VRP variants such as the VRPTW, the MDVRP, the SVRP and HVRP are producing similar results.

Table 4 VRP Variant

Variant	Number of articles (Total = 111)	Relative Percentage
Capacitated VRP	47	42.24%
VRP with Time Windows	42	37.84%
Green and Hybrid VRP	27	24.32%
Time Dependent VRP	21	18.92%
Multi Echelon VRP and VRP with Satellite Facilities	15	13.51%
Multi-Depot VRP	11	9.91%
Stochastic VRP	10	9.01%
Dynamic VRP	9	8.11%
VRP with Heterogeneous Fleet	9	8.11%
Multi-trip VRP	8	7.21%
Real-Time VRP and VRP with Real-Time Data	8	7.21%
Pickup and Delivery VRP and VRP with Backhauls	7	6.31%
Periodic VRP	3	2.70%
Split Delivery VRP	2	1.80%
Open VRP	1	0.90%

In Table 3, the proposed methods are presented, indicating that Heuristic and Metaheuristic algorithms are used more often to find optimal solutions. Exact methods are developed less often due to their computational complexity while simulation methods are also less common in the literature. It is a logical outcome that heuristic and metaheuristic methods are used more often than the rest of the methods, mainly because the VRP is an NP Hard Problem. It should be noted the sum of Relative Percentages does not equal 100% due to the fact that many of the examined papers do not propose any solution but conduct a review or a survey.

Table 5 Applied Methods

Applied Method	Number of articles (Total = 111)	Relative Percentage
Heuristic	41	36.94%
Metaheuristic	30	27.03%
Exact	5	4.50%
Simulation	5	4.50%

In Table 4, the correlation between VRP variants and solution methods are presented. It is obvious that the two most common VRP variants, CVRP and VRPTW, are solved primarily with heuristic methods and secondarily with metaheuristic methods. On the other hand, the TDVRP and the Green and Hybrid VRP, which have been studied mostly over the last decade, are more often solved with metaheuristic approaches. This means that a trend seems to be developing for the application of metaheuristic methods in solving the VRP. In regards the simulation method, it is used mainly in the calculation of travel times, which is an important parameter for solving most of the VRP variants.

Table 6 VRP Variants - Solution Methods

Variant	Heuristic	Metaheuristic	Exact	Simulation
Capacitated VRP	20	12	3	2
VRP with Time Windows	20	11	1	3
Green and Hybrid VRP	5	8	0	1
Time Dependent VRP	5	6	0	0
Two Echelon VRP and VRP with Satellite Facilities	8	4	2	1
Multi-Depot VRP	4	4	0	1
Stochastic VRP	3	1	0	2
Dynamic VRP	3	0	0	0
VRP with Heterogeneous Fleet	3	4	0	0
Multi-trip VRP	4	2	1	1
VRP with Real Time Traffic Data	2	0	0	0
Pickup and Delivery VRP and VRP with Backhauls	3	3	0	0
Periodic VRP	2	1	1	0
Split Delivery VRP	2	1	0	1
Open VRP	0	1	0	0

Most papers deal with more than one variants of the VRP each time. Hence, when the author of each paper solves a specific VRP with multiple variants, we consider that the method applied, solves all these variants. That is the reason why in Table 4, the sum of each method differs from the data in Table 3.
Table 5, indicates that most papers present Computational Results or Test Data due to the fact that a significant percentage of papers are relevant to Algorithms (whether they Propose/Develop or Present/Describe Algorithms), Case Studies and Real World Industrial Examples. Many Algorithms, and especially those who are proposed and developed, find application and tested in case studies, in order to be evaluated and draw conclusions from real problems. Furthermore, in many papers, time and traffic data of cities are received and are used in companies, in order to test and decide if the software and algorithm solutions they use are trustworthy. Literature Reviews or Surveys follow, as many researchers approach the VRP through a theoretical viewpoint. Finally, Software or Systems are rare, as few researches lead to such applications.

Table 7 Paper Type

Paper Type	Number of articles (Total = 111)	Relative Percentage
Computational Results or Test Data	80	72.07%
Propose/ Develop Algorithm or Present/Describe Algorithm	59	53.15%
Case Study & Real World Industrial Examples	27	24.32%
Literature Review or Survey	22	19.82%
Software or System	5	4.50%

4. CONCLUSION

A considerable number of papers have been written about the VRP for urban freight transportation, analyzing many different variants of it. Accordingly, many methods have been proposed for solving all the VRP variants. However, few research projects for the VRP have led to the real-life application of Decision Support Systems (DSS) or other Management Systems (MS). The papers of [21], [22] and [23] refer to Vehicle MS and DSS that endorse logistics managers by monitoring the status of deliveries in real time and suggesting optimal re-routing strategies whenever needed due to uncontrollable external events that cause perturbations in the schedule. The paper of [26] presents a model which evaluates software products through the Total Performance/Price criterion and proposes the proper solution as the selection of these systems has become increasingly difficult for decision makers due to a large number of software products available and the great variety of features and capabilities they offer. There are systems which are based on GIS (Geographical Information Systems) such as the [27], which is also reporting the need for ITS (Intelligent Transportation

Systems), offering the confrontation of high costs and environmental impact which is important especially in urban areas. Due to the need for lower costs, lower carbon emissions and higher customer services, DSS and MS can lead to sufficient and feasible solutions. This paper presents the results of an extensive literature review of the VRP for urban freight transportation. This review offers a summary of the latest knowledge of this research field and it can enhance the adaptation of appropriate methods in software solutions for freight transportation in cities.

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Wind Farms Suitability Analysis Using TOPSIS and VIKOR Approaches: A Case Study in Thrace Region

Vavatsikos[1], A.P Anastasiadou[2], E.V.
[1]Civil Engineer, PhD, Lecturer, e-mail: avavatsi@pme.duth.gr
Democritus University of Thrace, School of Engineering, Production and Management Engineering Dpt, 12 Vas. Sofias st., Xanthi, Greece
[2]Postgraduarte student, e-mail: anast.eirini@gmail.com
Technical University of Crete, School of Production Engineering and Management

Abstract

Wind farms siting can be considered as a Multi Criteria Decision Making problem that consists of set of alternative locations and set of selection criteria. As a result the implementation of multicriteria decision analysis frameworks to the spatial context can significantly support strategic spatial planning. Granted that the rapid increase of fossil fuels consumption resulted to the release of tremendous amounts of greenhouse gases and the rapid depletion of them, many countries as well as the European Union are implementing policy frameworks to support sustainable development. The use of renewable energy sources instead of the conventional ones is in the core of policy actions and consists a field of great priority nowadays. Due to integral role of renewable energy sources in future energy consumption much research emphasis has to put in enabling the implementation of these technologies. However, it is recognized that renewable energy resources are not fully environmentally safe granted that they are associated with a variety of environmental impacts. Recent experience highlights that as major disadvantage the fact that they are not available at every geographic location. Moreover their implementation is more favorable at remote locations that often are of high ecological value. Thus, identification of preferable locations for the establishment of renewable energy system is a decision-making problem that requires evaluation of the available land in relation with economic and environmental limitations.
The paper at hand presents a framework that examines both criteria and the constraints implementation into the wind farms site suitability problem. Both criteria and constraints form an objectives tree through their classification into three main criteria categories which namely are: environmental, socio-economical and design considerations. At the first step absolute suitability analysis aims to identify candidate siting locations that satisfy all the examined constraints by performing Boolean operators. Then relative suitability analysis is implemented in order to rank efficient locations using suitability measures in GIS environment. The proposed analysis is presented throughout a real case study in Eastern Macedonia and Thrace region, while multicriteria evaluation is implemented using TOPSIS and VIKOR decision models.

KEYWORDS

Suitability Analysis, GIS, TOPSIS, VIKOR, Wind Farms

1. INTRODUCTION

Spatial planning is a complex issue in which the decision makers and planners often are not fully aware of the range of factors involved or the implications of each. Sometimes, it is not until after generating a proposed solution that unforeseen consequences become perceptible or evident and that a reconsideration of the process that generated this solution becomes necessary (Simão et al., 2009). Given that wind plants siting involves spatial implications, planners must design projects and plans that maintain an ecological equilibrium but nevertheless contribute to economic growth (Hansen, 2005). Moreover, the extensive spatial diffusion of wind farm plants introduces the need for ensuring social acceptance of this technology (Höfer et al., 2016). Granted that wind farm site selection is the most important decision in the development of a wind farm it should be accomplished taking into account technical, environmental, and economical restrictions (Noorollahi et al., 2016). However, standard exclusion approaches using Boolean overlays are incapable of providing a scaling grade of suitability since all sites are considered equally suitable for the utilization of wind energy (Höfer et al., 2016). Multi-Criteria Decision Analysis evaluation methods can provide tools for

analyzing the complex trade-offs between choice alternatives with different environmental and socio-economic impacts (Hansen, 2005). When combined with Geographical Information Systems (GIS) MCDA enrich traditional geographical analysis with strategic planning capabilities for siting new wind plant facilities (Domínguez & Amador, 2007).

GIS are considered as appropriate IT-based tools that provide sufficient handling of spatial data and thus their use is necessary in planning and especially in supporting decisions aiming to define future land uses. Moreover they provide the basis for developing synergies with Operation Research and/or Management Science approaches to support spatially related decisions. In particular the combined performance of GIS and Multi-Attribute Decision Models (MADM) allows the expansion of GIS based tools to the consideration of decision criteria in land use planning. With respect to MC-SDSS implementation in planning wind energy exploitation projects and especially wind farms siting Vavatsikos & Karydakis (2016) shown that until 2001 a total of twenty two journal papers have been published. The fact that about 61% of those articles have been published since in the last six years illustrates that multicriteria GIS-based suitability analysis arise as a very interest research topic with respect to wind power projects. The paper at hand illustrates TOSIS and VIKOR decision models performance in GIS-based wind farms suitability analysis.

2. TOPSIS AND VIKOR DECISION RULES

2.1 TOPSIS

Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) introduced by Hwang &Yoon (1981) consists a multicriteria decision analysis framework based on the concept that the chosen alternative should have the shortest distance from the ideal and the farthest from the negative-ideal solution. The positive ideal solution (PIS) maximizes the benefit attributes and minimizes the cost attributes, whereas the negative ideal solution (NIS) maximizes the cost attributes and minimizes the benefit attributes (Wang & Elhag, 2006). TOPSIS combines the Euclidean distances to both the ideal and the negative-ideal solutions simultaneously by taking the relative closeness to the ideal solution (Hwang & Yoon, 1981). TOPSIS implementation demands decision matrix formations that contains m alternatives ($A_1, A_2, \dots, A_m$) under the consideration of n criteria ($X_1, X_2, \dots, X_n$). The performance x_{ij} denotes the performance of the ith alternative with respect to the jth criterion. To obtain consistent results the process transforms the various criteria dimensions into non-dimensional criteria, which allows comparison across the criteria. Such a normalization for ascend and descend criteria is presented in Equations 1 & 2. Then weighted normalized decision matrix is obtained using criterion weights elicitation approaches based on Equation 3. Ideal (A^+) and anti-ideal (A^-) solution are constructed by the maximum and minimum performances of the weighted normalized decision matrix (Eq. 4, 5), where J demotes the ascend criterion types and J′the descend criterion types. The separation between each alternative can be measured by n-dimensional Euclidean distance. The separation of each alternative from the ideal one is then given by Equation (6), while separation from the negative -ideal one is given respectively by Equation (7). Finally alternatives' are ranked based on the relative closeness to the ideal solution estimation (Eq.8). An alternative A_i is closer to A^* as C_i^* approaches to 1.

$$r_{ij} = x_{ij} - \min_i[x_{ij}]/\max_i[x_{ij}] - \min_i[x_{ij}] \tag{1}$$

$$r_{ij} = \max_i[x_{ij}] - x_{ij}/\max_i[x_{ij}] - \min_i[x_{ij}] \tag{2}$$

$$v_{ij} = \{w_j r_{ij} | i = 1,2,\dots,m, j = 1,2,\dots,n\} \tag{3}$$

$$A^* = \left\{(\max_i v_{ij} | j \in J), (\min_i v_{ij} | j \in J') | i = 1,2,\dots,m\right\} = \{v_1^*, v_2^*, \dots, v_j^*, \dots, v_n^*\} \tag{4}$$

$$A^- = \left\{\min_i v_{ij} | j \in J), (\max_i v_{ij} | j \in J') | i = 1,2,\dots,m\right\}\{v_1^-, v_2^-, \dots, v_j^-, \dots, v_n^-\} \tag{5}$$

$$S_i^* = \sqrt{\left\{\sum_{j=1}^{n} (v_{ij} - v_j^*)^2\right\}}, i = 1,2,\dots,m \tag{6}$$

$$S_i^- = \sqrt{\left\{\sum_{j=1}^{n}(v_{ij} - v_j^-)^2\right\}}, i = 1,2,\dots,m \tag{7}$$

$$C_i^* = S_i^-/(S_i^* - S_i^-), \quad 0 < C_i^* < 1, \quad i = 1,2,\dots,m \tag{8}$$

2.2 VIKOR

In accordance with TOPSIS, VIKOR (VlseKriterijumska Optimizacija I Kompromisno Resenje) method was developed to solve MCDM problems with conflicting and incommensurable criteria, assuming that compromising is acceptable for conflict resolution, the decision maker wants a solution that is the closest to the ideal, and the alternatives are evaluated according to all established criteria. However, VIKOR introduces the concept of "the majority of criteria" weight strategy definition (or "the maximum group utility") through the parameter v (Kackar, 1985; Opricovic, 1998). Relative closeness in VIKOR takes the form of Equation 9, where S_j is the utility measure (Eq. 10), R_j the regret measure (Eq. 11) and S^*, R^* are obtained using equations 12 and 13.

$$Q_j = v(S_j - S^*)/(S^- - S^*) + (1 - v)(R_j - R^*)/(R^- - R^*) \tag{9}$$

$$S_j = \sum_{i=1}^{n} w_i(f_i^* - f_{ij})/(f_i^* - f_i^-) \tag{10}$$

$$R_j = \max_i[w_i(f_i^* - f_{ij})/(f_i^* - f_i^-)|i = 1,2,\dots,n] \tag{11}$$

$$S^* = \min_j S_j = \min[(S_j)|j = 1,2,\dots,m], \quad S^- = \max_j S_j = \max[(S_j)|j = 1,2,\dots,m] \tag{12}$$

$$R^* = \min_j R_j = \min[(R_j)|j = 1,2,\dots,m], \quad R^- = \max_j R_j = \max[(R_j)|j = 1,2,\dots,m] \tag{13}$$

The best alternative, ranked by Q, is the one with the minimum value of Q. The main ranking result is the compromise ranking list of alternatives, and the compromise solution with the ''advantage rate". VIKOR is an effective tool in multi-criteria decision making, particularly in situations where the decision maker is not able, or does not know how to express his/her preference at the beginning of system design. The obtained compromise solution could be accepted by the decision makers because it provides a maximum ''group utility" (represented by min S) of the ''majority", and a minimum of the ''individual regret" (represented by min R) of the ''opponent". The compromise solutions could be the basis for negotiations, involving the decision maker's preference by criteria weights (Opricovic and Tzeng 2007; Tong et al. 2007).

2.3 Modified VIKOR

Although the VIKOR method is an effective tool for MCDM problems, some errors would occur in multi-criteria optimization calculation. When the i_{th} criterion has no difference among alternatives, i.e., $f_{i1} = f_{i2} = \dots f_{in} = f_i^* = f_i^-$, error calculation will occur and S_j and R_j cannot be determined by Equations 10 and 11. When the utility measure or/and regret measure has no difference among alternatives, the traditional VIKOR method cannot determine Q_j by Eq. (9). To overcome these drawbacks the selected criteria should be meaningful. If the criterion has no difference among alternatives, it is not suitable for regarding as a measure.

The compromise solution by VIKOR is with high acceptance, because the priority-ranking of alternative by VIKOR is the closest to the optimal solution. However, the calculation by the traditional VIKOR method would bring fault and the VIKOR index Q_j would be unavailable. These problems lower the value of the compromise ranking method. Chang (2010), proposed the modified VIKOR method to solve existing problems in the traditional VIKOR method. Because the modified VIKOR method has logic judgment, it can avoid numerical difficulties resulted from zero denominator. The modified VIKOR method still compares the alternatives according to the utility measure and regret measure. Thus, when the alternatives both have the same utility measure and regret measure, they will have the same priority ranking. Since the modified VIKOR index Q_j^* (Eq. 14) is valid index in any situations, any ranking results can be reasonably explained by the modified VIKOR method.

$$Q_j^* = \begin{cases} v(S_j - S^*)/(S^- - S^*) + (1-v)(R_j - R^*)/(R^- - R^*) & S^- \neq S^* \cap R^- \neq R^* \\ (R_j - R^*)/(R^- - R^*) & S^- = S^* \cap R^- \neq R^* \\ (S_j - S^*)/(S^- - S^*) & R^- = R^* \cap S^- \neq S^* \\ k = constant & S^- = S^* \cap R^- = R^* \end{cases} \quad (14)$$

3. CASE STUDY IMPLEMENTATION

Modified VIKOR suitability analysis framework is illustrated through a wind farms suitability analysis case study in Thrace Region, which is located on the northeast part of Greece. Thrace is characterized by mountainous regions, a very high forest cover, while about 31% of its total area and environmentally protected areas by NATURA 2000. These different conditions entail distinct challenges and tasks for wind energy development. The developed multicriteria evaluation framework examines a variety of environmental, socioeconomic and technological (operational) criteria. Analysis criteria has been selected in accordance with the most recent literature and national legislation. The process aims to ensure proper operation of the wind farms and to reassure social objections. The decision model is implemented in five steps: (a) the exclusion of infeasible sites, (b) the selection of decision criteria, (c) the creation of the normalized maps, (d) the application of TOPSIS and VIKOR methodologies in the GIS environment and last (e) the derivation of the suitable area. The overall approach is basically a procedure that combines spatially referenced data into a decision map. Table 1 summarizes both constraints and criterion weights adopted, while attributes normalization is performed using linear utility functions with the consideration of indifference and strict preference thresholds.

Constraints analysis allows feasible candidate locations identification. In order to ensure the quality of results buffer zones were set, i.e. minimum distances for the constraint criteria. In the next step of the analysis, decision criteria for finding optimal wind farm sites are defined. Decision Criteria are usually measured on a continuous scale and their aim is to enhance or detract the alternative locations. There are two types of factors: (a) benefit (ascend) criteria contributing positively to the site selection and (b) cost (descend) criteria contributing negatively to site selection (i.e. lower values are more preferable than higher ones). Then TOPSIS and VIKOR decision rules are performed in ArcGIS environment. The final step of the procedure is the generation of the suitable area maps. The suitable area is calculated by consolidating the exclusion area and the rated area in one map. Two different scenarios were generated in this study (a) an equal weighted model and (b) a weighted model, applied for both TOPIS and modified VIKOR methodologies.

Table 1 Analysis criteria.

Code	Criteria /Layers	Type	Const.	Prefer.	q	p	W (%)
	Environmental						
C100	Natura 2000 Net.	DCC	1.000 m	Ascend	1.000	max	5.61
	Socioeconomic						
	Development Prospects in:						
	a/ Tourism						
C211	Archeological sites	DCC	500 m,	Ascend	500	5.000	1.41
C212	Monasteries	DCC	500 m	Ascend	500	max	0.3
C213	Coastline	DCC	500 m	Ascend	500	1.500	0.66
C214	Inconsistent Land Uses	DCC	Exclusion	Ascend	min	Max	0.26
	b/ Industry & Mineral Exploit.						
C221	Industrial zones	DCC	Exclusion	Ascend	min	Max	0.79
C222	Mines	DCC	500 m	Ascend	500	Max	0.48
	c/ Livestock Farming						
C231	Pastures	DCC	200 m	Ascend	200	Max	1.04
	d/ Agriculture						
C241	High productivity areas	DCC	200 m	Ascend	200	500	1.35
	Aesthetic Considerations						
C251	Settlements	DCC	1.000 m	Ascend	1.000	3.000	4.49
C252	Primary road network	DCC	500 m	Ascend	500	Max	0.9
	Design Considerations						
C311	Wind speed	DCC	4 m/s	Ascend	4	Max	64.13

C312	Sandy areas	DCC	1.000 m	Ascend	1.000	Max	1.69
C313	Slopes	DCC	30%	Descend	30%	Min	8.47
	Floodplain Risk						
C321	Rivers	DCC	150 m	Ascend	min	5.000	1.01
C322	Lakes	DCC	150 m	Ascend	min	5.000	1.01
	Synergistic Utilities						
C331	Secondary Road network	DCC	<0.2 & >10 km	Descend	10	0,2	2.38
C332	Electricity grid:	DCC	<0.2 & >10 km	Descend	10	0,2	1.65
	Non-Synergistic Utilities						
C341	Trans Adriatic Pipeline	DCC	300 m	Ascend	300	500	0.3
C342	Burgas –Alex. Pipeline	DCC	300 m	Ascend	300	500	0.3
C343	Natural Gas Trans. Network	DCC	300 m	Ascend	300	500	0.3
C344	Antennas, Radar	DCC	250 m	Ascend	250	1.500	0.74
C345	Distance from airports	DCC	500 m	Ascend	500	max	0.75
DCC:	Decision Criterion with Constraint	P:	Strict Preference threshold				
Q:	Indifference Threshold	W:	Criterion Weight				

The final step, the ranking of Q^* is an important factor for the selection of the suitable area. The process proposed by the traditional VIKOR method requires the pairwise value control of alternatives in descending order. However, modified VIKOR distinguishes four logical cases, covering each possible scenario. The final classification is completed by running nested relationships (if). Fig. 1 shows the results of equal weighted and weighted model for the TOPSIS model. The weighted VIKOR model enables the software to present other classification cases. Thus, three scenarios in which the preference of the decision maker will be set by two different values. This variable is v and it will receive the values 0.5 (scenario 1), 0.25 (scenario 2) and 0.75 (scenario 3). In the first scenario, the preference of the decision maker is the same for ideal and non-ideal alternatives. The second scenario wants the decision maker to prefer non-ideal values more than ideal and in the third scenario applies the opposite. It has to be noted that all three of the scenarios are weighted models.

4. CONCLUSIONS

GIS-based Multicriteria decision analysis emerges as a rapidly growing area of scientific research during the last decade. Modern GIS software packages facilitate a variety of tools that enable fast utilization of both multi-attribute decision methods and decision models. Moreover, it provides planers, public servants and politicians with sophisticated tools that allow efficient handling of spatial data when land uses with respect to renewable energy are scheduled. On the other hand private sector can gain profits from the implementation of spatial multicriteria decision analysis to highlight investment opportunities.

Figure 1 TOPSIS implementation equal weighted model (left) and weighted model (right).

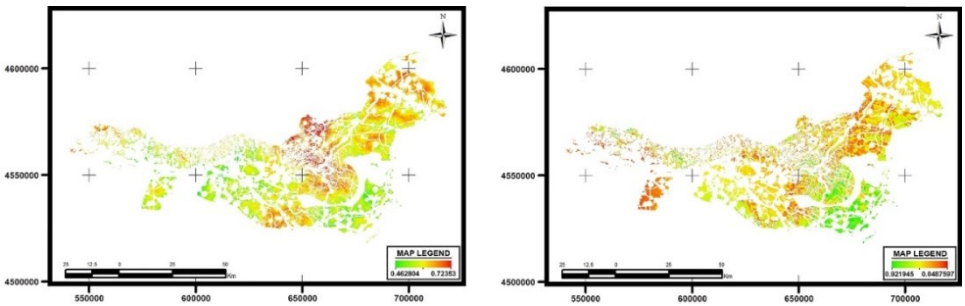


Figure 2 VIKOR implementation equal weighted model (left) and weighted model, scenario 1, $v = 0.5$ (right)

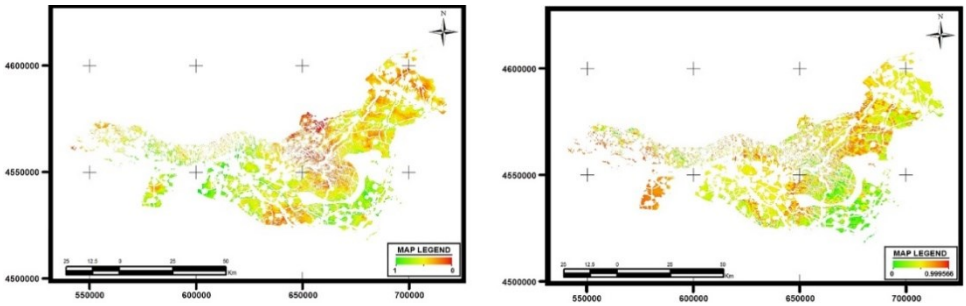
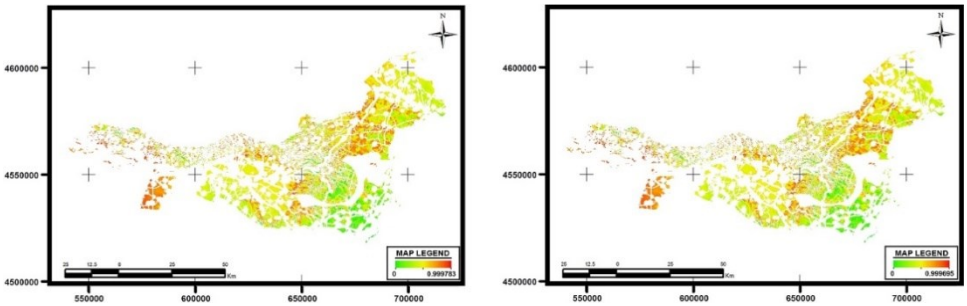


Figure 3 VIKOR implementation scenario 2, $v = 0.25$ (left) and scenario 3, $v = 0.75$ (right).



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Utilising Mullticriteria Decision Aid for the measurement of Project Success. The PROMITHEAS methodological frame

Isaak Vryzidis
University of Athens
Department of Primary Education
isaak.vryzidis@gmail.com

Athanasios Spyridakos
Piraeus University of Applied Sciences,
Business Administration Department
tspyr@puas.gr

Abstract

The evaluation of project success is characterized by complexity, diversity and ambiguity concentrating the strong interest of academics and business managers over the last decades. The measurement of project success is a complicated and unstructured process while: a) the results of a project or a group of projects can be obtained after and in many cases long time after the project completion, b) the longer term benefits are often indirectly related with the projects, c) the subjectivist perspective of different stakeholders is creating difficulties for the use of one success verdict, d) the correlation between the evaluation criteria and the organisation strategic goals taking into account the external environment is another challenging issue and e) the relative importance of the criteria varies between different stakeholders and depends on the time when the evaluation taking place. The proposed PROMITHEAS approach (PROject Multicriteria Interactive Tool for Holistic Effectiveness ASsessment) for the project success evaluation concludes to the estimation of a value system based on the selection criteria combining the disaggregation - aggregation multicriteria decision aid UTA methods and the Multi-Objective Linear Programming Techniques. Through this approach the following main objectives are achieved: 1) the evaluation of the projects' success according to the strategic goals of an organisation, 2) the use of a consistent family of criteria in the analysis taking into account the relative importance of the criteria and 3) the consideration of different stakeholders in all stages starting from the selection process of the projects' portfolio to the final evaluation of project success. The value system estimated by this approach can lead to the analysis of the success or failure of the projects by deducting differences from the initial strategic planning. The PROMITHEAS approach is illustrated through a real world case study concerning the evaluation of Post Graduate Educational Programmes of a higher Educational Greek Business School.

KEYWORDS

Multicriteria Decision Aid, Project Effectiveness, Project Success, Project Management

1. INTRODUCTION

The evaluation of project success is a challenging process which is influenced by the following factors: a) each case has its own criteria and it is defined by the nature of projects, the internal and external environment and the strategic planning of the organizations, b) the non-linearity of analysis parameters (each evaluation criterion does not have the same relative importance), c) simultaneous engagement of qualitative and quantitative parameters, which creates difficulties to synthesize them, d) stochastic criteria, which is another point that makes evaluation procedure more difficult, e) each stakeholder has a different set of criteria reflecting different needs and points of views, f) the impacts of a project are not limited to the time of implementation, but they mainly obtained after a short or long period of time after its completion. The methodological frameworks for evaluation of project success until now (Atkinson, 1999; Ika, 2009; Patanakul and Milosevic, 2009; Westerveld, 2003; Yu et al., 2005) has the following disadvantages: 1) they are limited in theoretical contexts and are not integrated structured methods, 2) the individual criteria are synthesized linearly, 3) no examination of the consistency of the evaluation criteria is taken into account, 4) unable to manage qualitative parameters, 5) lack of direct linking of evaluation criteria with strategic planning, 6)

unable to manage uncertainty, 7) difficulties to synthesize different views in a final conclusion. The proposed methodology PROMITHEAS provides a framework that can support the above points.

2. THE "PROMITHEAS" METHODOLOGICAL FRAME

The success of a project is a result of successful implementation by the management team (efficiency) and success of the final product (effectiveness), which can be summarized as (Baccarini, 1999):

Project success = Project Efficiency + Project Effectiveness **(2.1)**

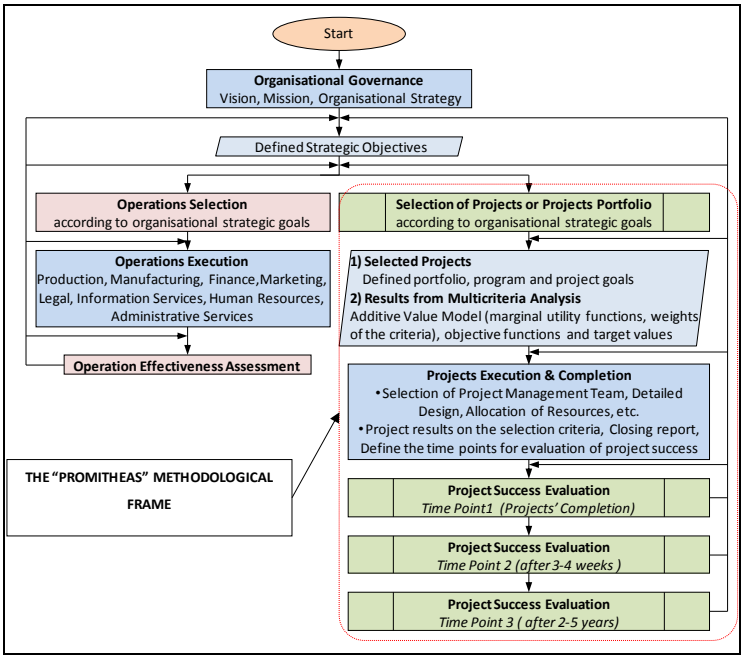
From this work is proposed to add two more relations for the needs of PROMITHEAS methodological frame.

Project Efficiency = Effective Selection + Project Management Effectiveness **(2.2)**

Project Effectiveness = **Strategic Goals** (Internal Environment) **+** **Stakeholders' Satisfaction** (External Environment) **(2.3)**

The PROMITHEAS methodological frame (PROjects' Multicriteria Interactive Tool for Holistic Effectiveness Assessment) is based on the selection criteria in accordance with the defined strategic objectives. The methodology stages in the organizational environment are illustrated in Figure 1. PROMITHEAS framework interacts with the processes of an organisation, uses the available information and results from other operations and provides feedbacks for both projects and operations at all levels of the organisation. The methodology is implemented in two stages (Green boxes in Figure 1): a) Selection Stage of Projects and b) Evaluation Stage of projects success.

Figure 1 Illustration of PROMITHEAS methodological frame in the Organisational level



2.1 Projects' Portfolio Selection Stage

The design and selection stage of projects or projects' portfolio includes two phases (Table 1):

(A) The evaluation of an Additive Utility Model (marginal utility functions $u_i(g_i)$, weights of the criteria p_i),

which will reflect the preference of the decision-maker in accordance with the strategic planning. Specifically, the PROMITHEAS methodology in the 1st Stage – 1st Phase utilize Multi-Criteria Decision Analysis (MCDA) for supporting strategy workshops, modeling the preferences of the general organizational governance for the future, linking the candidate projects with the strategic goals and evaluating them in a consistent family of criteria. Generally, the use of multicriteria methods by strategic planning teams has hardly been practiced even though it seems appropriate for such problems (Hodgkinson et al., 2006). An interesting work on this topic was done by Montibeller and Franco (2010). For this phase, the appropriate MCDA methods are the Disaggregation- Aggregation (D-A) approaches (Jacquet-Lagreze and Siskos, 1982; Siskos, 1980; Siskos et al., 2005; Siskos and Yannacopoulos, 1985) and especially the Stochasic UTA which allows the use of stochastic criteria for parameters with high uncertainty (for example, product demand, market share).
(B) In the 2nd phase of this stage, the PROMITHEAS methodological frame utilizes multi-objective linear programming techniques (Ehrgott and Wiecek, 2005; Evans and Steuer, 1973; Korhonen, 2005; Korhonen and Wallenius, 1990; Zeleny, 1974) in order to take into account the resources requirements and availability in the optimization of the global utility values (Strategic Goals, Internal Environment). The purpose of this phase is also to include other objectives in the analysis which are related to the external environment (e.g. economic, political, social, etc.). Essentially, in the second stage, the selection of projects takes into account both the internal environment of the enterprise or organization and the impact on the external environment.

Table 8 Selection stage 1 of PROMITHEAS methodological frame

Stage 1: Selection of Projects Portfolio		
Phase	Phase 1	Phase 2
Important Points	• Evaluation of candidate projects in regards with the strategic planning and operational goals. • Estimation of Additive Utility Function (marginal utility functions, weights of criteria)	Selection of projects' portfolio according with: • Strategic planning and organizational goals (Internal Environment). • Objective goals regarding to economical and social environment (External Environment) • Restrictions on available human and material resources
Method	Stochastic Disaggregation – Aggregation UTA Approaches	Multi-objective Linear Programming Techniques

2.2 Projects' Success Evaluation Stage

The second stage can be implemented either after the completion of a single project or at the end of the selected portfolio. Both project success and projects' portfolio success can be assessed with the multi-criteria PROMITHEAS methodological approach. The success measurement system is based on:

• The Additive Utility Model (marginal utility functions $u_i(g_i)$, weights of the criteria p_i), which is estimated with the stochastic UTA in the first phase of the selection stage. From that stage the marginal utilities ($u_i(g_i(a_j))$ and the global utilities ($U(a_j)$) of the selected projects in accordance with the projects' rating values on the consistent family of criteria at this point of time it is calculated.
• The objective functions $Z_l(X)$ and the target values $Z_{l\text{-target}}$, which are identified in the second phase of selection stage.
• The short-terms and long-terms achievements of projects' completion, which are related to the organizational strategy (internal environment) and to objective goals (external environment). The Additive Utility Model is used for the estimation of the marginal utilities $u_i^{'}(g_i(a_j))$ and the global utilities $U^{'}(a_j)$ in accordance with the projects' rating values on the consistent family of criteria at the evaluation point of time. Additionally, the values related to the objective functions $c_{lj}^{'}$ at the same time point are calculated.

In the PROMITHEAS methodological approach a value system is used to measure the efficiency and effectiveness of both interior and external environment. More specifically, for evaluating the success of a project (i) the following indices are used:

1) For the achievements in terms of a criterion (Cr) for a project (Pr):

$$R_{ij}^{Cr/Pr} = (1 + \Delta u_{ij}^{Cr/Pr})\, x_j, \text{ where } x_j = \begin{cases} 0 \text{ if project } a_j \text{ is not included to the selected portfolio} \\ 1 \text{ if project } a_j \text{ is included to the selected portfolio} \end{cases}$$

and $\Delta u_{ij}^{Cr/Pr} = u_i^{'}(g_i(a_j)) - u_i(g_i(a_j))$,

2) For the achievements of a project a_j with regard to the consistent family of criteria:

$$R_j^{Pr} = [1 + \sum_{i=1}^{n} (p_i \Delta u_{ij}^{Cr/Pr})] x_j, \text{ where } x_j = \begin{cases} 0 \text{ if project } a_j \text{ is not included to the selected portfolio} \\ 1 \text{ if project } a_j \text{ is included to the selected portfolio} \end{cases}$$

3) For the achievements of a project a_j with regard to the objective functions (OBF) Z_l (l = 2, ..., h):

$$C_{lj}^{OBF/Pr} = (1 + \Delta c_{ij}^{OBF/Pr}) x_j, \text{ where } x_j = \begin{cases} 0 \text{ if project } a_j \text{ is not included to the selected portfolio} \\ 1 \text{ if project } a_j \text{ is included to the selected portfolio} \end{cases}$$

and $\Delta c_{ij}^{OBF/Pr} = \dfrac{c_{ij}^{'} - c_{ij}}{\text{criterion scale}}$

For evaluating the success of all projects (portfolio or group of projects), the above indices are combined with the following indicators:

4) For achievements in terms of one criterion for a group of projects (GRP):

$$\text{Mean Value}: R_i^{GRP/Cr} = \frac{1}{\gamma} \sum_{j=1}^{\gamma} R_{ij}^{Cr/Pr},\ i = 1, 2, \ldots, n \text{ and } \gamma: \text{number of evaluating projects}$$

$$\text{Standard Deviation}:\ \text{STDEV-}R_i^{GRP/Cr} = \frac{1}{\gamma} \sum_{j=1}^{\gamma} (R_{ij}^{Cr/Pr} - R_i^{GRP/Cr})^2,$$

5) For the achievements with regard to the consistent family of criteria:

$$\text{Mean Value}: R_{GRP} = \frac{1}{\gamma} \sum_{j=1}^{\gamma} R_j^{Pr}\ ,\ \text{Standard Deviation}:\ \text{STDEV} - R_{GRP} = \frac{1}{\gamma} \sum_{j=1}^{\gamma} (R_j^{Pr} - R_{GRP})^2$$

6) For the degree of achievement of portfolio objectives in terms of objective functions Z_l (l = 2, ..., h):

$$\text{Mean Value}: C_l^{GRP} = \frac{1}{\gamma} \sum_{j=1}^{\gamma} C_{lj}^{OBF/Pr}, \text{Standard Deviation}: \text{STDEV} - C_l^{GRP} = \frac{1}{\gamma} \sum_{j=1}^{\gamma} (C_{lj}^{OBF/Pr} - C_l^{GRP})^2$$

The above indices can be concentrated in the following two tables (Table 2, Table 3). After the construction of these tables, the decision maker can start the interpretation of the results with the aid of the PROMITHEAS value system and deduct deviations from the initial design and planning in the portfolio level.

Table 9 Success Indices by criterion for a single project and a group of projects

	Consistent family of criteria			
Projects	g1	g2	…	gn

a1	$R_{11}^{Cr/Pr}$	$R_{21}^{Cr/Pr}$	…	$R_{n1}^{Cr/Pr}$
a2	$R_{12}^{Cr/Pr}$	$R_{22}^{Cr/Pr}$	…	$R_{n2}^{Cr/Pr}$
⋮	⋮	⋮	…	⋮
aγ	$R_{1\gamma}^{Cr/Pr}$	$R_{2\gamma}^{Cr/Pr}$	…	$R_{n\gamma}^{Cr/Pr}$
Mean Value	$R_{1}^{GRP/Cr}$	$R_{2}^{GRP/Cr}$	…	$R_{n}^{GRP/Cr}$
Standard Deviation	STDEV- $R_{1}^{GRP/Cr}$	STDEV- $R_{2}^{GRP/Cr}$	…	STDEV- $R_{n}^{GRP/Cr}$

Table 3 Success Indices for a single project and a group of projects in regards to strategic and objective goals

	Strategic Goals	Objective Goals			
Projects	Z1	Z2	Z3	…	Zh
a1	R_{1}^{Pr}	$C_{21}^{OBF/Pr}$	$C_{31}^{OBF/Pr}$	…	$C_{h1}^{OBF/Pr}$
a2	R_{2}^{Pr}	$C_{22}^{OBF/Pr}$	$C_{32}^{OBF/Pr}$	…	$C_{h2}^{OBF/Pr}$
⋮	⋮	⋮	⋮	⋮	⋮
aγ	R_{γ}^{Pr}	$C_{2\gamma}^{OBF/Pr}$	$C_{3\gamma}^{OBF/Pr}$	…	$C_{h\gamma}^{OBF/Pr}$
Mean Value	R_{GRP}	C_{2}^{GRP}	C_{3}^{GRP}	…	C_{h}^{GRP}
Standard Deviation	STDEV- R_{GRP}	STDEV- C_{2}^{GRP}	STDEV- C_{3}^{GRP}	…	STDEV- C_{h}^{GRP}

3. CASE STUDY

The proposed methodological approach can be applied to a set of problems where it is necessary to link project evaluation to strategic objectives and take more effective selection decisions based on available resources. For the illustration of the method a case study on the selection and evaluation of the effectiveness of postgraduate study programs (MSc) has been developed.

4. CONCLUSIONS

The proposed methodological approach PROMITHEAS is a holistic measurement system of project success because in the evaluation process takes into account: a) the strategic objectives and the vision of the organisation, b) the impact from project execution on different stakeholders, c) the restrictions on resources and d) the uncertainty about the impact of a project on one or more points of view (eg demand for a product or service). Also, it is a completed structured methodological framework, which is based on: 1) the Multi-criteria Analysis, which provides better alignment of options to goals, modeling of preferences according to strategic planning, means of synthesis the evaluation criteria by taking into account their relative importance, and 2) the Project Management discipline by adopting the key features and using the available information. Finally, a value system with indices has been developed, which link the initial selection criteria to the achievements and capture possible positive or negative deviations from the initial design. The value system is independent of the case under consideration.

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An application of non weight MCDM for the evaluation of GEM entrepreneurial ecosystems

Fotis Kitsios
University of Macedonia
Egnatia 156, Thessaloniki, Greece
kitsios@uom.gr

Ioannis Sitaridis *
University of Macedonia
Egnatia 156, Thessaloniki, Greece
mai1572@uom.edu.gr

Abstract

For over 15 years the Global Entrepreneurship Monitor (GEM) releases an annual report on Entrepreneurship. The data are collected by national experts and cover two basic elements, namely the entrepreneurial behavior and attitudes among the population and the entrepreneurial ecosystem. Moreover, explanatory national reports are written for each country by a panel of experts, but comparative studies are more rare. We apply multi-criteria decision methods in order to assess the entrepreneurial ecosystem of selected countries. We use data from the National Expert Survey (NES), indicating multiple facets of the economic and social environment, as input criteria and we examine each country as a different alternative. The multi attribute decision method used is based on Perron-Frobenius theorem on primitive matrix properties. The method produces a primitive comparison matrix based on pair comparisons of alternative cases on each criterion. Only the win-tie results of each comparison are taken in account and not the magnitude of the difference. Finally a ranking vector is extracted based on the spectral radius and the corresponding eigenvector. The main benefit of the method is that it does not require experts' assigned weights for the criteria used and it has reduced math complexity.

KEYWORDS (6)

entrepreneurial ecosystem, GEM, ranking, multiple criteria analysis, MCDM, non-weight method

1. INTRODUCTION

Gem has started as an initiative of scholars for the systematic observation and measurement of the role of entrepreneurship on economic development. GEM provides a large variety of data collected through harmonized surveys in more than 100 countries and studies the differences between countries with respect to individual and contextual factors.

The underlying conceptual model takes into account the country's phase of economic development. According to Porter's classification there are three distinct phases: "factor-driven economies", "efficiency-driven economies", and "innovation-driven economies" (Porter et al. 2001). The general national framework related to entrepreneurial activity evaluation, is based on data collected from the national experts survey (NES) and other available sources. The purpose of this part of the model is to recognize the ideal conditions under which economic development evolves. Another part of the data, measure the entrepreneurial attitudes, activity and aspirations, among the adult population. This mixture of attitudes, resources, and infrastructure is referred to as the entrepreneurial "ecosystem" and incorporates entrepreneurship down from the individual and firm levels, up to the region and national levels (Z. Acs et al. 2014). According to GEM, the Greek economy belongs to the most developed innovation driven economies (Kelley et al. 2016), but in the latest reports, opportunities perceived by the population are below the average of innovation driven economies. Additionally, the Total Entrepreneurial Activity (TEA) shows serious fluctuations indicating the effects of the prolonged economic recession (Ioannides et al. 2016). These facts are corroborated by Global Entrepreneurship and Development Institute, claiming that Greece is among the 10 countries with the biggest decline in global entrepreneurship index (Z. J. Acs et al. 2017) and the WEF ranking Greece's competitiveness at the 86th place among 138 countries.

We decided to compare the Greek economy with the economies of neighboring countries, or countries recently hit by economic crisis, in order to draw useful conclusions (Szerb and Trumbull 2015). In this line of reasoning the countries chosen are: Argentina, Bulgaria, Croatia, Cyprus, Ireland, FYROM, Portugal and Turkey. A multi-perspective comparison based on GEM entrepreneurial ecosystem data, can highlight the strengths and weaknesses of the Greek entrepreneurial environment. Such comparisons can help investors make judgments where they should invest (Dhochak and Sharma 2016), and provide implications for policy makers in order to take measures in the right direction. According to (B. Roy 1996), the decision support provides arguments based on models, answering the questions posed by a decision maker. An inherent difficulty for the decision maker is to consider all parameters in order to make rational choices.
The aim of this article is the use of methods of operational research, to provide decision makers with a straightforward way of ranking a set of entrepreneurial ecosystems, depending on a common set of criteria. The non linear - non weighted method (Huang and Moh 2016) , was used for the comparison does not require the selection of weights by a panel of experts, which minimizes the subjectivity of the results. This fact is convenient, when a simple ranking, based on criteria of equivalent importance, is satisfactory for the decision maker.

2. METHODOLOGY

2.1 Multi-criteria analysis

Multicriteria analysis decision making (MCDM) is a field of operations research attracting research interest, with a wide range of applications in business and politics. The majority of the MADM methods evaluate a number of alternatives, using weighted sum model, where each criterion is assigned a weight. Bigger weights, correspond to greater significance of the attributes. The result is a ranking of the alternatives, with all attributes taken in account simultaneously.
MCDM is gaining ground as an assessment tool in management research (Kitsios et al. 2009), attempting to predict economic development through measures of innovation, success etc (Dhochak and Sharma 2016) with comparative studies between countries. The method proposed by Huang and Moh, (2016) is an un-weighted ranking method (all weights are considered equally important), based on the Perron-Frobenious Theorem, similar to the football teams comparison methods proposed by Keener, (1993) and Google page ranking algorithm (Langville and Meyer 2006). The case in our example is a multi-attribute decision making (MADM) problem depending on the twelve criteria of entrepreneurial ecosystems of GEM.

2.2 Data Analysis

The method used is a Multiple Attribute Decision Making (MADM) approach, specialized in handling discrete problems. The fact that no criteria weights are used, eliminates the time spent by experts for the evaluation of criteria relative importance, ensures objectivity of judgments. In Table 1 we present the assessment for the entrepreneurial ecosystems for nine countries. The performance score for each country is provided by the GEM national experts survey. Higher values indicate better performance. Our objective is to rank the countries based on their performance on the criteria c1-c12.

Table 1 The performance scores for 9 different countries on twelve entrepreneurial ecosystem criteria

THE ENTREPRENEURIAL ECOSYSTEM

GEM 2016	Financing for entrepreneurs	Governmental support and policies	Taxes and bureaucracy	Governmental programs	Basic school entrepreneurial education and training	Post school entrepreneurial education and training	R&D transfer	Commercial and professional infrastructure	Internal market dynamics	Internal market openness	Physical and services infrastructure	Cultural and social norms
	c1	c2	c3	c4	c5	c6	c7	c8	c9	c10	c11	c12
Argentina	1.74	3.30	1.34	2.91	1.77	3.12	2.38	2.67	3.26	2.14	3.17	3.08
Bulgaria	2.64	1.67	2.87	1.92	1.64	2.30	1.94	3.04	2.91	2.27	4.08	2.18
Croatia	2.30	1.73	1.48	2.14	1.61	2.33	1.70	2.56	3.29	1.95	3.77	1.82
Cyprus	2.02	2.29	2.46	2.01	1.75	2.79	2.18	3.06	2.74	2.60	3.66	2.40
Greece	2.15	1.78	1.49	1.77	1.84	2.62	2.49	2.79	3.38	2.49	3.77	2.25
Ireland	2.85	2.78	2.83	3.37	2.18	2.70	2.78	3.06	2.47	2.90	3.31	3.02
FYROM	2.21	2.10	2.68	2.37	2.32	2.66	2.11	3.10	3.37	2.14	3.68	2.26
Portugal	2.95	2.85	1.77	3.07	2.10	3.10	2.76	3.27	2.17	2.45	4.41	2.47
Turkey	2.80	2.68	1.82	2.26	1.68	2.90	2.63	3.22	3.70	2.43	3.49	2.89

In this example, the nine $(m = 9)$ countries (Argentina, Bulgaria, Croatia, Cyprus, Greece, Ireland, FYROM, Portugal and Turkey) represent the different alternatives to be ranked with respect to the twelve $(t = 12)$ criteria, c1 to c12, used for the assessment. Each line of Table 1, constitutes the performance score vector of the corresponding country $P_r = [p_{r1}, p_{r2}, p_{r3} \ \dots, p_{rt}]$, with higher p_{rk} values indicating higher performance of the specific economy, in respect to the criterion c_k, $r = 1,2,\dots, m$ and $k = 1,2,\dots,t$.

As a first step, a comparison matrix $A_{mxm} = (a_{rs})_{mxm}$ of the alternatives $P_1, P_2, \dots, P_m$, over the criteria c_1, c_2 ,..., c_t, with a_{rs} defined as :

$$a_{rs} = \left(g_{rs} + \frac{1}{2} e_{rs}\right) / t, \text{ where } r, s = 1,2, \dots, m,$$

is calculated, where g_{rs} is the count of wins $(p_{rk} > p_{sk})$ and e_{rs} is the count of ties $(p_{rk} = p_{sk})$ of alternative r over alternative s, respectively, with $k = 1,2,\dots,t$. *Considering all* p_{rk}, $(r = 1,2,\dots, m$ k=1,2,...,$t)$ values are available for comparison, then all $a_{rs} \in R^+$. In Table 2, is illustrated the comparison matrix produced by the win-tie count procedure of Table 1, which is a primitive matrix (Huang and Moh 2016; Langville and Meyer 2006, p. 120).

Table 2 The comparison matrix

0,5	**0,416667**	**0,333333**	**0,416667**	**0,666667**	**0,666667**	**0,541667**	**0,666667**	**0,583333**
0,583333	0,5	0,333333	0,666667	0,583333	0,75	0,666667	0,833333	0,833333
0,666667	0,666667	0,5	0,666667	0,791667	0,833333	0,833333	0,916667	0,916667
0,583333	0,333333	0,333333	0,5	0,416667	0,708333	0,583333	0,75	0,666667
0,333333	0,416667	0,208333	0,583333	0,5	0,833333	0,666667	0,833333	0,75
0,333333	0,25	0,166667	0,291667	0,166667	0,5	0,333333	0,416667	0,333333
0,458333	0,333333	0,166667	0,416667	0,333333	0,666667	0,5	0,75	0,666667
0,333333	0,166667	0,083333	0,25	0,166667	0,583333	0,25	0,5	0,25
0,416667	0,166667	0,083333	0,333333	0,25	0,666667	0,333333	0,75	0,5

The Perron-Frobenius theorem (Gantmacher 1959) suggests that every primitive matrix *A* has a positive real eigenvalue λ that is the spectral radius of *A*. Then λ is the maximum absolute value of all possible eigenvalues of matrix *A*. Furthermore, λ has an algebraic and geometric multiplicity of 1 and a positive eigenvector $v > 0$, such that all positive eigenvectors of *A* are multiples of v. Given the comparison matrix A_{mxm}, its spectral radius λ and a vector $v_0 = [1, 1, 1, \dots, 1]^T$, then the $lim_{n\to\infty} \left(A/_{\lambda}\right)^n \cdot v_0 = cv$, where $c = u \cdot v_0 > 0$, given *u* is some positive row vector, which is a multiple of the eigenvector v. Let us define $d = cv$, be the ultimate ranking vector (Huang and Moh 2016).

So, in order to derive a ranking vector based on a comparison matrix A_{mxm}, given its spectral radius λ and a vector $v_0 = [1, 1, 1, \dots, 1]^T$, we have to calculate the expression:

$$d = lim_{n\to\infty} \left(A/_{\lambda}\right)^n \cdot v_0 ,$$

where d is the ranking vector :

$$d = [d_1, d_2, d_3, \dots, d_m]^T ,$$

and each d_n is the ranking of the *n* -th alternative.

Since *d* is a multiple of the eigenvector *v*, we are allowed to use the eigenvector itself as a ranking vector (Huang and Moh 2016).

Table 3 The ranking vector and country rank comparisons

Country	NWM (Huang and Moh 2016)	
	Ranking vector *d*	Rank #
Argentina	1,170	5
Bulgaria	1,404	8
Croatia	1,658	9
Cyprus	1,190	6
Greece	1,251	7
Ireland	0,681	2
FYROM	1,048	4
Portugal	0,631	1
Turkey	0,854	3

The rankings of the countries produced from the comparison matrix of Table2, by the Non-Weight Method (NWM), are illustrated in Table 3. In this case, lower d_n values indicate higher rank. The Greek entrepreneurial ecosystem, regarding the development of entrepreneurial activity, is ranked in the 7-nth place.

3. DISCUSSION

GEM's national expert survey evaluates the entrepreneurial ecosystem of each country, with respect to twelve common criteria. A simultaneous comparison, based on multiple criteria, becomes a complex problem, which can be solved with the assistance of multi-criteria analysis. The application of the proposed Non-Weight Method (Huang and Moh 2016) produced a unique ranking for every country, according to the corresponding value of the eigenvector calculated based on the properties of primitive matrices. The ranking of the Greek economy in the 7th place, highlights that the Greek entrepreneurial ecosystem has more weaknesses than strengths. This finding justifies why, at least currently, Greece shows reduced interest for

national and international investors. These results incorporate valuable information for policy makers. Future research could evaluate the performance of the adopted method, by comparing the NWM results with the rankings of other, established MADM methods as suggested by Kitsios et al. (2009).

4.CONCLUSIONS

The non-linear NWM for multi-criteria decision making proposed by Huang and Moh, (2016), based on the Theorems of Perron-Frobenius on the properties of primitive matrices, can be used for the ranking of entrepreneurial ecosystems of multiple countries, based on a common set of criteria. In this example, a set of nine entrepreneurial ecosystems were used as different alternatives compared on twelve equally weighted criteria. As a result, NWM can successfully rank alternatives when the criteria used are of equal importance. The benefits of NWM are the objectivity of the ranking due to the independence from subjective experts' weights and the low requirements of the method both in mathematical and computing complexity.

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The Robustness of Portfolio Optimization Models: An Empirical Comparative Analysis

Antonis Pavlou, Michalis Doumpos
Technical University of Crete
School of Production Engineering and Management
Financial Engineering Laboratory
University Campus, 73100 Chania, Greece

Abstract

The selection of investment portfolios is a major topic in financial decision making with many portfolio optimization models available in the literature. These models extend the traditional mean-variance framework using a variety of other risk-return measures. Existing comparative studies of such models have adopted a rather restrictive approach focusing solely on the minimum risk portfolio without considering the whole set of efficient portfolios, which are also relevant for investors. This paper, tries to move a step forward, focusing on the performance of the whole efficient set, rather of a single portfolio. To this end, we examine the out-of-sample robustness of efficient portfolios derived by popular optimization models, namely the traditional mean-variance model, mean-absolute deviation, conditional value at risk, and a multi-objective model. Tests are conducted using data for S&P 500 stocks, over the period 2005-2016. The results are analyzed through novel performance indicators representing the deviations between historical (estimated) efficient frontiers, actual out-of-sample efficient frontiers, and realized out-of-sample portfolio results.

KEYWORDS

Portfolio optimization, Efficient portfolios, Multi-objective optimization, Robustness.

1. INTRODUCTION

Portfolio optimization includes all those actions made by an investor to construct suitable investment portfolios, by maximizing return, while reducing risks as much as possible, taking into account the investor's risk-return profile. Nowadays portfolio optimization covers a wide range of financial assets, such as stocks, funds, bonds, commodities, currencies, and loans, whereas similar concepts and ideas are also applicable to non-financial portfolios (e.g., project portfolios).

The foundations of portfolio optimization were set by Harry Markowitz in the 1950s, through the introduction of the mean-variance (MV) model. Since then, portfolio optimization has evolved significantly in terms of modeling sophistication. Among others, one can mention the introduction of new risk-return portfolio selection criteria, the addition of realistic features, including transaction costs and cardinality constraints, new modeling and algorithmic approaches, as well as the consideration of new aspects such as social responsibility and other dimensions in a multi-criteria/objective framework. A recent overview of research developments and trends in portfolio optimization can be found in the work of Kolm et.al. (2014).

In the literature, several comparative studies have been presented for different portfolio optimization models (Jobst *et al.*, 2001; Mansini and Speranza, 2003; Angelelli, Mansini and Speranza, 2008; DeMiguel, Garlappi and Uppal, 2009). Despite, however, the rich literature on comparative studies among portfolio optimization models, two main shortcomings can be identified. First, past studies have adopted a rather restrictive point of view focusing on solely on the minimum risk portfolio. This approach obviously ignores other relevant efficient portfolios corresponding to different risk-return preferences that an investor may have. Moreover, the comparisons are usually performed on a bi-objective context through a single measure of risk and risk-adjusted financial criteria (e.g., the Sharpe ratio, factor models, etc.). On the other hand, optimization models adopting a multi-objective point of view have not been thoroughly examined on out-of-sample data.

This study aims to fill these gaps in the literature, focusing on conducting a thorough analysis of the true performance of efficient portfolio frontiers generated by popular portfolio optimization models. In the

analysis we considered standard bi-objective models based on different risk measures as well as multi-objective model. The comparison of the obtained frontiers is based on indicators that assess the discrepancies between estimated (historical) frontiers, the actual (future) performance of the portfolios, and a true optimal (ideal) benchmark. Empirical results are presented on a data set consisting of S&P 500 US stocks over the period 2005-2016.

The rest of the paper is organized as follows. Section 2 describes the portfolio optimization models used in the analysis as well as the proposed performance indicators. Section 3 describes the empirical setting, including the data and the testing framework used for the comparative analysis and also presents the obtained results. Finally, section 4 concludes the paper and discusses some future research directions.

2. PORTFOLIO OPTIMIZATION MODELS AND PERFORMANCE INDICATORS

In this section, we briefly outline the models used in the analysis as well as the indicators employed to evaluate the performance of the derived portfolios.

2.1 Optimization models

The analysis is based on three popular bi-objective models as well as multi-objective formulation. The considered models are based on different measures of risk:

- Variance of portfolio returns: $\sigma = \mathbf{x}^\top \mathbf{\Sigma} \mathbf{x}$, where $\mathbf{x}$ is the vector of the stock weights in a portfolio and $\mathbf{\Sigma}$ is the covariance matrix of historical stock returns.
- Mean absolute deviation: the expectation of the absolute differences between the return r_t of a portfolio at period t and the mean return $\bar{r}$ of the portfolio, i.e., $MAD = E(|r_t - \bar{r}|)$
- Conditional value-at-risk: the expected losses exceeding the value-at-risk threshold at confidence level $0 < \alpha < 1$.

These risk measures are combined with return, thus leading to three bi-objective models: (1) return-variance (MV model; Markowitz, 1952), (2) return-mean absolute deviation (MAD model; Konno and Yamazaki, 1991), and (3) return-conditional value at risk (CVaR model; Krokhmal, Palmquist and Uryasev, 2001). MV is a quadratic optimization model, whereas MAD and CVaR are formulated in linear programming form.

Additionally, we also consider a four-criteria model that combines return and the above three risk measures into a multi-objective optimization model (MOO model), which is formulated and solved through the augmented Chebyshev scalarization function approach (Steuer and Choo, 1983).

2.2 Performance indicators

Given that the above described models consider different risk measures, their results are not directly comparable. To make the comparison in a meaningful manner we employ two approaches based on novel and simple indicators. The first approach is suitable for comparing efficient frontiers in a bi-objective setting, whereas the second one enables the generalization of the comparisons to a multidimensional scenario.

In both cases, the two main comparisons are considered, focusing on the robustness of the portfolios' performance in terms of the difference between in-sample optimization and out-of-sample actual results. The first one involves the efficient frontiers derived using past (historical) data at the portfolio optimization phase (as implemented through the above models). Henceforth, these frontiers will be referred to as the *historical frontiers* (denoted by $\mathcal{H}$). The corresponding efficient portfolios are then tested on out-of-sample (future) data and their performances yield the *resulting frontier* (denoted by $\mathcal{R}$), i.e., the actual results of the investment. Finally, we also define *true efficient frontiers* (denoted by $\mathcal{F}$), which describe the truly optimal portfolios based on the out-of-sample data. Thus, investors use historical data (*historical frontier*) seeking to

obtain future results (*resulting frontier*) as close as possible to the true best choices (*true frontier*). The performance indicators used in the analysis quantify the differences between these frontiers.

2.2.1 Bi-objective risk-return indicators

The first two indicators are based on the work of (Kao and Steuer, 2016), who introduced them in the context of assessing the value of information used in portfolio selection. In this study, we use the indicators in a different manner, i.e., as performance measures to assess the differences described above (in-sample versus out-of-sample). Both indicators are implemented in a bi-objective risk-return setting.

First, we consider a regret indicator comparing the choices that an investor makes from efficient portfolios on frontier $\mathcal{H}$, against the true best results of frontier $\mathcal{F}$. For instance, assume a point of view focused on returns and let $(r_p^{\text{true}}, s_p^{\text{true}})$ denote the actual (out-of-sample) return and risk (variance, MAD, or CVaR) of an efficient portfolio $p \in \mathcal{H}$. Moreover, let $\hat{r}_p$ be the return of a portfolio on the true frontier $\mathcal{F}$ having the same (or similar) risk as portfolio p. Then, the return performance indicator I for portfolio p, is defined as follows:

$$I_p^{\text{return}} = \hat{r}_p - r_p^{\text{true}}$$

This indicator is non-negative with higher values indicating a larger discrepancy between the actual return of portfolio p and an efficient benchmark portfolio of the same risk level. We also compute same indicator in terms of risk, as the risk difference between portfolios of the same return (henceforth this will be denoted as I^{risk}).

A second indicator (denoted by D) quantifies the differences between the risk-return estimates for efficient portfolios on frontier $\mathcal{H}$ and their actual results (i.e., a robustness indicator). For instance, assume a point of view focused on returns and let $(r_p^{\text{est}}, s_p^{\text{est}})$ denote the estimated (in-sample) return and risk (variance, MAD, or CVaR) of an efficient portfolio $p \in \mathcal{H}$. The return performance indicator D is defined for portfolio p as follows:

$$D_p^{\text{return}} = r_p^{\text{est}} - r_p^{\text{true}}$$

Unlike the previous indicator I, the indicator D can take both positive and negative values. Negative values indicate that the actual return of a portfolio exceeds what was expected on the basis of historical data, whereas the case $D > 0$ indicates that the actual return is lower than the expected one. Similarly, to indicator I, we also compute D in terms of risk (henceforth this will be denoted as D^{risk}).

2.2.2 Mean distance between frontiers

While the indicators described above are intuitive and easy to use and interpret in a risk-return context, they cannot be extended to more than two dimensions. Thus, in order to enable the comparisons to a more general setting, we use the distance indicator proposed by (Knowles and Corne, 2002), which enables comparing two frontiers A (reference frontier) and B (approximation frontier) through the following metric:

$$C_{AB} = \frac{1}{n_A} \sum_{\mathbf{x} \in A} \min_{(\mathbf{y} \in B)} \{d(\mathbf{x}, \mathbf{y})\}$$

where n_A is the number of solutions considered from frontier A and $d(\mathbf{x}, \mathbf{y})$ is the $\boldsymbol{\lambda}$-weighted Chebyshev distance between a point $\mathbf{x} \in A$ and a point $\mathbf{y} \in B$, with weights defined as scaling constants that account for the different scales of the objectives. The indicator represents the mean Chebyshev distance (averaged over all solutions of frontier A) of all solutions on frontier B from each one on frontier A.

For the purposes of the analysis, the comparisons described above for the two bi-objective indicators are also considered for this indicator, too. Therefore, the calculation of the Chebyshev distance metric is performed twice, first for the pair $(A,\ B) = (\mathcal{F}, \mathcal{R})$, and second for the pair $(A,\ B) = (\mathcal{H}, \mathcal{R})$.

3. EMPIRICAL ANALYSIS AND RESULTS

The portfolio optimization models described in the previous section were applied to an extensive dataset consisting of stocks traded in the S&P 500 US index. The sample period covers 572 trading weeks (11 years) from January 2005 to July 2016.

Using this dataset, multiple tests are performed, through a rolling window approach, similarly to Gilli and Schumann, (2011). In each test, daily return data over a period of one year (~250 days) are used as in-sample estimates for portfolio optimization. The subsequent quarter is used for out-of-sample testing. For example, starting at the end of 2005q4, the daily data over the period 2005q1-2005q4 are used to construct 20 efficient portfolios (in-sample optimization) and 2006q1 is used for testing (out-of-sample). Then, the time window is moved one quarter ahead (2005q2-2006q1 for optimization and 2006q2 for testing) and the process is repeated until 2016q2. Overall 42 test are conducted. In each test run, all portfolio optimization models are applied to derive historical efficient frontiers $\mathcal{H}$ (with the in-sample optimization data), which are then examined for their out-of-sample performance (resulting frontiers $\mathcal{R}$). The optimization models are also applied to the out-of-sample data to derive 20 efficient portfolios from the true frontiers $\mathcal{F}$.

Table 1 presents the averages of all performance indicators over the 42 tests described above. The best results for each indicator are marked in bold. It is evident that in terms of the two bi-objective indicators, the MV model outperforms the MAD and CVaR models. The MAD model performs similarly to the MV model, but it is slightly inferior, whereas CVaR provides consistently much less robust results (this is appears to be consistent with the findings of Lim, Shanthikumar and Vahn, 2011). In order to assess the statistical significance of the differences between the models' results for the bi-objective indicators, a paired-samples t-test was conducted. The results showed that MV performed significantly better than MAD and CVaR in terms of the two risk-based indicators (I^{risk} and D^{risk}) at the 1% significance level. Regarding the return-based indicators (I^{return} and D^{return}), the differences MV-CVaR and MAD-CVaR were both found significant at the 1% level, whereas the differences between MV and MAD where significant only at the 10% level (p-value=0.097 for I^{return} and 0.059 for D^{return}). On the other hand, regarding the two multidimensional Chebyshev distance indicators, the MV model outperforms the other models in terms of the regret indicator $C_{\mathcal{F},\mathcal{R}}$, whereas the multi-objective model is the best performer on the robustness indicator $C_{\mathcal{H},\mathcal{R}}$. Again, CVaR yields the worst results in both indicators.

Table 1 Summary of performance indicators (averages over all tests)

	I^{return}	I^{risk}	D^{return}	D^{risk}	$C_{\mathcal{F},\mathcal{R}}$	$C_{\mathcal{H},\mathcal{R}}$
MV	**0.00479**	**0.33822**	**0.00233**	**0.23828**	**0.42620**	0.33050
MAD	0.00488	0.37063	0.00239	0.27267	0.43433	0.33234
CVaR	0.00616	0.71763	0.00267	0.34615	0.61388	0.35545
MOO	-	-	-	-	0.47704	**0.32151**

In order to derive further insights into the relative performance of the models, we further computed a Chebyshev distance indicator $C_{\mathcal{F},\mathcal{R}}$ to compare the out-of-sample performance of model against the true Pareto frontier derived with model. This test enables us to examine if the results of a model are robust across

different risk metrics. Table 2 summarizes the results of these comparisons (mean differences and p-values from paired samples t-tests). Each entry in this table corresponds to the comparison between the $C_{\mathcal{F},\mathcal{R}}$ indicator for the model in row and the same indicator for the model in column, when the frontier $(\mathcal{F},\mathcal{R})$ is defined by the model in row. For instance, to obtain the (MV, MAD) entry, we use the true MV frontier $\mathcal{F}$ derived from out-of-sample data and compare it to: (1) the actual out-of-sample mean-variance results of the MV model (leading to the calculation of $C_{\mathcal{F},\mathcal{R}}^{\mathrm{MV}}$), and (2) the actual out-of-sample mean-variance results of the MAD model (leading to the calculation of $C_{\mathcal{F},\mathcal{R}}^{\mathrm{MAD}}$). The (MV, MAD) entry reports the mean difference $C_{\mathcal{F},\mathcal{R}}^{\mathrm{MV}} - C_{\mathcal{F},\mathcal{R}}^{\mathrm{MAD}}$ (over the 42 test) and the associated p-value in parentheses. Naturally, one would expect that $C_{\mathcal{F},\mathcal{R}}^{\mathrm{MV}} < C_{\mathcal{F},\mathcal{R}}^{\mathrm{MAD}}$, because in this comparison the true frontier is defined in mean-variance terms, so the MV model should provide results closer to the true optimum than the MAD model, which is based on a different risk measure. However, this is not the case as the mean difference is slightly positive (0.002), although it is not significant. Interesting, the results show that there no significant differences between the three bi-objective models. The MOO model, on the other hand, performs significantly better results that all the bi-objective models. This finding, indicates that a multi-objective approach does in fact provide a more robust approach, even when a simpler bi-objective setting is assumed.

Table 2 Comparison of the models in terms of their robustness over different portfolio risk measures

	MV	MAD	CVaR	MOO
MV	-	0.002 (0.397)	-0.003 (0.489)	0.009 (0.014)
MAD	-0.003 (0.164)	-	0 (0.926)	0.007 (0.022)
CVaR	0 (0.990)	0.002 (0.792)	-	0.014 (0.043)
MOO	-0.010 (0.008)	-0.009 (0.016)	-0.013 (0.028)	-

4. CONCLUSIONS

This paper presented a novel empirical comparison of popular bi-objective portfolio optimization models based on performance indicators that allow the consideration of the whole efficient frontier, rather than focusing on the minimum risk portfolio. Except for well-known bi-objective models, we also tested a multi-objective formulation through an extensive in-sample and out-of-sample evaluation protocol.

The obtained results indicate that the traditional MV model is the more robust bi-objective model, compared to other well-known approaches (MAD and CVaR). The multi-objective model was shown to be quite attractive, providing good results, which were actually found to be closer to the true bi-objective frontiers than the results of the bi-objective models.

This analysis can be extended towards several different directions. First, other state-of-the-art portfolio optimization models as well as simple investment strategies can be added in the analysis, together with the consideration of additional realistic scenarios and settings (transaction costs, different rebalancing periods, cardinality constrained portfolios, etc.). The investigation of the connections between the proposed performance indicators and portfolio performance measures from the financial theory is also worth the consideration. Finally, it seems promising to develop more sophisticated multi-objective models and further analyze their performance under multiple performance measures and sound data-driven testing protocols.

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Reciprocity in Trade: An Empirical Investigation Using Experimental Economics Methods Under Real Circumstances

Antonios Avgeris
M.Sc. Researcher, Aristotle University of Thessaloniki, Greece, Dpt. of Agricultural Economics
antoavge@agro.auth.gr

Achilleas Kontogeorgos
Assistant Professor, University of Patras, Greece, Dpt. of Business Administration of Food and Agricultural Enterprises
akontoge@upatras.gr

Maria Dalamitra
M.Sc. Researcher, Aristotle University of Thessaloniki, Greece, Dpt. of Agricultural Economics
dalamitra@agro.auth.gr

Panagiota Sergaki
Assistant Professor, Aristotle University of Thessaloniki, Greece, Dpt. of Agricultural Economics
gsergaki@auth.gr

Abstract

Despite the fact that Expected Utility Theory (EUT) constitutes the central theory of individual decision making under risk in economics, experimental findings of the last decades have shown that this theory does not give a good representation of human behavior from a descriptive point of view. A large number of studies suggest that reciprocity constitutes a basic motivational drive. People are reciprocal if they reward kind actions and punish unkind ones. They, on the other hand, are rational if they make every effort to maximize their (economic) benefit and their utility. Rationality is called the optimization of economic and not only behavior. Positive reciprocity is the act in which the people pay and reward good deeds. In this survey, we present the results of an empirical investigation of reciprocity's measuring through the experimental economy. Homo Economicus and Homo Reciprocans, the two kinds of economic people, ''conflict'' amid two different games of Game Theory. These games (Ultimatum Game and Dictator Game) were combined and interacted with the aim of producing reliable conclusions about the human behavior and reciprocity in financial transactions. According to the experimental results, subjects seem to be reciprocal, in general, in their trades with other people.

KEYWORDS

Experimental Economics, Game Theory, Homo Economicus, Homo Reciprocans, Reciprocity

1. INTRODUCTION

The Theory of Expected Utility is the basic theory that explains how people make decisions in emergency situations (Bernoulli, 1954). Although this theory consists of the basic theory of making individual decisions, experimental findings of recent decades indicate that they do not present an accurate visualization of human behavior. Although this theory is a very important tool of normative behavior, empirical research has shown that individuals behave in many cases differently than what the particular Theory predicts. The result of this phenomenon was that a number of "unexpected utility" models appeared. The aim of these theories was to show a more flexible, and psychologically, more logical image of human behavior (Panas, 2007).

So, in this point the question is; Are people cooperative or selfish?

Almost all of economic theory is built on the assumption that people act selfishly and do not care about the well-being of other human beings. Most of economic models are based on the assumption of rational and selfish agents. In these models, fairness and reciprocity motives can affect behavior. Many influential, renowned and well-known economists, including Adam Smith (1759), Gary Becker (1974), Kenneth Arrow (1981), Paul Samuelson (1993) and Amartya Sen (1995), pointed out that people often do care for the well-being of others and that this may have important economic consequences. However, most economists still routinely assume that material self-interest is the sole motivation of all people (Dufwenberg & Kirchsteiger 2004).

A large number of experimental and field studies indicate that economic decisions are in many cases motivated not only by material self interest, but also by concerns of fairness, altruism and reciprocity. This evidence has led to the development of several recent theoretical models that incorporate the above characteristics as determinant of economic behavior (Fehr & Gächter, 2000; Sobel, 2005; Fehr & Schmidt, 2006).

Reciprocity is therefore, in a way, a response to friendly but hostile actions (positive or negative). Numerous experiments have proved to be evidence of this behavioral disposition of individuals. The positive reciprocity that is the act of rewarding, in fact collaborative or courteous actions has been documented by games Trust and Gift Exchange (Fehr, Kirchsteiger and Riedl, 1993). Reciprocity is based on the concept of donation as a basic social act. It also presupposes the symmetry, i.e. that each side receiving a gift has an incentive to respond offering a gift in return. There is a large body of evidence which indicates that reciprocity is a powerful determinant of human behavior: experiments and questionnaire studies performed by psychologists and economists as well as an impressive literature in sociology, ethnology and anthropology emphasize the omnipresence of reciprocal behavior (Kahneman, Knetsch & Thaler 1986a; Fehr & Gächter 2000; Falk & Fischbacher 2006).

Actually, Maximiano (2012) discovered in a research she was doing for her paper that, people appear to be very heterogeneous in their preferences. Thus, subjects instead of being motivated only by their personal interest, are concerned about the fairness and the welfare of others and behave with reciprocity, i.e., they are willing to sacrifice some money (utility or usefulness) to reward (or punish) good (or bad) behavior of others with whom transactions are done (Maximiano 2012). Especially, if those subjects belong to common groups of people like groups of policy or religion, they tend to help and trust each other and reciprocate favors (Fehr & Falk 1997). This evidence is inextricably linked with a large body of evidence gathered by experimental economists and psychologists during the last two decades. It indicates that a substantial percentage of people are strongly motivated by others' preferences and that the concerns for the well-being of others, fairness and reciprocity cannot be ignored in social interactions (Fehr & Schmidt 2006). On the other hand, since the work of Güth, Schmittberger and Schwarze (1982), negative reciprocity has been reported in dozens if not hundreds of so-called Ultimatum bargaining Games. In these games many subjects are willing to reject positive, yet uneven offers, although the rejection is costly for them. This induces the other bargaining party to make offers that are closer to the equal split (Güth 1995; Camerer and Thaler 1995; Roth 1995; Fehr and Gächter 1998).

A broad set of experimental results indicates that people frequently choose actions that do not maximize their monetary payoffs. People reject positive offers in the Ultimatum Game, make positive allocations to anonymous parties in the Dictator Game (Roth, 1995; Güth & Tietz, 1990; Ledyard, 1995). Recent experimental research on Ultimatum and Dictator Games has found that first movers in such games tend to offer more to their counterparts than non-cooperative game theory would predict. In fact, the modal offer is generally half the pie to be divided, while non-cooperative game theory would suggest an offer of the smallest monetary unit (Hoffman et al., 1994).

2. SCOPE

As mentioned at the Abstract, this paper aims to investigate and measure the reciprocity between human (economic) relations. In particular, that is if people are possessed by feelings of reciprocity or opportunism. In other words, it attempts to provide answers regarding the battle between the two kinds of economic people in experimental economics, Homo Economicus versus Homo Reciprocans. The two well-known games of Game Theory, Ultimatum Game and Dictator Game were used and applied for this reason. That is to say, it attempts to identify whether the individuals are only interested in their own financial well-being or in their neighbor's as well.

Taking into consideration the above-mentioned, this particular paper presents the findings of a combined research conducted with undergraduate students at the University of Patras, in the Departments **of** Business Administration of Food & Agricultural Enterprises **and of** Environment & Natural Resources Management, based in Agrinio.

3. METHODOLOGY

This research was carried out over a five-month period (March-June 2015). The research approach that was followed in this work concerned the use of Experimental Economics methods combined with a questionnaire research. The questionnaire contained questions about trust, fairness, collaboration and reciprocity that students have in their daily lives and continued with questions about their economic behavior. For grading the answers, the five-level scale was used (Likert scale) depending on the degree of agreement or disagreement. After the end of the experimental process the students could, if they wanted, add new answers based on Likert scale. For the statistical analysis a 17.0 version of SPSS program was used.

The survey is divided in two separate sub-researches. The first one consists of a (N=100) sample of students and each individual had 10€ (not real money) available for playing the experimental process. For the second, real-funded study, a cash amount of 250€ was gathered and shared among the participating students. In the second sample (N=50) for the second run of the experiment each subject had 5€ (real money). In this way and by comparing the results, we pursued to examine if individuals present a different economic behavior and reciprocity when it comes to real money or not. Two games of the experimental economics were used in the experimental part of the survey. These games are the Ultimatum Game and the Dictator Game.

The Ultimatum Game (first developed by Güth, Schmittberger, and Schwarze, 1982), is a game in economic experiments. The first player (the proposer) receives a sum of money and proposes how to divide the sum between the proposer and the other player. The second player (the responder) chooses to either accept or reject this proposal. If the second player accepts, the money is split according to the proposal. If the second player rejects, neither player receives any money. In the Dictator Game (first developed by Kahneman, Knetsch & Thaler, 1986b), the first player, "the dictator", determines how to split an endowment (such as a cash prize) between himself and the second player. The second player, "the recipient", simply receives the remainder of the endowment left by the dictator. The recipient's role is entirely passive and has no input into the outcome of the game.

As far as ethical issues are concerned, researchers have fully respected them. Each student participated with his / her personal volition while firstly they had been informed about the subject of the survey. Even after this, the participants retained the right not to join in, but if the experimental process had begun, a withdrawal from the part of the student was impossible, because an even number of participants was required.

4. RESULTS

To begin with, the first two questions in the questionnaire, after the demographic ones, were dichotomous: the first, *i) I believe it is fair when someone shares something equally between himself and some other person*, and the second, *ii) If someone did an unfair share against me then I would refuse to accept it.* In both those questions the participants showed their agreement and answered in the affirmative, in a more than 75% rate in each case, (real and not real money). During the experimental part of the research, various actions and reactions from the participating players were observed. More specifically, almost, in a 50% rate, for both the first (Ultimatum) and the second (Dictator) games, the money offered amounted to half of the available funding (10€-not real money & 5€-real money) for each player. These actions showed a clear manifestation tendency of reciprocity behavior and collaboration between students. However, with regard to the first experimental process, there is a **16%** (*Graph. 1, below*) rate of these offers (Ultimatum Game → Dictator Game) rejected by the participants. On the other hand, the corresponding rate for the second run of the experiment (with actual funding) was **0%** (*Graph 2, below*). So, this difference, according to a "Independent Samples t-Test analysis" is statistically significant at a 95% confidence level (**2-tailed Sig.=0.004<0.05**).

Last but not least, no significant changes in students' responses to the five-level Likert scale questions were observed. A fact which indicates that people have held their opinions. The only remarkable change is in the question of the first experiment (not real money): *"When I deal with or negotiate with strangers it is better to pay attention before I trust them".* According to a "Paired Sample t-Test analysis" the deference

between the answers (before and after the experiment) is statistically significant at a 95% confidence level (**2-tailed Sig=0.045<0.05**).

Chart 1 The answers of players No 2 in players' No 1 offers for the first experimental procedure (not real money)

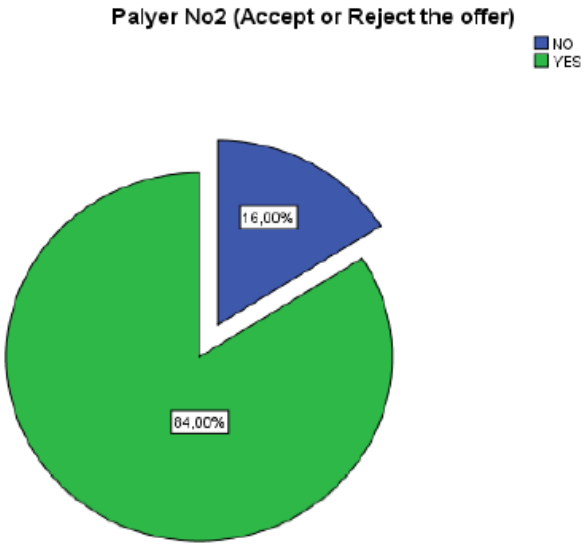
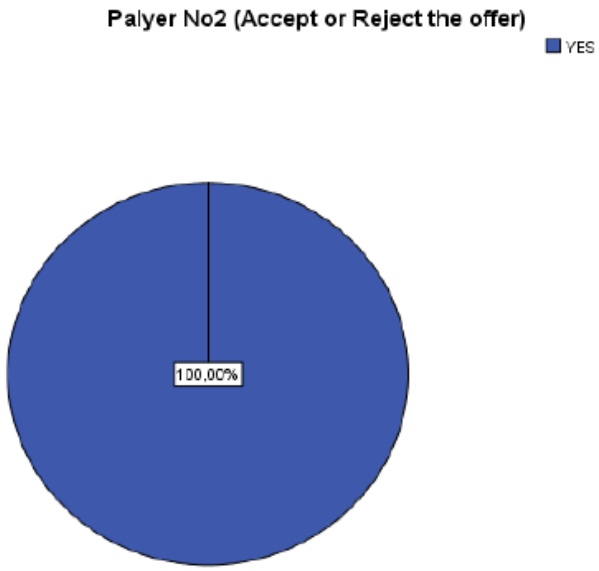


Chart 2 The answers of players No 2 in players' No 1 offers for the second experimental procedure (real money)



5. CONCLUSIONS

The analysis of the results of the survey as well as the comparison of the two sub-surveys draws out particularly useful conclusions, concerning the reciprocity of individuals. In particular:

i. Individuals wish to share and distribute something worthy and equally straightforward.

ii. They react and seem to be negative to accept an unfair offer, failing, thus, to maximize their utility and therefore to verify the phenomenon of "Homo Economicus".

iii. Regarding the question of reciprocal behavior people seem significantly positive and willing to help and to serve, but also suspicious and very careful when dealing with strangers.

iv. They did not want to exploit the status-advantage of the “Dictator” and to win by this. Instead, they retaliated the good deals they received, demonstrating the feeling of reciprocity and altruism. This particularly verifies (iii).

v. Offers particularly low (for the first experimental procedure) were rejected, which varifies the conclusion (ii).

A general conclusion that can be deduced is that the majority of students who participated in the two separate sub-researches showed a behavior of positive reciprocity by identifying with the so-called "Homo Reciprocans".

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Income taxation from Real Estate property (physical and legal persons)

Tsianaka Eleni
PhD Candidate
Department of Applied Informatics
University of Macedonia
N. Egnatia Str.156
54006, Thessaloniki, Greece
elena.tsianaka@gmail.com

Stavropoulos Antonios
Associate Professor
Department of Applied Informatics
University of Macedonia
N. Egnatia Str.156
54006, Thessaloniki, Greece
stavrop@uom.gr

Seretidou Dimitra
PhD Candidate
Department of Applied Informatics
University of Macedonia
N. Egnatia Str.156
54006, Thessaloniki, Greece
dseretidou@gmail.com

Abstract

The real estate business environment since 2008 has changed dramatically. Changes have been located in the evaluation price of real estates, the reduction of demand on real estate market, overtaxation, the lack of bank finance etc.

Real estate properties are part of the economic capital and first we will examine how we tariff properties when the holder is a natural person (individual) and second how we tariff properties when the holder is a legal entity.

The article 35 of law 4172/2013 among other things, states that the income from capital includes income that an individual acquires from real estate property. These provisions are applied when income has been earned from real estate in the tax years starting from 01/01/2014 onwards. In the same law and specifically article 47, the legislator stipulates that all revenues earned by legal persons and by legal entities are considered income from business activity and the result (profit) is taxed as profit.

Taking all the above distinctions into consideration, in this paper we will first be occupied with what the law dictates for individuals and especially with 1. The determination of the concept of income from real estate, 2. When the income from rents which are disbursed retroactively by law or court order are considered to be subject of tax income, 3. Indicative cases of the concept of income from real estate property, 4. Valuation of income in kind from own use or allotment, discharge, 5. Scale taxation of income from Real Estate 6. Uncollected rents.

Moreover, all the above issues will be approached from the aspect of legal persons and we will identify the tax burden with examples. Finally, for a complete reference to the properties, there will be a brief analysis of the context of enforcing other taxes on real estate rights.

1. Undivided taxes of Real Estate and other clauses (Law 4223/2014). (EN.F.I.A.)

2. Special real estate tax (Law 3091/2002, article 15).

3. Transfer of Real Estate property.

KEYWORDS

Real estate properties,taxanation, undivided taxes of Real , alloment, income taxation

1. INTRODUCTION

In Greece after tourism, real estate is one of the key pillars of the Greek economy, since over the last 50 years it was the main form of investment for Greek residents.

However, since 2008 there has been a steady decline in both the commercial value of properties and in rents, as well as in demand for residential and business properties.

The difficulty in stabilising the domestic property market and in it recovering can be attributed primarily to the unfavourable economic environment, the imposition of capital controls, the lack of liquidity, high levels of

unemployment, negative business and household outlooks, a drop in disposable income and the instability of the tax regime. The only sectors which have stood out and managed to attract investment interest have been tourist properties and high-spec income-generating properties (such as offices and retail units).

More specifically, there is excessive supply in the housing market, an exceptionally limited number of transactions are taking place, prices are declining although at a more restrained rate than before, since the high price drops noted in 2012 and 2013 flattened out from 2014 onwards, and during 2016 a gradual stabilisation in prices was observed. Overall though, from 2008 to 2016, the price of apartments fell by 41.3% (in nominal terms), and in terms of geographical region, the price drop continues to be most intense in Greece's two large urban centres (Athens: -43.6% and Thessaloniki: -45.5%) compared to other large cities (-38.7%) and other regions (-37.4%). As for business premises, investment interest and demand for office space and retail units has remained low. Based on available data collected from Greek real estate investment companies and credit institutions, during the first half of 2016 compared to the same half year in 2015, nominal prices for high-spec office space rose marginally by around 0.3%, while corresponding retail unit prices dropped marginally by 0.4% for the country as a whole.

During 2016 the tourist property sector proved to be the most resilient and dynamic segment of the property market, which is directly tied into tourism's excellent performance, especially from 2013 onwards. A significant number of investments are planned for Attica, including the re-opening or refurbishment of old hotels and the creation of new top class hotels (four stars or more), while deals -especially acquisitions of existing hotels- have also been completed at other tourist destinations nationwide (such as Mykonos, Corfu, Kos, etc.) helping the influx of capital into the economy and boosting employment, and helping foster a sense of trust and stability that will attract new private investments to the Greek property market. (Bank of Greece)

Given this difficult situation, this analysis will attempt to clarify what 'real estate' means and will examine, having regard to the tax regime currently in place, whether a property investor should operate as a private individual or legal person.

2. THE DEFINITION OF 'REAL ESTATE'

The Hellenic Income Tax Code (Law 4172/2013) categorizes income depending on its source into the following four categories:

1) Income from salaried employment
2) Income from business activity
3) capital income and
4) Income from the goodwill arising from capital transfers

Capital income

'Capital income' as a category covers income a private individual acquires during the tax year in cash or in kind, in the form of dividends, interest, royalties and income from property.

Article 39 of that Law states that income from property (which is part of the capital income category) means income in cash or in kind arising from:

a) Leasing or

b) owner-occupancy or

c) Gratis concession of use of land or properties.

Analyzing these points, the following clarifications need to be made:

For income to be characterized as income from property, the lessor must divest itself of the right to use the property, without simultaneously providing other types of services to the lessee (such as cleaning, security, etc.). If, when leasing a property, the lessor provides the lessee with other types of services such as cleaning, security, etc. then the income in its entirety is classified as income from business activity.

Income from property can be acquired by any person to whom a right of full ownership, possession, usufruct or habitation, as appropriate, has been lawfully transferred by a final sale contract or acquired by court ruling or through adverse possession, or by the sublessor in the case of subletting arrangements.

Moreover, the owner can grant the right to lease the property to another person in the case of subletting, or he can grant that right gratis. In all three cases, though the method may be different, there is income from property.

Other cases of income from property

Renting furnished property or property with equipment

In case of leasing, subletting or gratis concession of the use of land or a property, along with furniture or machinery (equipment), the income generated from leasing the furniture or equipment is also deemed to be income from property.

Leasing or granting use of a space for billboards, antennas, etc.

Income acquired from leasing, subletting or gratis concession of the use of land or properties, to install an antenna, wind turbine, billboards, etc. is also deemed to be income from property.

Leasing, subletting or gratis concession of communal areas in properties belonging to owners in apartment buildings (ownership by floors)

The income must be declared in order to be taxed in the individual income tax returns, along with any other income from property of the owners of such apartment buildings, pro rata with their holding in the communal areas.

Transfer of the right of usufruct

The consideration collected when transferring the right of usufruct is treated as income from property.

Compensation for early termination of commercial leases

Compensation paid by lessees to lessors for terminating commercial leases early under Article 43 of Presidential Decree 34/10.2.1995 is income from property.

Income from private use of properties - deemed income

Income from private use of land or properties (other than owner-occupancy) is deemed income for the owner of the property but is also a deductible expense.

Income from private use or gratis concession is deemed to be 3% of the property's objective value.

2.1Income from property paid in kind.

Given the definition above, the consideration for the transaction may either be in cash or in kind.

Renting properties for consideration in cash or in kind

In contracts that specifically refer both to the rent agreed as payable in cash and rent payable in kind (i.e. part of the rent is provided in the form of improvements, extensions to buildings, etc.) income from property is considered to be both the agreed cash amount and the cost of improvements, extensions, etc.

Where the lease is terminated early, the total remaining amount of expenditure paid to improve or extend the property, which is still to be allocated, must be declared as lump-sum income generated by the property in the tax year that the lease was terminated.

Erecting a building on land belonging to another

In this case, the lessor generates income from property in kind, which is taxable either as income from property in the case of private individuals under the provisions of Article 40 of Law 4172/2013, or as income from business activity in the case of legal persons or legal entities, under the provisions of Article 58 of that Law.

Examples

- Take a 10-year lease entered into in the 2014 tax year. It is agreed that the property will be leased to the lessee if he shoulders the cost of installing a lift.

The rent payable in cash is € 7,000 a year, and the budgeted cost of installing the lift is € 15,000 which is agreed in consideration of part of the rent, which is to say it is a supplementary rent.

In this case, the lessor earns income from property under the provisions of Article 39 of Law 4172/2013 comprised of the annual rent payable in cash (€ 7,000) and the rent payable in kind (€ 1,500) (€ 15,000/10 years of lease), commencing from the 2014 tax year (the year in which the lease started) up to the end of the lease, irrespective of the time at which installation of the lift is completed. When installation of the lift is completed, the actual cost will coincide with the budgeted one, and so it is not necessary to amend the budgeted rent payable in kind (€ 1,500) in the remaining years after completion of installation works.

- Take a 25-year lease entered into in the 2014 tax year. It is agreed that a land parcel will be leased for an annual rent of € 10,000 payable in cash.

The lessee erects a metal structure (prefabricated building) costing € 100,000. It is not agreed as being a supplementary rent. When the lease expires, the land parcel will be handed back to the lessor without that structure on it.

In this case, only the annual rent of € 10,000 payable in cash is income from property for the lessor, under the provisions of Article 39 of Law 4172/2013, commencing from the 2014 tax year (the year in which the lease commenced) until the lease expires, and no annual rent in kind is taken into account.

If the metal structure does in the end devolve to the lessor then:

a) if the lessor is an individual whose income is not income from business activities, at the end of the lease he acquires income from the goodwill on the transfer of capital under the provisions of Article 41 of Law 4172/2013 and b) if the lessor is a legal person or legal entity, or private individual whose income is income from business activity, at the end of the lease it/he will acquire income from business activity under the provisions of Article 47 or 21 of Law 4172/2013 at the market value of the metal structure at that time.

<u>Mixed contracts involving granting of a right for a business to be present and to operate on a property (property commercial exploitation rights)</u>

In 'mixed contracts', which are contracts granting a right for a business to be present and operate on a property (i.e. there is a right to commercially exploit the property) which includes a separate, secondary right to lease the property, the income from property is deemed to be both the rent agreed by the contracting parties, and the value of the intangiblerighttocommerciallyexploit the property.

3. TAXABLE INCOME

Taxable income is the income calculated by deducting expenses for each category of income from the gross income. The following expenditure can be deducted from income from property. If the lessor or concessionaire is a private individual, 5% of the gross income from the property is deductible for the cost of repairs, maintenance, renovations or other fixed charges and overheads for the property. Tax rates for income from property. Income earned by individuals from property is taxed in line with the tax brackets presented below:

Income from property	Rate as a %
€ 0 - 12,000	15%
€ 12,000 - 35,000	35%
€ 35,001 and over	45%

For legal persons and legal entities, the tax rate is 29%, but in the case of legal persons in order to calculate the taxable income one deducts expenses incurred to achieve their objectives, from the income, without the 5% limit applicable to individuals applying here.

If one assumes that the deductible expenses are on a par for both an individual and a legal person, it is quite clear that it is more advantageous for incomes of over € 12,001 to be acquired by legal persons.

Stamp duty

Retail units, warehouses, offices, etc.: Rental incomes in these cases are subject to stamp duty at 3.6% (comprised of 3% stamp duty and additional OGA Fund levy at 20% of the stamp duty).

All properties belonging to individuals or legal entities on the 1st of January of every year are subject to the **Single Real Estate Property Tax ("ENFIA"), following the** provisions of recent Law 4223/2013. The term "property" mentioned above includes: a) the right to full and bare ownership, usufruct and the right to habitation of a property and b) the right to exclusive use of parking spaces, auxiliary spaces and swimming pools that are located in the jointly-owned part of a basement, terrace or unbuilt section of those properties. The taxable value of buildings (main and auxiliary spaces) is determined by several factors, such as area, price zone, floor the property is on, the age of building, whether it has a façade facing the street, the percentage of ownership, and other special circumstances.

ENFIA includes not only the principal tax, but also an additional one, which is imposed by the following scale when the value of the property exceeds €300,000: Value of property (€) Rate (%) 0.01 - 300,000 0.0% 300,000.01 - 400,000 0.1% 400,000.01 - 500,000 0.2% 500,000.01 - 600,000 0.3% 600,000.01 - 700,000 0.6% 700,000.01 - 800,000 0.7% 800,000.01 - 900,000 0.8% 900,000.01 - 1,000,000 0.9% over 2,000,000 1.0%.

4. CONCLUSIONS

One can reasonably conclude from the foregoing analysis that there is a particularly high tax burden on real estate and in the case of high incomes, it is recommended that properties be exploited by a legal entity. We look forward to lower tax burdens, which will help free up income to re-start this pillar of the Greek economy.

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A Roadmap to Social Media Analytics

Misirlis Nikolaos
University of Macedonia
Egnatia 156, Thessaloniki

Nanos Ioannis
University of Macedonia
Egnatia 156, Thessaloniki

Vlachopoulou Maro
University of Macedonia
Egnatia 156, Thessaloniki

Abstract

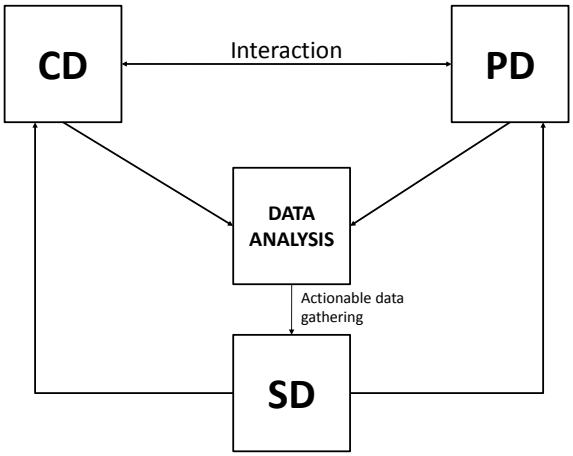
On January 2017, Facebook counts more than 1.8 billion active users and Google more than 415 million. We upload 10000 photos on Instagram and we perform over 20000 times of Skype calls every second. Internet produces 31500 GB of data every second. If Facebook was a country it would be bigger than China or India, two times bigger than Europe, ten times bigger that Russia and 1.8 million times bigger than Vatican City (esa.un.org). In 2010 social media represented a revolutionary way for companies to do business and for governments to apply e-Government techniques. Social media can be seen as the most remarkable innovation penetrating the everyday life, also for public administration tasks. Five years later, more than 70% of marketers use Facebook to successfully gain new customers in a total of 93% of marketers who use social media for business matters (shortstack.com). Forrester Research, Inc. predicts that social media will be the second-fastest growing marketing channel in US in 2016 .Constantinides and Fountain (2008) claim that Internet of Things and Web 2.0 will offer endless possibilities in the business world. Social media, also as a part and sub-category of big data platforms, will contribute to such possibilities, as well. As a result of these innovative web models and technologies on the social media landscape, considerable research issues and questions arise, regarding social media analytics and big data technologies: How to render actionable the large datasets from social media? How to classify all the relevant techniques? How to capitalize all the existing information? The objective of this study is to approach the above research issues regarding several social media types, social media analytics and social media tools in precise definitions and categories, based on literature review and Internet search.
We analyze social media on marketing and its research options. Furthermore, we perform a full report of social media landscape, presenting four main classification suggestions for social media. In the following section we present the main definitions for social media analytics analyzing further different approaches in analysis, dividing in structural and content-based approach. Finally, we provide with concluding remarks and future research implications.

1. INTRODUCTION

Social media analytics is the practice of gathering data from social media platforms and applications and analyzing that data to make effective business/ marketing decisions. The most common use of social media analytics is to mine customers' sentiment, support marketing and customer service activities.
In specific, research on social media marketing and analytics is divided into three areas, according to the point of focusing the involved entities and their roles. Therefore, social media analytics can be approached from several perspectives, related to the different involved entities: the users'/ customers' perspective, the platform and application providers' perspective, and the suppliers'/organizations' one. Therefore, consumer-centric studies generally focused on social media use and their impact on consumer behavior. Researchers need to study several perspectives of such use. For example, which is the specific platform and application used, how and when or what do they seek, how often, what is their demographic and which is the specific field of interest (e.g. health, tourism, general info, travel, sports, games, etc.). This research analysis leads to large volumes of data, here and after known as Customer Data or **CD** that constitute valuable resource for the marketing strategy of several organizations. On the other side, **platforms** and applications of several social media, concentrate also the interest of researchers posing a series of questions, like: who are the appropriate or most preferred platforms and applications, what data they record, which is the relationship between platforms and customers. We call these data, Platform Data or **PD**. The third perspective is consisted of the supplier-related social media studies, focusing on the specific use of social media by several organizations/ brands (e.g. TripAdvisor, Skyscanner, Uber, Booking, Trivago, etc.). Companies may have doubt as to whether

their investments in social media marketing could turn into business or how much resources they should invest in several social media platforms/ applications. These research questions can be answered based on data collected and analyzed in order to provide clues or directions for their future marketing strategy. The ultimate goal of the organizations for employing several social media is to convert social media visitors to actual customers, using social media platforms for information dissemination – sharing, brand awareness, engagement or for direct sales. The companies' social media sites are the intermediate factors between platforms and customers, combining useful, but different data from different sources and media (also known as Suppliers'/ Business Data or **SD**), rendering these data actionable for business insights and decision-making procedures. The raised challenge for marketers and data analysts is what to do with this amount of user-generated data, and how exactly to analyze these data in order to be more effective.
The first step in a social media analytics initiative is to determine which business goals the data that is gathered and analyzed will benefit. Typical objectives include increasing revenues, reducing customer service costs, getting feedback on products and services and improving public opinion of a particular product or business division. Once the business goals have been identified, specific metrics (e.g. key performance indicators -KPIs) for objectively evaluating the data should be defined. There is a number of types of software tools for analyzing unstructured data found in social media platforms and applications. SMA refers to the approach of collecting data from social media platforms and evaluating that data to make business decisions.

Figure 1 Data interaction between customers, platforms and suppliers/ businesses



2. SOCIAL MEDIA ANALYTICS

Social media constitute a source of data, information and knowledge, which analysis leads to understanding real-time consumer choices, intentions and sentiments. The most prevalent application of social media analytics is to get to know the customer base on a more emotional level to help better target customer service and marketing. As we notice, the social media environment is complex enough with plethora of definitions and classifications. As a consequence, SMA is also not yet fully clarified. Many researches argue that there is a scientific gap concerning the taxonomy of the field of SMA and its relative techniques. Next we provide with several definition approaches for SMA, four from scientific journals and four from the business world. Understanding the field exactly, will help us to further analyze every sub-category of the SMA.

Table 10 Main classifications of social media

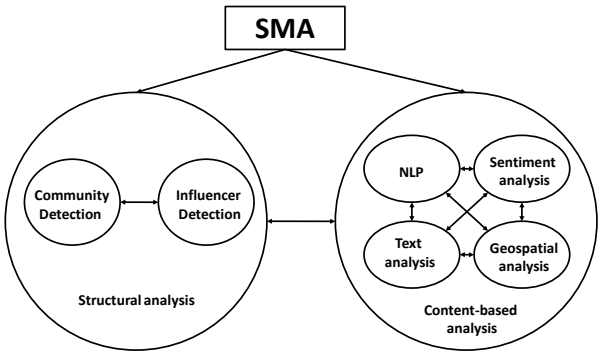
Authors	Social media categories

Authors	**Social media categories**
Constantinides and Fountain (2008)	• Blogs • social networks • content communities • forums • content aggregators
Kaplan and Haenlein (2010)	• collaborative wikis • blogs • social content • virtual communities
Mangold and Faulds (2009)	• social networking sites • creativity work sharing sites • users sponsored websites • company sponsored cause • invitation-only social networks • business networking sites • collaborative web sites • virtual worlds • commerce communities • podcasts • news delivery sites • educational material sharing sites • open-source software communities • social bookmarking sites

Next, we classify SMA in sub-categories, providing related short definitions and a classification scheme. More analytically, SMA can be subdivided in two main categories: a) structural analysis and b) content-based analysis.

With the emergence of social data and the advance of analytical technologies and methodologies, organizations can apply SMA in order to create a competitive advantage within their markets. Studying several approaches on SMA, we conclude that there is not a specific choice suitable for every decision, but it is common the combined use of several analyses. In specific, according to the literature, SMA can be divided in structural and content-based. Each of them contains different subcategories of analyses. Through structural analysis we conduct community and/ or influencer detection. With content-based analysis we conduct sentiment, text, geospatial analysis and natural language processing.

Figure 2 SMA subdivision



2.1 Structural analysis

Structural analysis is performed mainly by graphs. It is the base notion for two important techniques; community and influencers' detection (Gandomi & Haider, 2015). Community detection is capable of revealing homophily and shared characteristics among users. Behavioral patterns of community can also be detected from graphs (Aggarwal, 2011). Influencers' detection is also another useful technique on structural analysis and graphs. By counting, for example, the number of edges of a node, analysts understand which user is more active, who interacts with whom, who posts more item etc. Community and influencers' detection is strongly correlated with behavioral analytics and social science and represents a field of study for many researchers (Amichai-Hamburger & Vinitzky, 2010; Bishop, 2007; Kaptein, Markopoulos, de Ruyter, & Aarts, 2009; Moore & McElroy, 2012; Ryan & Xenos, 2011).

2.2 Content-based analysis

Content-based analysis is the most complete type of analysis on social media. This subcategory contains all the data mining techniques based on statistics, computing, engineering and machine learning. Generally, the content-based analysis focus on user generated content, whether this content is text, video, images and/ or geospatial data. This type of data is mostly unstructured, noisy and dynamic. Today, 2.5 billion GB of unstructured content (sensors, social media posts and photos) is created every day, while only a 1% of the data is finally analyzed. Unstructured data represent the 90% of all data available (IBM, n.d.; Syed, Gillela, & Venugopal, 2013; Valkanas & Gunopulos, 2013).

Three sub- analysis processes are included in content-based analysis:

a. **Natural Language Process** (NLP). In this type of analysis, data mining is performed on text, trying to produce meaningful outcomes. NLP is related to computer-human interaction, artificial intelligence and linguistics. After studying relevant definitions, we conduct that text analysis is supplementary for NLP. Text analysis conducts lexical analysis by recognizing patterns and word frequencies (Bello-Orgaz, Jung, & Camacho, 2016; Gandomi & Haider, 2015).

b. **Sentiment analysis**. This type of analysis applies the NLP outcomes in order to extract users' sentiments and opinions on a subject. Sentiment analysis adapts tools from machine learning, such as automatic procedures for determining opinions and extracting subjective information from users (Batrinca & Treleaven, 2015).

c. **Geospatial analysis**. This type of analysis includes four types of diverse data such as: a. both location and time sensitive data (e.g. foursquare), b. location sensitive only data (e.g. yelp), c. time sensitive only data (e.g. Facebook status updates and tweets), and d. neither location nor time sensitive data (YouTube videos and Wikipedia entries).

3. CONCLUSION

With social media we produce a vast amount of data, introducing data analysis procedures in the big data era. Marketing science, together with information technology and statistics have great interest on understanding and analyzing social media and the data created. Even if SMA can be considered on its early stages of maturity, organizations and other involved entities can capitalize on social media turning them to their advantage. This can be succeeded by using right and scientifically the available tools, by creating the right strategies, turning SMA in actionable insights, and by employing the right technology.
By knowing how to effectively measure the social media value, companies and individuals can produce insights that allow them to improve and promote their products and services, or even themselves (for individuals). Paraphrasing Peter Sondergaard, from Gartner Research, Data Analysis, Big Data and Social Media are the oil of the 21st century and analytics, the combustion engine.

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The influence of social media on consumers' behavior

Evangelia Kyriakopoulou
School of Information Sciences, Department of Applied Informatics, University of Macedonia, P.O. Box 1591, GR54006 Thessaloniki, Greece.
kyriakop.eva@gmail.com

Fotis Kitsios
School of Information Sciences, Department of Applied Informatics, University of Macedonia, P.O. Box 1591, GR54006 Thessaloniki, Greece.
kitsios@uom.gr

Abstract

Online social networking has become one of the most popular online activities that more and more people preferably spend their free time on. Lately, the high rate of data transmission combined with the hectic everyday lifestyle that the actual society imposes, have raised the necessity of time-saving solutions. As a result, consumers search for direct and quick alternatives for their purchases, in order to cover their needs. Also, the most important role of social media is that it has changed the way of how consumers and marketers communicate. Social media is a great communication tool that people use to connect to others or communicate with organizations. Social networking platforms as a part of everyday life are virtual places where people as users, share their opinion, warnings, experiences and information. The consumers' social and commercial experience on the internet has been enriched through the daily use of social media. On the other hand, companies benefit from this state and try to provide their products through a "friendly" environment such as social networks, less direct to the consumers, aiming to maximize the customers' experience. The present study aims at estimating the influence of the use of online advertisements in consumers' behavior. This paper is related to the impact of social media on consumers' behavior, therefore it has been made a quantitative research. The study has been conducted with the use of questionnaires addressed to active users of social media. Furthermore, the results have been analyzed, aiming to underline the effectiveness of advertising via social media as means of sales.

KEYWORDS

Social media, consumer behavior, brand, consumer perception, social networks, social media marketing

1. INTRODUCTION

Lately, there has been a constantly increased spread and usage of social media from single users and companies, worldwide. Social networking sites such as Facebook, Twitter or Instagram, are being used as means of communication amongst users, data exchange, information about recent topics in addition with market issues. Truly, social media have transformed radically the information sharing facilitating thus the assimilation of information on the Internet (Akrimi & Khemakhem, 2012). Additionally, customers view social media sites as a service channel, where they can engage on real-time bases with the businesses (Leggat, 2010).

Social networking sites are a powerful marketing tool being widely used as means of connection amongst users and between companies as users. Thus, it can be said that social media helps firms to build brand loyalty through networking, conversation, and community building (McKee, 2010).

Social media marketing is different than traditional methods of marketing; therefore, it requires special attention and strategy building to achieve brand image and loyalty (Erdoğmuş & Çiçek, 2010). Social media marketing is related to relationship marketing, where the firms need to shift from "trying to sell" to "making connections" with the consumers (Gordhamer, 2009). The consumer is given this way the opportunity to meet new products or be informed about provided products-services of any brand. It is widely acknowledged that the consumers' brand loyalty is affordable if the brand itself emphasizes on better customer's service in order to maximize customer's experience (Kitsios & Kamariotou, 2016a; 2016b). Branding is central to creating customer value, not just images and is also a key tool for creating and maintaining competitive advantage (Holt, 2015). This rapidly increasing trend evolves into an excellent opportunity for companies, thus direct communication with customers achieved. Social media marketing is defined as "*the connection*

between brands and consumers" while offering simultaneously a personal channel focused on social interaction (Chi, 2011).

Studies in domestic and international case studies demonstrated a lack in researches related to the influence of social media advertising on consumers' behavior and companies' product sales. It has been specified, in former research, that consumers' brand attitude is influenced by social media (Abzari et al., 2014).In this particular research the sample is narrowed amongst undergraduate students, thus, the extension of the research is recommended for further analysis.

The present study aims at estimating the influence of the use of online advertisements in consumers' behavior. This paper is related to the impact of social media on consumers' behavior, therefore it has been made a quantitative research.

Section 2 reviews the literature and the existing empirical researches in this field. Section 3 describes the data collection process and method of analysis. Section 4 presents the outcome and results, whereas Section 5 presents the conclusions and sets future research propositions.

2. LITERATURE REVIEW

Social media such as Facebook, Twitter, Youtube and most recent Instagram, are acknowledged as online platforms where users are able to sign up with a personal account in order to communicate with other users, receive information or be advertised. The rapid increase in the popularity of social media created the necessity for the use of social media as a fundamental tool of industry's promotion and product sales. Social media are able to modify the marketing methods, since businesses interact immediately with the consumers-user (Solomon et al, 2010). Social networking sites lead the race in human communication and have a huge impact in human behavior (Cheung & Lee, 2010).

The high levels of effectiveness of social media compared with traditional ways of communication, has leaded the industry titans to report the compulsory-coordinated presence every company should have on social media in order to succeed in digital environments (Kaplan & Haenlein, 2010).

In 2010, Cox made a research in order to investigate the relation between age and consumers attitude. In this particular research is concluded that social media users' behavior in contrast to other digital users 'behavior differed among various age groups. Cox (2010) mentioned that the age group of 18-28 expresses a positive attitude against blogs, videos and brands' official websites. Age group of 35-54 seems to prefer videos and brands' channels. The general conclusion is that direct advertisements are welcomed by the users. On the contrary, pop up advertisements or those with website extensions were labeled as disturbing by users of social media and web (Cox, 2010). Internet groups seem to affect directly the consumer's purchase intentions while having an indirect impact on the final purchase decision making. For example, social media are an extraordinary means of expression and information sources about products and services, thus facilitating the users' final decision (Kozinets et al., 2010).

Staying competitive in today's fast moving business landscape requires a solid social media strategy. Companies hire social media experts and consultants to decide on content and characteristics of their offers and activities in social media environments so that the hearts and minds of the consumers are captured and brand loyalty follows (Coon, 2010). Research by eMarketer has shown that consumers go to social media sites to keep up with a brand's products and promotional campaigns (Mangold & Faulds, 2009; Leggat, 2010).

For the research to be conducted, the following hypotheses were stated:

H1: Social media advertising is able to affect the consumers' behavior.

H2: Internet and online advertising is able to affect the consumers' behavior.

H3: Brand is able to affect the consumers' behavior.

Common parameter in all three hypotheses is the level of influence in consumers' behavior which is the main goal of this particular research. Through the questionnaire and literature review, the hypothesis above, were created and studied in order to be accepted or rejected using SEM analysis.

3. METHODOLOGY

The data collection was conducted through an online questionnaire addressed to social media users. The basic condition for the completion of the query was for the subjects to possess at least one active account in any social networking site.

The questionnaire's structure was based on previous researches, relative to the object (Abzari et al., 2014; Charlene Li, 2007; Kodjamanis & Angelopoulos, 2013; Schlosser et al., 1999; Trainor et al., 2014), in addition with information deriving from international case studies.

The first step was the creation of a pilot questionnaire which was answered by approximately thirty users in order to locate any ambiguities or defaults. Afterwards, the questions were rephrased aiming to stimulate the interest of both the companies and the consumers. Finally, the cover letter was redacted. The questionnaire was sent via email and facebook, in addition with a few printed forms for the facilitation of particular subjects. The final step was the collection of required sample which was later on analyzed through the AMOS software.

The query is based on four thematic units. At the first one, the subjects answered to general questions about their presence in social media. For example, "how often do you sign in to social media?", "do you have an account on any social media?" or "what do you use social media for?". The second unit inquires variables which aided the study of the relation between social media and their users' behavior as consumers. In the third unit, subjects were asked for answers related to their shopping habits on internet. The fourth unit investigates the consumers' attitude against brands. The final part of the questionnaire includes the subjects' demographic variables such as age, sex etc. It has to be pointed out that, the questionnaires of non-active users were excluded. Current sample size was estimated at 203. A convenience-sampling approach was used to collect data. Structural equation modeling was employed to analyze data using AMOS software.

4. DATA ANALYSIS

Table 1 presents the results of the individual tests of the significance of the relationship among the variables.

Table 1 Results

Model		Unstandardized Coefficients		Standarized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	,986	,144		6,837	,000
	C1	,072	,028	,126	2,565	,011
	C2	,178	,064	,136	2,759	,006
	C3	-,011	,033	-,016	-,326	,744

a. Dependent Variable: E

Through the current analysis, it occurs that hypothesis 2 is confirmed with $p<0.05$, while hypothesis 1 and hypothesis 3 are rejected with $p>0.05$ (Table 2). On the contrary, in another research both hypotheses are confirmed (Abzari et al., 2014).

Table 2 Hypothesis

Hypothesis	Independent Variable	Dependent Variable	Results
H1	Social media	Consumers' behavior	rejected
H2	Internet		confirmed
H3	Brand		rejected

Figure 1 shows the overall explanatory power, the standardized path regression coefficients that indicate the direct influences of the predictor upon the predicted latent constructs for the model, and associated t-values of the paths of the research model. As figure shows, due to the small sample, it is recommended for future researchers to collect a larger sample in order to conduct the research. The model produced a chi-square of 291,715.

The goodness of fit is index GFI=0,834, the comparative fit index CFI=0,334, NFI=0,312, the Tucker-Lewis index TLI=0,102, and the root mean square error of approximation GMSEA=0,106.

Figure 1 Standardized regression coefficients proposed model

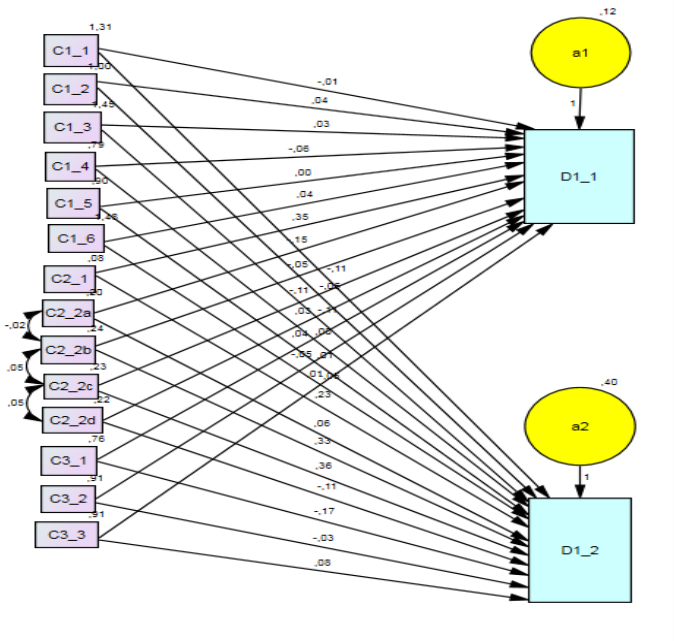

Figure 1 presents the variables that should remain in the model. These variables are the following: C1_6, C2_1 and C2_2b. They should remain in the model as the most statistically significant.

5. CONCLUSIONS

The present study aims at estimating the influence of the use of online advertisements in consumers' behavior. This paper is related to the impact of social media on consumers' behavior, therefore it has been made a quantitative research.

As social media are able to affect on customers' decision making and purchase intension, managers have the opportunity to make conversations in order to promote their products. Through the virtual interaction with customers, companies have the chance to improve their products, their brand and total appearance on social media aiming to satisfy consumers' needs. If company succeeds in having satisfied customers, in turn, the company's reputation will be widely spread, creating a positive aura around company's brand. Thus, through positive referrals related to the company, customers are drifted into purchasing company products.

As the results show, due to the small sample, it is recommended for future researchers to collect a larger sample in order to conduct the research.

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An Empirical Evaluation of Strategic Information Systems Planning Phases in SMEs: Determinants of Effectiveness

Maria Kamariotou, Fotis Kitsios
School of Informatics, Department of Applied Informatics
University of Macedonia, P.O. Box 1591, GR54006 Thessaloniki, Greece

Abstract

Strategic Information Systems Planning (SISP) supports business goals and business strategy, through the use of Information Systems (IS). Findings from previous surveys indicate that many managers make too much effort to SISP process while others too little. When managers invest too much effort, the process could be confusing, delayed or its implementation could be prevented. When managers avoid investing too much time to the process, the implemented plans could be inefficient so the objectives could not be achieved. Consequently, the assessment of the process is significant because managers can reduce these unsatisfactory results. Findings conclude that managers concentrate more on Strategy Conception and Strategy Implementation and they do not invest time on Strategic Awareness and Situation Analysis. As a result the implemented plans are not effective, successful and they do not meet the objectives. Many factors which influence SISP process could be taken into consideration in order to explain these results. Almost 80% of businesses have been highly influenced by the financial crisis. So, more attention is needed to be payed to Small-Medium Enterprises (SMEs) and how they use IS and strategic planning in order to deal with the crisis. Despite the fact that family businesses focus on business's long-term sustainability, they do not develop strategic planning. The purpose of this paper is to indicate the phases which contribute to a greater extent of success and to provide conclusions regarding on the implementation of this survey in SMEs. Data was collected using questionnaires to IS executives in SMEs, particularly in North Greece. The questionnaire assessed SISP in terms of Strategic Awareness, Situation Analysis, Strategy Conception, Strategy Formulation and Strategy Implementation Planning. The contribution of this paper is twofold. Firstly, it expands the current knowledge regarding the significance of SISP and secondly it helps IS executives to improve the process.

KEYWORDS

Strategic Information Systems Planning, Planning success, Business Strategy, Information Technology

1. INTRODUCTION

The current business environment is getting more and more complex and uncertain. Thus, businesses are obliged to deal with that environmental uncertainty. The use of Information Systems (IS) and Strategic Planning facilitate this effort. IS support business strategy, and accommodates decision making using management skills to increase competitive advantage (Zubovic et al., 2014). The integration between IS and Strategic Planning is known as Strategic Information Systems Planning (SISP).

Researchers have paid attention to the process of SISP since 1970. SISP support business goals and business strategy, through the use of IS. Moreover, SISP enhances the innovation, the development of new products, the reduction of costs and the enhancement of relationships with customers (Kamariotou & Kitsios, 2018; 2015; Ullah & Lai, 2013). IS help businesses to compete in a global market, to meet consumer needs and to reduce the product life cycles. Researchers claim that the use of technology could be a source of sustainable competitive advantage only if the IS strategy will be aligned with business strategy (Kamariotou & Kitsios, 2017; Ullah & Lai, 2013). The process of SISP involves five phases, named; strategic awareness, situation analysis, strategy conception, strategy formulation and strategy implementation planning. These phases support businesses to define IS strategy as well as to develop IS.

Previous surveys have studied the impact of these phases on SISP success in large firms. However, studies in SMEs which compose the most important part of each economy, are limited (Newkirk et al., 2003). Other researchers have discussed the positive relationship between SISP and firm performance. These surveys conclude to the relationship between SISP and firm performance have been limited, as they only theoretical results (Lederer & Sethi, 1996).

SMEs are significant components of national economy, because they constitute of the large amount of businesses of a country. Nowadays they have been negatively affected by financial crisis. In order to face this, SMEs are obligated to gather information for their environment. This information should be the appropriate in order to compete and face the environmental complexity, so the process of gathering information should be strategic. As SMEs try to compete in the current uncertain environment, so that it could be innovative and increase their growth, they need to align their business and IT strategy (Bourletidis et al., 2014; Kitsios & Kamariotou, 2017). The most important challenges which SMEs face which led to the failure of the alignment process are the lack of conscious planning, the lack of strategic decision making and sharing information. Also SMEs do not invest on IT. As a result the communication between the departments is difficult (Kitsios & Kamariotou, 2017; Rathnam et al., 2004).

In this view, the purpose of this paper is to indicate the phases which contribute to a greater extent of success. Specifically, the objective is to determine which phases contribute more and how they can be improved.

The structure of this paper is as following: after a brief introduction to previous researches, next section includes the literature review in order to highlight the issues which are discussed in this paper. Section 3 describes the methodology, while Section 4 shows the results from the implementation of the proposed approach. Finally, Section 5 discusses the results and concludes the paper.

2. LITERATURE REVIEW

The selected methodology was suggested in the field of IS. The three steps of the suggested methodology are: the search, in which the definition of keywords and databases and the selection of individual topics are analysed, then the "backward search" and finally the "forward search." At the end, the analysis and synthesis of the main ideas of articles follows (Webster & Watson, 2002).

Databases and keywords are selected from previous literature reviews on the field of SISP. Databases are Scopus, Science Direct, Web of Science and ABI/INFORM and searching was done with combinations of keywords, "information systems strategy", "firm performance" and "strategic information systems planning", Articles are only in English and are published in scientific journals or conferences, not in books.

Having searched all databases, the titles and abstracts of the relevant publications were scanned and the citations and references of the residual articles were then reviewed. A total of 89 articles results consist the final sample. Search was completed when it resulted in common articles from all databases and different combinations of keywords. It was then that the critical mass of relevant literature sources was considered as having been collected.

SISP has been defined as the ability to formulate the strategy of a business with the help of tools, techniques and methodologies which were used to support organizations in identifying potential opportunities to develop IS with greater competitiveness (Peppard et al., 2014). SISP has been considered as an integrated process which contains specific phases. These phases and the relevant activities are presented as follows.

Table 1 presents the phases with the major activities. In this paper, these phases and activities were used in order to measure SISP.

Table 11 SISP phases and their activities

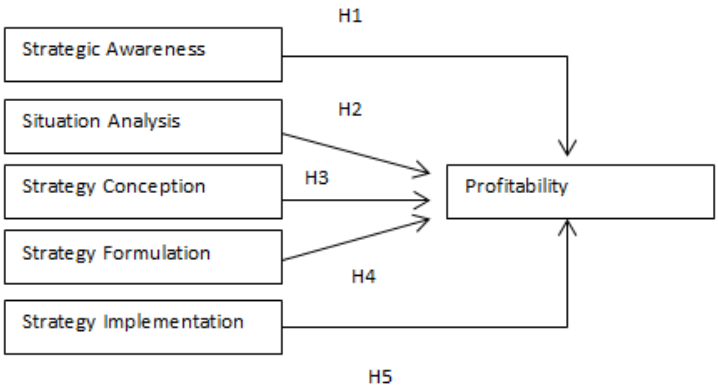
Phases	Activities	References
Strategic Awareness	Determine key planning issues Determine planning objectives Organize the planning team Obtain top management commitment	Brown, 2004; 2010, Kamariotou & Kitsios, 2018; 2017; 2016; Kitsios & Kamariotou, 2016; Maharaj & Brown, 2015;
Situation Analysis	Analyze current business systems Analyze current organizational systems	Mentzas, 1997; Mirchandani & Lederer, 2014; Newkirk &

	Analyze current information systems Analyze the current external business environment Analyze the current external IT environment	Lederer, 2006; Newkirk et al., 2008
Strategy Conception	Identify major IT objectives Identify opportunities for improvement Evaluate opportunities for improvement Identify high level IT strategies	
Strategy Selection	Identify new business processes Identify new IT architectures Identify specific new projects Identify priorities for new projects	
Strategy Implementation Planning	Define change management approaches Define action plans Evaluate action plans Define follow-up and control procedures	

As the current financial crisis has negatively influenced SMES, they try to be competitive and reduce uncertainty. Financial barriers, as well as the lack of technological, managerial and human capabilities may complicate their efforts to deal with the financial crisis (Bourletidis et al., 2014). Another factor which negatively influences their efforts is the lack of strategic planning. In this view, formal processes which are related to strategic management and information handling help SMEs to formulate strategies, redesign structures and processes that aim to increase firm performance (Giannacourou et al., 2015).Based on previous findings and regarding previous researchers who highlighted the effect of SISP on firm performance (Lederer & Sethi, 1996) the following hypothesis were indicated in order to be tested:

H1: Strategic Awareness positively affects firm's profitability.
H2: Situation Analysis positively affects firm's profitability.
H3: Strategy Conception positively affects firm's profitability.
H4: Strategy Formulation positively affects firm's profitability.
H5: Strategy Implementation positively affects firm's profitability.

Figure 12 Research Model



As SISP is a formal process, SMEs can implement it to formulate IS strategy and implement the most suitable IS for their needs. This process supports businesses to make decisions on the planning and the development of IS by analyzing their resources while taking into consideration both the environmental opportunities and the threats. Moreover, SISP includes all the factors and the tasks which are shown above as the benefits of the formalization. Mirchandani & Lederer, (2014), examined SISP phases and they concluded that the more complex the environment becomes, the more Situational Analysis is required. The analysis of current business systems, organizational systems and IS, as well as current external, internal business environment and current external IT environment gives the opportunity to the organization to identify problems and diagnose opportunities.

3. DATA AND METHODOLOGY

Data for the empirical investigation was obtained through SMEs in Thessaloniki. These firms were selected from the icap list. The questionnaire was developed to capture IS executives' views on how SISP phases affect firm performance. The questionnaire was based on previous surveys regarding SISP phases (Kamariotou & Kitsios, 2017; 2016; Kitsios & Kamariotou, 2016; Mentzas, 1997; Newkirk & Lederer, 2006; Newkirk et al., 2008) and firm performance (Cao & Schniederjans, 2004; King & Teo, 2000). The questions were pre-tested in a pilot study. Four IS executives were asked to participate in a pilot test. Then, the survey was sent to 300 IS executives and a total of 55 returned the survey. Data analysis was implemented with Multiple Regression Analysis in order to test the hypothesis.

4. RESULTS

Respondents in this study were employed in a variety of industries, well educated, and experienced. Table 2 presents the Cronbach's alpha results for the phases of SISP, each one with four or five tasks and the firm profitability which is the dependent variable. The internal consistency, calculated via Cronbach's alpha, ranged from 0.812 to 0.856, exceeding the minimally required 0.70 level (Newkirk et al., 2003; Pai, 2006).

Table 2 Reliability statistics

Constructs		Scale Mean if Item deleted	Scale Variance if Item deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item deleted
Strategic Awareness	SP1	17,425	14,913	,642	,839
Situation Analysis	SP2	17,547	14,898	,584	,852
Strategy Conception	SP3	17,368	14,978	,733	,822
Strategy Formulation	SP4	17,566	15,258	,660	,835
Strategy Implementation	SP5	17,660	14,188	,778	,812
Firm Performance	FP1	18,000	17,086	,536	,856

The hypothesized relationships presented in Figure 1 were testing using Multiple Regression Analysis. Table 3 summarizes the hypothesis testing. Of the five hypotheses, two were supported. A discussion on the results related to the hypotheses follow.

Table 3 Coefficients [a]

Model	Unstandardized coefficients		Standardized coefficients	t	Sig.	Hypothesis
	B	Std. Error	Beta			
Constant	1,105	,305		3,620	,000	
SP1	,006	,084	,088	,076	,940	H1 (-)
SP2	,038	,072	,053	,524	,602	H2 (-)
SP3	,214	,105	,254	2,048	,043	H3 (+)
SP4	,265	,088	,324	3,022	,003	H4 (+)
SP5	,031	,106	,040	,292	,771	H5 (-)

This study first examined the relationship between Strategic Awareness and firm's profitability. H1 found no support. As SISP managers do not invest time on Strategic Awareness, they do not determine planning objectives and they are not committed. As a result this phase does not affect firm's profitability. Also, Situation Analysis found no support (H2). Despite the fact that this phase is very tedious for IS executives in order to gather information about competitors, industry and customers, results show that they do not focused their attention on this phase (Newkirk & Lederer, 2006; Newkirk et al., 2003). So, this phase does not contribute to firm's profitability. As predicted by H3, Strategy Conception shows a positive relationship with

firm's profitability (β=0,214, p<0.005). Consequently, H3 is supported. In contrast, previous findings show that more strategy conception does not, apparently, produce a better set of alternatives to executives in order to choose (Newkirk & Lederer, 2006; Newkirk et al., 2003). Moreover, H4 is supported since the Strategy Formulation has a significant positive effect on firm's profitability (β=0,265, p<0.005). Finally, H5 found no support. The strategy implementation planning phase is especially interesting, because implementation is generally seen as the most significant impediment to success. Plans may be conceived and formulated but are seldom implemented. Unfortunately, the results of this study show that managers do not implement their plans.

5. CONCLUSIONS

So far limited academic studies have focused on the impact of SISP phases on firm performance. This study proposed a framework to suggest a formal process which will be followed by IS executives and managers in order to plan and use the right IS and to increase competitive advantage. The results of this study show that they concentrate on Strategy Conception and Formulation, focusing on identifying IT objectives and architectures. As a result, they might be planning inefficiently and ineffectively.

The authors contribute to the existing surveys by raising IS executives awareness of the strategic use of IS planning in order to achieve competitive advantage. Understanding those phases may help IS executives focus their efforts on their goals and realize greater value from the planning process in their own organization. Second, the results of this study can increase their awareness of the phases of SISP. IS executives should be knowledgeable about the five phases, but the individual tasks in each might suggest overlooked activities. These might hamper the organization from achieving its planning goals and thus from realizing greater value.

A limitation of the model stems from the fact that the sample was not adequate. Nevertheless, the results of an exploratory study will be summarized in an improved conceptual model for further research. This study is made for SMEs. Future researchers could investigate and compare these results with relative ones from big companies. Apparently, future researchers may use different methodologies for data analysis.

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Measuring Leaders' Strategic Thinking

Maria E. Georgakalou
Hellenic Open University
Associate Research Staff
Business Administration
Undergraduate Program
georgakalou.maria@ac.eap.gr

Fotis C. Kitsios
School of Information Sciences,
Department of Applied Informatics,
University of Macedonia,
P.O. Box 1591, GR54006
Thesaloniki, Greece
kitsios@uom.gr

Maria Kamariotou
School of Information Sciences,
Department of Applied Informatics,
University of Macedonia,
P.O. Box 1591, GR54006
Thesaloniki, Greece
tm1367@uom.edu.gr

Abstract

Can a visionary person be understood by only taking a glance in the person's written texts? And what about the person's tendency to risks' undertaking? And what happens when this person is a leader in any kind of activity? Leaders establish and share the values, develop and communicate the vision, determine the mission and formulate and implement the strategy. Apart from being determined, the leader should be able to present his vision and to stir up his audience and envisage them. Additionally, he should be determined to undertake risks. Previous researches have examined the link between their personal characteristics and planning system, the human capabilities of leaders and the effect of organizational characteristics. The Leadership Excellence Model which has been studied by many researchers contains these elements but they cannot be measured directly. Additionally, as far as it concerns measurement of characteristics found in written texts, the measures of texts' characteristics were initially introduced and constructed. Previously, researchers have proposed three new measures in order to quickly see the degree of entrepreneurial thought of an individual, as this can be sought in the individual's written texts and constructed those measures. The purpose of this paper is to propose measures in order to investigate and measure the degree of a person's strategic thinking, mainly focusing on leaders. These measures concern: (a) the measure of risk taking (which is actually a score) and (b) the measure of (visionary). This might be useful for evaluators of modern enterprises and for researchers of political and social sciences, trying to find out the vision which is found in the written texts of the particular person.

KEYWORDS

Heuristic Measures, Strategy, Leadership

1. INTRODUCTION

The past decades, much work has been done on defining the attitudes of a leader. Furthermore, a discussion on determining the attitudes of successful leaders and those of charismatic ones has been held. Scientists have tried to find out the relation between the person's written texts and the person's character and qualities as they reflect in the written texts.

Strategic thinking has been identified as one of the main capabilities of leaders with high performance (Bonn, 2005; 2001; Goldman and Casey, 2010; Shirvani and Shojaie, 2011), while limited research has been done regarding factors concurring to strategic thinking (Bonn, 2005; 2001; Goldman and Casey, 2010). The relation between leadership and strategic thinking has also been investigated (Zabriskie and Huellmantel, 1991), while the fact that great ideas and thoughts require time to develop into great successes in the future to reach your defined vision (Goldman and Casey, 2010; Shirvani and Shojaie, 2011; Sarfraz, 2017) has also been recognised. The previous papers relevant to characteristics that can be measured in written texts are about leaders' attributes (Georgakalou and Moustakis, 2008; 2006) and about entrepreneurial qualities found in written texts (Georgakalou and Kitsios, 2015; 2011).

To sum up, a significant aspect of strategic thinking is the ability to take a holistic perspective of the organization and its environment. Organizations must search for opportunities and envision better ways of

doing things (Bonn, 2005; Kamariotou and Kitsios, 2016; Kitsios and Kamariotou, 2017; Zabriskie and Huellmantel, 1991). In our effort to identify the major characteristics of a strategic thinker that should be investigated in the person's written texts, we have found much discussion about the elements of strategic thinkers (Ebersole, 2017; Goldman and Casey, 2010; Liedtka, 1998), which have not been investigated in depth yet (Goldman and Scott, 2016), their tendency to discover opportunities (Shirvani and Shojaie, 2011) and their principles (O'Shannassy, 2010).

This paper is aimed at introducing two new measures of attributes in written texts. These measures are going to measure the tendency to risk taking (which is actually a score) as well as the tendency to be visionary of the writer of the text. Those are two characteristics any strategic thinker should be able to demonstrate.

The reminder of the paper has been structured as follows: The next section describes work related with Strategic thinking competencies. Section 3 describes the data collection process and method of analysis. Section 4 presents the outcome and results, whereas, conclusion and suggestions for future research conclude the paper.

2. LITERATURE REVIEW

Strategic thinking includes elements such as envisioning the future and making trade-offs between short and long term objectives (Simon et al., 2015). Strategic thinking makes the goals of the organization more specific and the organization pays attention to them. The final aspect of strategic thinking identifies it as a hypothesis-driven process. Strategic thinkers examine scenarios such as "what happens if .....?". Regarding these hypothesis, strategic thinking make thinkers to discover opportunities (Shirvani and Shojaie, 2011). So, the understanding of the past, present and future of the organization is a significant principle of strategic thinking (O'Shannassy, 2010).

As already mentioned, measures of texts' attributes with the use of Shannon's information theory have been proposed in previous works. More specifically, the measures previously proposed are: (i) Regarding the overall identities of a text (Georgakalou and Moustakis, 2006, 2008) the proposed measures are: (a) measure of identity, (b) measure of security-insecurity, (c) measure of emotional state, (d) measure of certainty (which is actually a score), (e) measure of commonality (a score as well), (f) measure of positive impression, (g) measure of negative impression, (h) measure of overall impression. (ii) Regarding the entrepreneurial orientation of a text, the measures proposed (Georgakalou and Kitsios, 2011; 2015) are: (a) measure of determination, (b) measure of socioeconomic orientation (which is actually a score), (c) measure of political thought (a score as well).

To sum up, a significant aspect of strategic thinking is the ability to take a holistic perspective of the organization and its environment. Organizations must search for opportunities and envision better ways of doing things (Bonn, 2005; Zabriskie and Huellmantel, 1991).

3. METHODOLOGY

Algorithmic measures of the semantic attributes of texts were developed based on Shannon's theory (Shannon, 1948). This methodology was used because the instances of categories in a text tend to vary linearly with the logarithm of the number of possibilities, the algorithmic measure seems to be more useful. Furthermore this methodology is closer to the proper measure. Finally, the base 2, makes it mathematically more suitable. Additionally, the logarithm simplifies a lot many of the limiting operations.

During the past decades, there have been many attempts to produce software packages aiming to support semantic analysis of written texts. In this paper the General Inquirer was used because it is academic tool and its development and evolution is an ongoing procedure. Also several elements from the rest of the software packages were used.

The current research explores a set of 172 written texts (Georgakalou, 2006). Those texts mainly belong to leading personalities, covering different historical eras (from the ancient years to modern period). The texts refer to both men and women regardless whether their domain is politics, sports, fashion or philosophy. The aim is to provide a tool to support organizations recognize strategic thinkers in a glance using their written texts. This tool will be quite helpful in a globalised environment.

Researchers tend to agree that two of the main qualities a strategic thinker should possess are the tendency to undertaking risk and the ability to create and communicate a vision (Ebersole, 2017; Liedtka, 1998). Thus, the two measures we are introducing in the current paper refer to those two qualities.
The proposed measure of the person's tendency to undertake risks p(risk taking) is a score (that is the reason why it is measured on a four-grade scale) and is calculated with the use of the following formula:

$$p(risktaking) = abs\{[f(Pos) + f(Pstv) - f(Neg) - f(Ngtv) + f(\mathrm{Stng}) + f(Power) - f(Weak) + f(Actv) - f(Psv) + f(Undst) - f(Negate) + f(Know) + f(Solve) + f(Arousal) + f(Conform) + f(Goal) + f(Try) - f(Fail) + f(Rise) - f(Fall) + f(Begin) + f(Finish) + f(Persist) + f(Time^*) + f(Yes) - f(No)] * log_2[f(Pos) + f(Pstv) - f(Neg) - f(Ngtv) + f(\mathrm{Stng}) + f(Power) - f(Weak) + f(Actv) - f(Psv) + f(Undst) - f(Negate) + f(Know) + f(Solve) + f(Arousal) + f(Conform) + f(Goal) + f(Try) - f(Fail) + f(Rise) - f(Fall) + f(Begin) + f(Finish) + f(Persist) + f(Time^*) + f(Yes) - f(No)]\}$$

Proposed thresholds:
great risk taking , when p (risk taking) > (μ+σ)
rather risky, when (μ+σ)>= p (risk taking)> μ
medium risk taker, when μ>= p(risk taking) > (μ-σ)
little risk taker, when p(risk taking) <= (μ-σ)
The proposed measure of the person's ability to develop and communicate a vision p(visionary) (as a measure it is measured on a three-grade scale) and is a calculated with the use of the following formula:

$$p(visionary) = abs\{[f(Pos) + f(\mathrm{Pstv}) + f(Virtue) - f(Neg) - f(Ngtv) + f(Strng) + f(Power) - f(Weak) - f(Negate) + f(Arousal) + f(Goal) + f(Try) + f(Rise) + f(Begin) + f(Finish) + f(Persist) + f(DAV) + f(SV)] * log_2[f(Pos) + f(\mathrm{Pstv}) + f(Virtue) - f(Neg) - f(Ngtv) + f(Strng) + f(Power) - f(Weak) - f(Negate) + f(Arousal) + f(Goal) + f(Try) + f(Rise) + f(Begin) + f(Finish) + f(Persist) + f(DAV) + f(SV)]\}$$

Proposed Thresholds:
very visionary, when p (visionary) > (μ+σ)
Quite visionary, when (μ+σ)>= p (visionary)> (μ-σ)
Not visionary, when p(visionary) <= (μ-σ)

4. RESULTS

After testing the proposed measures on a body of 172 texts (Georgakalou, 2006), the first results are presented below:
As far as it concerns p (risk taking) and p (visionary) the first results are presented in Table 1.

Table1 The first results for p (risk taking) and p (visionary)

p (risk taking)		p (visionary)	
Number of texts	172	Number of texts	172
Mean	0.473552	Mean	0.462514
Standard deviation	0.049963	Standard deviation	0.049384
μ+σ	0.523515	μ+σ	0.511897
μ-σ	0.423589	μ-σ	0.41313
p (risk taking) > (μ+σ)	20	p (visionary) > (μ+σ)	22

(μ+σ)>= p (risk taking)> μ	89	(μ+σ)>= p (visionary)> (μ-σ)	125
μ>= p(risk taking) > (μ-σ)	34		
p(risk taking) <= (μ-σ)	29	p(visionary) <= (μ-σ)	25

As already mentioned the 172 texts cover many different domains and many different historical eras. The ANOVA results for political leaders' texts (Pericles, Abraham Lincoln. Mahatma Gandi, Martin Luther King, Margaret Thatcher, Tony Blair, G.W. Bush Sr,Carter, Bill Clinton, Reagan, Andreas Papandreou, Fidel Castro, Winston Churchil, Michael Gorbachov, Vladimir Nikolai Ilyich Lenin, Nelson Mandela, Richard Nixon, Joseph Vissarionovich Stalin, Leon Trotsky) show that there is significance difference among the groups on a p=0.001 level and are shown below in Table 2.

Table2 The Two-Factor ANOVA without replication results for the group of the political leaders (p=0.001)

Source of Variation	SS	df	MS	F	P-value	F crit
Rows	0.001108	1	0.001108	8.96861	0.007448	8.184947
Columns	0.0234	19	0.001232	9.96861	3E-06	3.027358
Error	0.002347	19	0.000124			
Total	0.026855	39				

Although most of the texts tested were political ones, the number of groups actually compared were 10 (political, ancient, religious, Business men, celebrities, rock stars, winners, raped women, science, history). The results for the ten groups are shown in Table 3.

Table 3 The results for the 10 groups of texts

	Political	Ancient	Religious	Business Men	Celebrities	Rock Stars	Winners	Raped Women	Science	History
p(risk taking)	0.485263	0.415242	0.449433	0.445547	0.423807969	0.445782	0.472147	0.411003642	0.519054	0.468758
p(visionary)	0.474737	0.433681	0.472807	0.449519	0.454702544	0.449652	0.464085	0.393728343	0.481245	0.437474

The Correlation matrix for the ten different groups shows that the correlation is significant at the 0.001 level for all groups and is presented in Table 4.

Table 4 The correlation matrix for the ten groups of texts (p=0.001)

	POLITICAL	ANCIENT	RELIGIOUS	BUSINESS MEN	CELEBRITIES	ROCK STARS	WINNERS	RAPED WOMEN	SCIENCE	History
POLITICAL	1									
ANCIENT	-1.000	1								
RELIGIOUS	-1.000	1.000	1							
BUSINESS MEN	-1.000	1.000	1.000	1						
CELEBRITIES	-1.000	1.000	1.000	1.000	1					
ROCK STARS	-1.000	1.000	1.000	1.000	1.000	1				
WINNERS	1.000	-1.000	-1.000	-1.000	-1.000	-1.000	1			
RAPED WOMEN	1.000	-1.000	-1.000	-1.000	-1.000	-1.000	1.000	1		

SCIENCE	1.000	-1.000	-1.000	-1.000	-1.000	-1.000	1.000	1.000	1	
History	1.000	-1.000	-1.000	-1.000	-1.000	-1.000	1.000	1.000	1.000	1

Furthermore, Table 4 shows that where the correlation is equal to 1, there is a perfect positive linear relationship between the two groups and when the correlation is equal to -1 (meaning that the data are lined up in a perfect line and they have a negative relationship), there is a perfect negative relationship between the two groups.

5. CONCLUSIONS

The first results of the current research have shown that the two new measures should be further investigated in order to be useful for analysts of strategic thinking in enterprises. It seems that recognizing the strategic orientation of a person with a glance in the person's written texts is possible apart from being crucial in a globalised environment.

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Taxonomy for effective decision making in medium size tourist resorts

Dimitrios J. DIMITRIOU
Department of Economics, DUTH Univ. Campus, 69100 Komotini, Greece

Maria F. SARTZETAKI
Department of Economics, DUTH Univ. Campus, 69100 Komotini, Greece

Vasileia N. PAPADOPOULOU
Department of Economics, DUTH Univ. Campus, 69100 Komotini, Greece

Abstract

This paper deals with the key factors affecting decision making and management towards effective use and allocation of resources in the hotel industry, focused on medium size resort hotels that are the majority in Mediterranean region. By adopting a System of System concept a multi-agent decision framework for the hotel industry is presented development, highlighting the key decision objectives, variables and stakeholders. Based on functional analysis approach, the taxonomy for an effective capability driven DSS system relevant for medium-size resorts is discussed and the data driven functions are presented. The results of a gap-analysis for the hotel-resorts in Alexandroupolis region in Northern Greece are discussed, providing key messages to planners, decision makers and managers towards tourism sector resilience and productivity.

KEYWORDS

Decision making evaluation, resort-hotel business strategy, tourism industry, business analytics

1. INTRODUCTION

For the south European countries tourism plays an important role in regional economic development, and in many cases, it significantly contributes to local development, representing the main source of income for residents. Despite an unstable economic environment, the southern European holiday tourist destinations have faced enormous growth in the tourist field during the last decade, which in turn has significantly increased the adequacy of the available hotel and resort infrastructures. UNWTO (2015) indicate that tourism growth in 2014 in absolute terms was led by Northern European and Mediterranean countries (which reported a growth of 7%). The dimensions of competitiveness are key factors towards resilience and sustainability, while the socially coherence, stability and security are issues promoting the business uncertainties. Dimitriou et al. (2011) indicates the remarkable contribution of tourism to regional economies, providing evidence that the selection of the final tourist destination is related to infrastructures efficient management.

Tourism is a dynamic and competitive industry and one of the fastest growing industries in terms of revenues. Despite the unpredictable business environment, travel and tourism industry continued to present high resilience and according to WTTC (2017) the growth of the sector outpaced that of the global economy for the sixth year. The outlook for business and leisure travel in 2017 remains robust. Continues growth of tourism makes the industry extremely competitive and causes a whole set of desires, needs and travel requirements on behalf of the consumers, that should be fulfilled. Cornerstone towards effective and successful business development is to provide the facilities, the services and the prices that meet the needs of demand. Therefore, for the tourist services providers, the development of flexible organizational scheme, the implementation of an effective Decision Support System (DSS) supporting substantial decisions making and the monitoring of performance in infrastructure operation and business financials, are the key success forces towards business resilience and enterprise profitability.

This paper deals with the assessment of the Decision Making (DM) making in medium size tourist resorts. Key objective of the paper is to define an approach to review the DM in terms of outputs in management performance, business development and company intelligent innovation. The methodology approach includes two essential steps: (a) the development of a set of key areas assess and monitoring the contribution of DM in resorts operation and development; and (b) the evaluation of the performance for a group of similar resorts. The assessment methodology based on multi-objective unweighted analysis to range the DM performance in the scale of strategic planning and management. The application deals with a sample of high attractive tourist resorts in region of Thrace in Greece, providing key messages and conclusions in field of decision making and effective management.

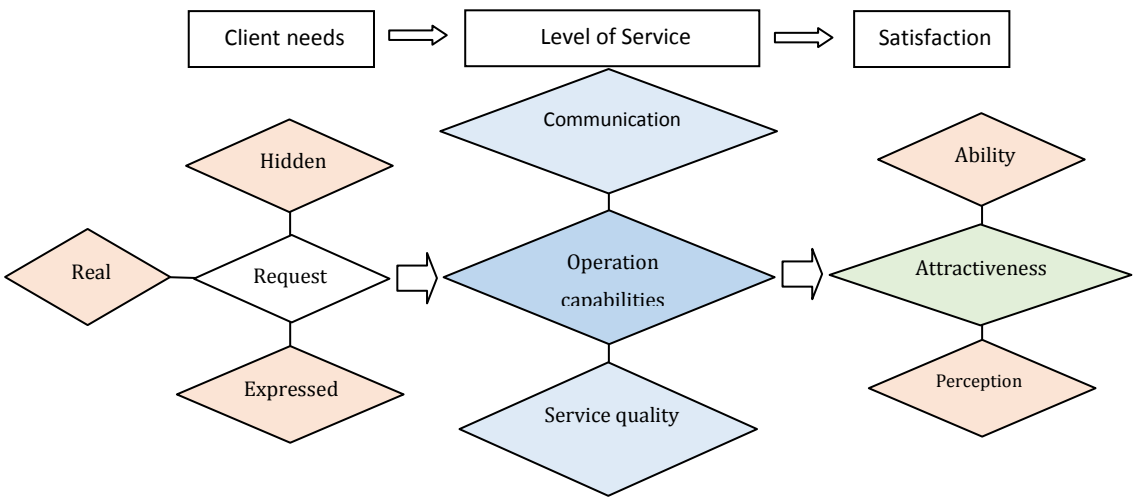
2. TOURIST RESORTS PERFORMANCE

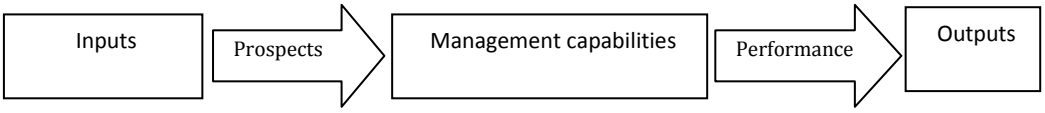
As a service industry tourism has numerous tangible and intangible elements. Tangible elements include transportation, accommodation, and other components. Intangible elements relate to the needs of service. To meet the needs of service several components must work alongside and smoothly to create a prosperous result. Hotel industry benchmarking deals with various methodologies over time to review performance, by focusing on certain aspects of operation efficiency, however, research on evaluating the performance of decision making process and outputs are very limited. Measuring and comparing the performance of resorts provides two features become crucial to the analysis: the choice of variables to be used and the methodological approach to evaluate the different case studies and estimate the best performance. The following paragraphs provides such information of the proposed methodology constructed to assess the question of evaluation of DM in resorts.

2.1 Management key components

Successful management can develop quality visitor experiences that meet, and ultimately exceed, consumer expectations. To reach this goal the managers must joggle between a certain level of communication on the visitor's behalf and a certain level of service from the hotels to find an equilibrium and ultimately moderate and influence the level of satisfaction that will conclusively translate in the resort attractiveness. The managerial key elements that influence the attractiveness of a resort is of key importance to recognize the central role of perceptions and prospects that make a tourist choose a destination. Tourists are pushed by their needs. The choice will progress from an initial state where the visitor examines witch destination will fulfill the clients' requests and needs. The level of satisfaction from the choice made will judge the resort attractiveness after all. As a result, is very importance from a managerial perspective to first stimulate the clients interest to convince them make the choice that best meets their needs and when the choice is made managers must moderate the performance to meet a certain level of satisfaction that is promised to the client by stimulating their interest in the destination.

Figure 1 Managerial key elements influencing resort attractiveness



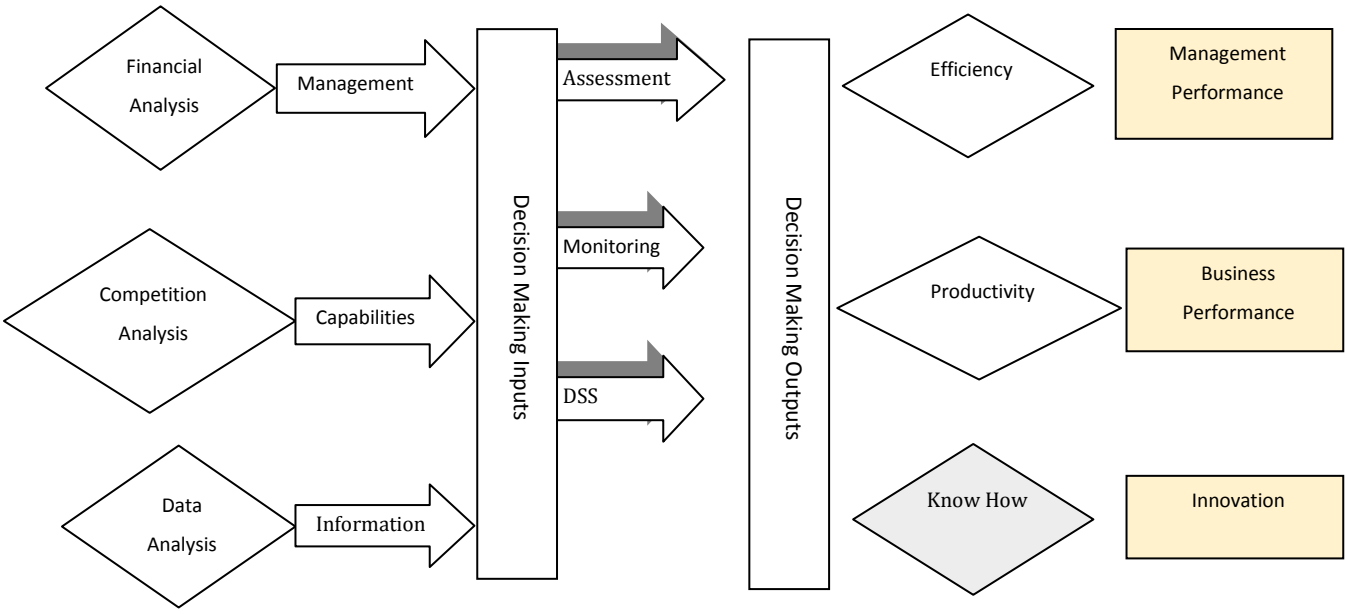


2.2. Tourism resorts Decision Making framework

Effective decision making is of crucial importance towards business resilience and sustainable development. Main target of this research is to identify the DM performance of tourist resorts and investigate the determinants that are associated with variations in hotel business and operation, which affect the decision process. Resorts' performance is described as a set of performance ratios defined by financial and physical measures of inputs and outputs presented in figure 1.

Effective decision making in tourist resorts consists from the financial, competition and data analysis through evaluating the efficiency, productivity and innovation and the results lead up to conclude management performance, business performance and Innovation. Financial analysis takes into account the regional competition, the resorts financial (equity, assets, etc) and the human resources in order to monitor the efficiency that leads up to the management performance. Competition analysis examines the international competition, the infrastructures, the suppliers and the capabilities in general of the resort in order to make an assessment on the productivity that will ultimately help the business performance. Through data analysis and the collection and storage of the information the business supports the knowhow and has a clear set goal to innovation. According to above definitions and Based on System of System concept and the agent theory, the key variables effectiveness in decision process given the taxonomy of effective DM for the resorts business development depicted in the following figure.

Figure 2 Decision Making taxonomy for evaluate tourist resorts performance



3. METHODOLOGY TO REVIEW DECISION MAKING PERFORMANCE

This section describes the evaluation framework and outlines the methodology used in the assessment of DM in resorts development. The evaluation framework derives from a qualitative approach of the total scores, by using a rating-oriented depiction of resorts DM performance. This methodology brings a strategic vision to the performance analysis and is designed to furnish a tool for evaluating the impacts of DM to resort's business development.

The outcome of this analysis depicting the performance aspects of airport business on regional tourism market is shown in figure 2. The performance ranking is divided into 6 performance areas, related the information use to meet managerial and business targets. The first level of rating represents the absolute necessary data analysis outputs to operate resort business and the sixth level, which is the highest, a world class resort operation. The margins of each area are formed by the level of data analysis and the resources used to support decisions. The methodology consists on comparing the total performance provided by the evaluation of several factors, allowing comparisons between different resorts in the same period. The application of the multi-variable assessment of decision-making is based on information provided by the resorts management providing the necessary framework to apply the current ranking of each resort in relation to the benchmark (best performing resort of the group).

The rating values is based on the star (*) approach, commonly, used in hotel industry. The description of the rating levels is presented in following table.

Table 1 Rating of management capabilities by level of data use

Rating	Information Recourses Variety	Data analysis framework	MIS	Use of outputs
1*	Company/Reception	Storage	DB	Auditing
2*	Suppliers	Blending	MIS	Administration
3*	Local Authorities	KPIs	MIS/GIS	Regional coordination
4*	National DB	Analytics	DSS	National cooperation
5*	International reservation systems	Big Data	CDS	International cooperation
5*+	Global reservation systems	Mega Data	IDS	Innovation - new products

4. NUMERICAL APPLICATION

Using a multivariate technique specifically, a conceptual model of 5+ star rating we examine how elements like data, application, system and the use of outputs are used to achieve the desired levels of efficiency and productivity management in hotel industry. We later use a sample of three medium size resorts in the region of Thrace specifically in the town of Alexandoupolis.

The numerical application deals with a sample of three medium size resorts in the region of Thrace and specifically, resorts located close to the town of Alexandroupolis. The data used in this study are given by the Astir Alexandroupolis, Thraki Palace Thalasso spa & Conference Center, and Alexander Beach Hotel & Spa. Using attributes as characteristics of the hotels, presented above we use Astir Alexandroupolis (AA), Thraki Palace (TP), Alexander Beach Hotel (AB). Using a range between 1 and 5+ star rating scheme to review efficiency and productivity it is examined how parameters such auditing, administration, monitoring, finance, competition and use of data and connection to external data recourses, support the hotel industry decision making towards efficient management, business resilience and innovation. Using a star rating of efficiency and productive management analysis we present the table below.

Table 2 Evaluation of decision making performance for the sample of resorts

	Decision Making Function									
	Management			Business			Innovation			
Data Use	**AA**	**AB**	**TP**	**AA**	**AB**	**TP**	**AA**	**AB**	**TP**	**Average**
Auditing	4*	4*	3*	4*	3*	2*	3*	3*	2*	3.1
Administration	4*	4*	3*	3*	4*	3*	4*	4*	2*	3.1
Monitoring	4*	3*	2*	3*	4*	2*	3*	3*	1*	2.7
Finance	4*	4*	3*	3*	3*	3*	2*	3*	2*	3.2

Local/Regional Competition	4*	3*	2*	3*	3*	3*	3*	4*	1*	2.8
International Competition	3*	2*	1*	3*	4*	2*	2*	3*	1*	2.3
Resources	3*	3*	2*	3*	3*	2*	3*	3*	2*	2.6
Storage	3*	3*	3*	3*	4*	2*	3*	3*	1*	2.8
Collection	4*	4*	2*	2*	4*	1*	2*	2*	1*	2.4
Average	3.6	3.6	2.4	3.0	3.2	2.0	2.7	2.8	1.5	2.7

It's worth mentioned that from the sample of the three hotels in this study only AA is branch of a hotel brand. This resorts seems to present a mentionable performance because the DM that are used for the whole the group of resorts. However, AB seems to present the highest performance, mainly because, its management DM independency and the resort high attractiveness from international travels because of its casino, result high attention to business attractiveness. Finally, TP that do not belong to any national or international chain it presents essential difficulties in DM, representing a typical family business and resulting lack of tools towards supporting efficient decisions.

5. CONCLUSIONS

Tourism continued to play a significant role in the development of European regions, contributing to employment and wealth creation. Last three years, in Greece, tourism grow very fast despite the economic restrictions and the political risks in the surround countries. Within this context, effective decision making is a key driver towards tourism development and optimum operation of holiday resorts. This paper presents a multi-objective analysis to evaluate decision making performance, implementing in a sample of summer holiday resorts in Alexndroupolis. The results are given in rating of 6 levels of data analysis used related to management efficiency, business productivity and innovation. The analysis framework as well as the case study results could be considered encouraging, other test cases should be examined and studied for bigger samples and longer time periods to confirm the above findings.

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Simulation study of an adaptive decentralized approach for the optimization of traffic control systems

Diamantis Manolis
Dynamic Systems and Simulation Laboratory, School of Production Engineering and Management, Technical University of Crete, Technical University Campus, 73100 Chania, Greece

Iakovos Michailidis
Department of Electrical and Computer Engineering, Democritus University of Thrace, Xanthi, and Information Technologies Institute, Centre for Research and Technology Thessaloniki, Greece

Christina Diakaki
Dynamic Systems and Simulation Laboratory, School of Production Engineering and Management, Technical University of Crete, Technical University Campus, 73100 Chania, Greece

Ioannis Papamichail
Dynamic Systems and Simulation Laboratory, School of Production Engineering and Management, Technical University of Crete, Technical University Campus, 73100 Chania, Greece

Elias Kosmatopoulos
Department of Electrical and Computer Engineering, Democritus University of Thrace, Xanthi, and Information Technologies Institute, Centre for Research and Technology Thessaloniki, Greece

Markos Papageorgiou
Dynamic Systems and Simulation Laboratory, School of Production Engineering and Management, Technical University of Crete, Technical University Campus, 73100 Chania, Greece

Abstract

This paper presents, investigates via realistic traffic-flow simulations and discusses L4GCAO (Local for Global Cognitive Adaptive Optimization), a novel model-free optimization approach aiming at maximizing global performance of a given control system by calibrating its control parameters through decentralized self-learning elements that periodically share a single piece of information, which is the overall system performance. L4GCAO performance is also compared against CAO (Cognitive Adaptive Optimization), its centralized counterpart developed and successfully applied in the past, and the results indicate its ability to achieve a performance close to the performance achieved by the centralized CAO approach, albeit with significantly less computational effort.

KEYWORDS

Decentralized optimization, adaptive optimization, large-scale traffic control systems

1. INTRODUCTION

Successful traffic control system design requires availability of large volumes of data and the personal involvement of experienced engineers. In addition, even if they are well-designed at first place, they still require fine-tuning, as well as periodic re-calibration and maintenance due to the changing behavior of the traffic flow. To overcome these problems, centralized and decentralized adaptive optimization techniques have been developed, which, however, cannot always guarantee efficiency due to the involved highly stochastic dynamics, scaling or model unavailability problems, as well as data transmission limitations. To confront such problems, L4GCAO (Local for Global Cognitive Adaptive Optimization), a novel model-free approach, has been developed.

L4GCAO (Kosmatopoulos et al., 2015) aims at maximizing global system performance by calibrating the parameters of a given control strategy through decentralized self-learning elements that periodically share a single piece of information, which is the overall system performance. To investigate its performance and efficiency, L4GCAO is used to fine-tune the control parameters of a signal control strategy implemented locally at the junctions of the urban network of the city center of Chania, Greece under simulated traffic conditions. Investigations are also undertaken to compare its performance against CAO (Cognitive Adaptive

Optimization), its centralized counterpart developed and successfully applied in the considered urban network in the past (Kouvelas et al., 2011).

This paper presents and discusses the main principles underlying the adopted control schemes along with the results and conclusions of the conducted simulations tests.

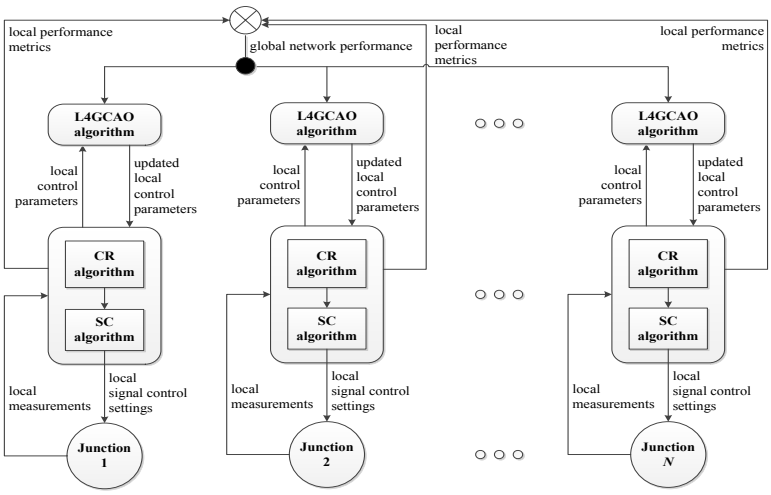
2. THE ADOPTED CONTROL AND FINE-TUNING APPROACH

The local signal control strategy adopted herein consists of a cycle regulation (CR) and a split control (SC) algorithm, which are used to update the signal control settings, namely the cycle time and the green splits, i.e. the relative green duration of each stage (as a portion of the cycle time), at the local junction level (Schild et al., 2017). To update the signal settings, the feedback-based cycle regulation (CR) algorithm of the TUC (Traffic-responsive Urban Control) strategy (Diakaki et al., 2003) is first used, which identifies cycle times suitable for the prevailing link saturation levels. Then, a variant of the max pressure (MP) algorithm (Kouvelas et al., 2014) is used, which splits the identified cycle times in the corresponding cycle stages, aiming at maximizing throughput.

The aforementioned algorithms operate at frequent actuation intervals in order to respond timely to the random variations of the prevailing traffic conditions, and include a number of parameters (let **θ** denote the vector of all these parameters), which affect their behavior and should be suitably configured to ensure good control performance. Within the adopted control scheme (see Figure 1), these parameters are automatically fine-tuned by L4GCAO algorithm as follows:

a) At the end of appropriately defined periods (e.g. at the end of each day) and given the vector of tunable parameters **θ** applied on that period, the algorithm receives the value of a real (measured) performance index (e.g. average speed or network productivity) for this particular period. Let J(**θ**) denote the measured value of the performance index for a given **θ**.
b) Using the measured performance over multiple past periods, the algorithm estimates the gradient of J(**θ**) and calculates a new **θ**-vector to be applied at the next period (e.g. the next day) in an attempt to improve the system performance.
c) This (iterative) procedure is continued over many periods (e.g. days) until a maximum in performance is reached. Then, the tuning algorithm may remain active for continuous adaptation or can be switched off and re-activated at a later stage (e.g. after few months) to update the parameters **θ** in case of possible further system changes.

Figure 1 The adopted experimental setup



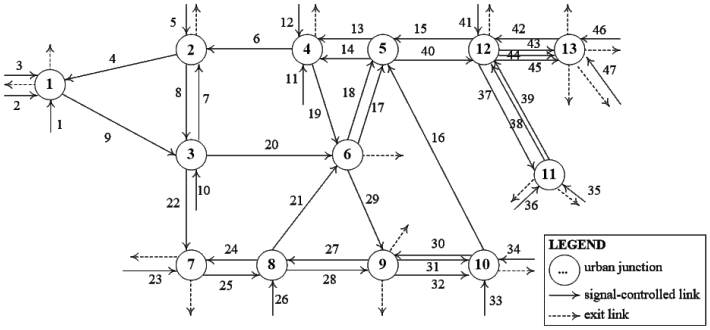
L4GCAO is the distributed version of the CAO algorithm that, as mentioned earlier, was developed and used in the past for the centralized optimization of control parameters (Manolis et al., 2015). Both CAO and L4GCAO

have the advantage that they can tune the aforementioned parameters in real-time, i.e. while the system is in operation. As opposed to CAO, however, the distributed L4GCAO approach to handle the global control problem, allows for hashing a very large-scale problem to several smaller ones, while aiming towards the same global optimization goal. In addition, its enhanced adaptive capabilities allow for tracking the system behavior within a huge variety of occurring system states and scenarios, thus establishing a rich basis, which ensures control efficiency.

3. SIMULATION INVESTIGATIONS

To study and compare the performance and efficiency of L4GCAO and CAO in fine-tuning the parameters of the considered local signal control strategy under realistic traffic conditions, the road network of the city center of Chania, Greece, has been used (see Figure 2). This network, which suffers from severe congestion problems leading sometimes even to gridlocks, was simulated in AIMSUN, a well-known microscopic traffic flow simulation software tool.

Figure 2 A simplified model of the Chania city network



The investigations involved comparisons of the following four control cases, on the basis of the AIMSUN-calculated average delay time per vehicle (in s/km), and mean network speed (in km/h) and density (in veh/km):

- *Reference case (RC)*: Application of fixed 90 s cycle time plans. These plans correspond to one of the fixed predefined network-wide signal plans used by the Traffic Control System of the city.
- *Control case 1 (CC1)*: Application of the CR/SC algorithms with arbitrarily-chosen constant parameter sets at all junctions throughout the whole simulation horizon.
- *Control case 2 (CC2)*: Application of the CR/SC algorithms with parameter sets updated via iterative application of the centralized CAO algorithm.
- *Control case 3 (CC3)*: Application of the CR/SC algorithms with parameter sets updated via iterative application of the decentralized L4GCAO algorithm.

The number of control parameters to be optimized are:

- 52 for the CR algorithm plus 22 for the SC algorithm, thus 74 parameters in total in CC2, where CAO is used; and
- 5-7 parameters in total at each junction (4 and 1-3 for the CR and SC algorithms, respectively), in CC3, where L4GCAO is used.

Clearly, the L4GCAO control approach reduces significantly the required computational effort compared to CAO.

The aforementioned control cases were applied and tested in 1-h simulations of a demand scenario involving a peak period starting at the 20th minute and lasting for 20 minutes. During the last 20 minutes of the simulation, the demand is gradually reduced to zero, leading to an empty network at the end of the simulation horizon, which ensures a fair comparison of the different cases. The traffic network characteristics (e.g., saturation flows and turning rates) and all control constraints (e.g., minimum green times and minimum/maximum cycle times) necessary for the simulation were set as suggested by the system operators

of the Traffic Control Centre (TCC) of the city during a past study (Kouvelas et al., 2011). Finally, as performance index for the fine-tuning of the control parameters, network productivity (NP), i.e. the product of network demand (ND) with network mean speed (NMS), was used, similarly to a real-life tuning application of CAO (Manolis et al., 2015). To this end, ND was calculated as the sum of time-averaged flows measured by detectors located at the network origins, while NMS was estimated as the ratio TTD/TTS, with TTD, the total travelled distance, estimated by multiplying flow measurements with the respective lengths of junction links, and TTS, the total time spent by all vehicles in the network, estimated through occupancy measurements, using a function that takes into account the length of links and the respective detector positions.

Figure 3 summarizes the results of the simulation tests of CAO (CC2) and L4GCAO (CC3) for 50 consecutive iterations in terms of the performance criterion NP, which is used by both algorithms while tuning the control parameters of the locally applied signal control strategy. The figure displays also the trends of the trajectories of the considered performance criterion. In addition, Table 1 summarizes the simulation results of all control cases in terms of the AIMSUN-calculated performance indices.

Figure 3 Evolution of performance during tuning by CAO (CC2) and L4GCAO (CC3)

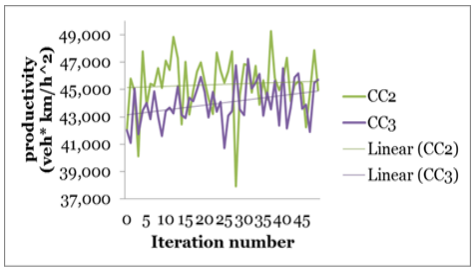


Table 1 Simulation results with arbitrarily-chosen control parameters

Control case	Delay (s/km/veh)	% change	Speed (km/h)	% change	Density (veh/km)	% change
RC	147.71	-	17.46	-	9.10	-
CC1	134.76	–8.8	17.66	+1.2	8.99	–1.1
CC2 (CAO)	120.34	–18.5	19.20	+10.0	8.25	–9.3
CC3 (L4GCAO)	124.40	–15.8	18.91	+8.3	8.39	–7.7

According to the simulation results, the application of the CR/SC algorithms, even with arbitrarily-chosen control parameters and without any tuning (see CC1 in Table 1), improves the traffic conditions compared to the reference case (see RC in Table 1). With tuning, however, traffic conditions improve further (see CC2 and CC3 in Table 1). Moreover, as Table 1 indicates, despite the reduced set of data used for the self-learning process in the decentralized case (CC3), L4GCAO achieves to identify in a sufficiently accurate manner the influence of the local CR/SC algorithms' parameters on the overall estimated/aggregated system performance and to improve the control performance at levels comparable to those achieved via the centralized approach (CC2) of CAO (see CC3 vs CC2 in Table 1).

Simulation investigations highlighted also some interesting properties of the L4GCAO and CAO algorithms. As mentioned earlier, even without any tuning, the CR/SC algorithms manage to improve traffic conditions in the network compared to the fixed-time control of the RC. As however the results of Table 2 indicate, an experienced traffic engineer could manually tune these algorithms and achieve, after some experimentation, an even better performance. When, however, automatic tuning is performed with either CAO (CC2) or L4GCAO (CC3), the performance of the CR/SC algorithms improves further without any need for human intervention and independently of whether the initial set of control parameters has been arbitrarily chosen (see Table 1) or manually tuned by the traffic engineer (see Table 3).

Table 2 Simulation results of CC1 vs RC, with arbitrarily-chosen and experience-based parameters

Control case	Delay (s/km/veh)	% change	Speed (km/h)	% change	Density (veh/km)	% change
RC	147.71	-	17.46	-	9.10	-
CC1 with arbitrarily-chosen parameters	134.76	–8.8	17.66	+1.2	8.99	–1.1
CC1 with experience-based parameters	128.58	–13.0	18.36	+5.2	8.64	–5.0

The improvement gains reduce when experience-based parameters are used as the initial point for CAO or L4GCAO tuning. For example, with constant arbitrarily-chosen control parameters, the application of CR/SC algorithms reduces delay compared to RC by 9% approximately (see CC1 vs RC in Table 1), while with experience-based parameters the delay reduces by 13% (see CC1 vs RC in Table 3). When L4GCAO tunes the control parameters, an additional delay reduction of around 7% is achieved if tuning uses as initial point the arbitrarily-chosen set of values (see CC3 vs CC1 in Table 1); while the corresponding reduction in case the experience-based set of values is used is only around 4% (see CC3 vs CC1 in Table 3). Nevertheless, independently of the initially chosen parameter values, the performance levels finally achieved are similar (see e.g. CC3 in Table 1 vs. CC3 in Table 3).

Table 3 Simulation results with experience-based control parameters

Control case	Delay (s/km/veh)	% change	Speed (km/h)	% change	Density (veh/km)	% change
RC	147.71	-	17.46	-	9.10	-
CC1	128.58	–13.0	18.36	+5.2	8.64	–5.0
CC2 (CAO)	121.19	–18.0	19.25	+10.3	8.24	–9.4
CC3 (L4GCAO)	122.87	–16.8	18.79	+7.6	8.43	–7.3

4. CONCLUSIONS

The simulation study presented herein indicates that both the centralized CAO and decentralized L4GCAO optimization approaches can improve the performance of a given control system in real time by allowing it to automatically, i.e. without any human intervention, adapt to the changing conditions of traffic flow. It also indicates that L4GCAO can achieve a performance close to the performance achieved by CAO.

As the tuning algorithm utilizes both demands and information of the overall system state, the centralized approach of CAO leads to the same performance results a few iterations earlier compared to L4GCAO, where only local information is available, along with the overall network performance. On the other hand, the main drawback of the centralized approach is the necessity of a centrally available, large data set including information concerning the overall-network state, a fact that may limit its applicability and operational efficiency to small and medium scale control problems. As the investigations presented herein indicate, this drawback may be overcome with the decentralized approach, without having to really sacrifice system performance.

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A fairness-informed modelling extension to the single-airport slot scheduling problem

Andreas T. Makris
Aristotle University of Thessaloniki, Department of Economics Faculty of Law, Economics and Political Sciences Building, 54124, Thessaloniki, Greece

Michael A. Madas
University of Macedonia, Department of Applied Informatics 156, Egnatia Str., 54636, Thessaloniki, Greece

Konstantinos N. Androutsopoulos
Athens University of Economics and Business, Department of Management Science and Technology 47A, Evelpidon Str. & 33, Lefkados, 11362, Athens, Greece

Abstract

In the face of severe airport congestion problems and delays, a promising research direction lies on the deployment of schedule optimization methods and models for allocating scarce airport resources, expressed in slots, among competing airlines. Existing research has pursued modelling formulations of the current IATA-based slot allocation mechanism by mainly opting for the minimization of schedule efficiency, expressed in the form of some schedule displacement metric (i.e., difference between requested and allocated slot times) and optimized with respect to multiple objectives. In our paper, we propose a fairness-informed modelling extension to the existing single-airport slot scheduling models by introducing and modelling the notion of "marginal schedule displacement", which can be defined as the incremental schedule displacement caused by each slot request. The proposed model aims to ensure that each airline absorbs its "fair share" of the total marginal schedule displacement exerted onto the system. In doing so, we enrich previous, single-objective modelling formulations aiming to minimize total schedule displacement with a fairness constraint ensuring a fair allotment of marginal schedule displacement.

KEYWORDS

slot allocation, airport scheduling, marginal displacement, fairness

1. INTRODUCTION

The high air transport growth that has been witnessed over the past 30 years has not been matched by an equivalent airport capacity expansion, hence leading to severe congestion problems and notable delays. This persistent gap between demand and airport supply, which is further amplified by mismanagement and misuse of existing capacity, imposes a heavy burden on the entire air transport system, in economic and operational as well as social and environmental terms. Suffice it to say, according to IATA (2014a), Air Traffic Management inefficiencies in the EU during 2012 alone caused 10.2 million minutes of flight delays and 7.8 million tonnes of wasted CO_2, incurring an economic cost as high as €11.1 billion.

In the face of this imbalance between demand and supply, the need for a direct treatment of the congestion and delay problems poses a pressing dilemma: demand management or capacity enhancement? Supply-side solutions (that is, capacity enhancement by means of new infrastructure) require time and high capital investments and are normally hindered by inertia forces and political/public opposition. On the other hand, airport demand management solutions, which aim to cope with congestion through the allocation of scarce airport capacity, have lately gathered the interest of the academia, industry and policy makers. Demand management seeks to propose quick improvements by dealing with the spatial or temporal distribution of demand. In the context of air transport, we may distinguish upfront two major and distinct – but not necessarily mutually exclusive – strategic options: i) research proposals that adopt various market-driven or pure economic instruments, and ii) contributions that opt for an enhancement of the current IATA-based allocation mechanism by deploying airport scheduling methods and models.

The scope of our work lies on the airport scheduling stream of research. In particular, it capitalizes on previous single-airport scheduling models aiming to optimize the total efficiency of the allocation process, expressed in

the form of total schedule delay or displacement (i.e., sum of difference between requested and allocated slot times). Furthermore, we propose a fairness-informed modelling extension to the existing single-airport slot scheduling models by introducing and modelling the notion of "marginal schedule displacement" aiming to ensure that each airline absorbs its "fair share" of the total marginal schedule displacement exerted onto a system of scarce airport resources.

2. CURRENT SLOT SCHEDULING PRACTICE

The allocation of scarce airport capacity is currently governed by a slot scheduling framework dating back to a system created by IATA in 1947 and further developed or adapted with local variations and adjustments (IATA 2014b; European Commission 1993). This IATA-driven allocation mechanism is the predominant demand-side regime which is presently applied at more than 170 of the busiest airports on a global scale (except for U.S. airports). It is composed of a complex set of administrative rules, criteria and guidelines that were introduced to rationalize capacity allocation by first expressing it in slots; that is, time intervals on specific dates and times during which a carrier is permitted to use the full range of airport infrastructure for the purpose of landing or take-off at a slot-controlled airport (European Commission 1993). The IATA-based mechanism offers a strategic schedule coordination process that aims to match available slots with specific airlines' requests. A critical property of each slot request is that it essentially involves series of slots rather than individual slots, namely 5 or more slots requested for the same time and day of the week within a given scheduling season.

The matching of airline's requests with specific slots is inherently constrained by available capacity. For scheduling purposes, this is expressed in the form of declared capacity, an administrative measure specifying the number of slots (scheduled arrivals and departures) available for allocation at a slot-controlled airport during each coordination time interval. The coordination time interval represents the unit of time used as the basis for capacity determination and slot allocation. Declared capacity is then subject to a set of rolling constraints which restrict the number of arrivals, departures and total movements within various time intervals (e.g., 5, 15, 30, 60 minutes) with view to controlling the concentration of traffic and reducing capacity saturation conditions throughout the day. In operational terms, the allocation of declared capacity among competing users conforms to a set of criteria that designate different priorities to various requests. These criteria broadly classify requests in three priority classes: i) requests with historical usage rights ("grandfathered slots"), ii) requests with new entrant status, and iii) all remaining requests.

3. EMERGING RESEARCH DEVELOPMENTS

The existing framework briefly set out above exhibits several problems and limitations (e.g., allocation inefficiencies, slot misuse), especially in the case of busy airports operating close to or even at maximum capacity for major parts of the day (Madas and Zografos 2008). These problems have stimulated both research interest and numerous policy studies on two alternative (and potentially complementary to each other) directions. As part of the first stream of research, there is a plethora of researchers investigating market-driven or pure pricing mechanisms/instruments with explicit consideration to market valuations (or approximations thereof) of access to congested airport resources. Typical instruments addressed in existing literature involve some form of auctioning of part of or the entire slot pool (Nilsson 2003; Le et al. 2004), secondary slot trading, either as a main or complementary instrument to primary trading (Verhoef 2010), as well as congestion-based pricing schemes (Brueckner 2002; Morrison and Winston 2007). Another stream of research deals with the development of schedule optimization methods and models for allocating scarce airport slots. This promising research direction pursues modelling formulations of the current IATA-based slot allocation mechanism as a slot scheduling problem with different underlying criteria and objectives. In its generic form, the strategic airport slot scheduling problem seeks to optimally allocate (few months before operations) slot times to specified coordination time intervals on the basis of airlines' requests (classified in various priority classes) for landing or take-off either at a single airport or a network of airports. Slot times are normally allocated as series of slots during a scheduling period, taking into consideration the airport capacity and other underlying operational constraints.

The strategic airport slot scheduling problem has been only recently introduced but extensively addressed in the literature during the last decade or so (Zografos at al. 2017a). The first generation of slot scheduling models focused on the efficiency of the scheduling process by introducing the notion of "schedule delay" or displacement (both are now used interchangeably), a term initially cited by Koesters (2007). Schedule delay was initially referred to as the absolute value of the difference between the requested and allocated slot times (Koesters 2007; Zografos et al. 2012). In other words, a flight experiences a schedule displacement when it is eventually scheduled earlier or later than the originally requested slot times. Those first-generation scheduling models have basically considered total schedule displacement objectives (Zografos et al. 2012; Castelli et al. 2011; 2012; Corolli et al. 2014) at single or airport network level. Models involving the total schedule displacement objective pursued the minimization of the total sum of schedule displacement hence targeting towards the efficiency of the entire scheduling process.

Drawing on the aforementioned models, subsequent research efforts have been channeled in the direction of enriching efficiency objectives with further considerations, namely those of acceptability and fairness. New models usually opted for the minimization of different expressions of schedule efficiency, while often incorporating further considerations (e.g., acceptability, fairness). The underlying motivation was that the total schedule displacement objective may offer a "solution" to the optimum utilization of available capacity through a redistribution of the demand profile (i.e., flight rescheduling) over time during congested periods. However, it does not guarantee that the final allocation outcome will be actually acceptable (if practical at all), especially in cases where a slot displacement may jeopardize the feasibility of an airline's master schedule over its network or the commercial viability of the flight. In effect, a new class of models (Pyrgiotis and Odoni 2015; Jacquillat and Odoni 2015; Zografos et al. 2017b) employed simultaneously schedule efficiency and acceptability objectives, with the latter being modeled by the maximum schedule displacement metric as a measure of the worst-case service level provided to airlines. Furthermore, Zografos et al. (2017b) elaborated further in the trade-off between scheduling efficiency and acceptability by explicitly accounting for the number of allocated slots that "unacceptably" violate the corresponding slot requests above certain acceptability thresholds (or tolerance levels). Lately, some researchers introduced fairness considerations by postulating that the schedule displacement "assigned" to each airline should be proportional to the number of slots requested by that specific airline (Zografos and Jiang 2016). Moreover, they adopt a differentiated weighted displacement metric that weighs the scheduled displacement by the aircraft size and the flight length in order to safeguard connectivity and accessibility to/from small regional airports and communities.

4. A FAIRNESS-INFORMED MODELLING EXTENSION TO THE SINGLE-AIRPORT SLOT SCHEDULING PROBLEM

In our paper, we propose a fairness-informed modeling extension to the existing single airport slot scheduling models; that is, to couple the concern over the efficiency of the slot allocation process with fairness considerations in the course of the said process. In particular, we seek to explore a different take with respect to fairness considerations already addressed in existing literature. The number of slots requested by each airline represents indisputably an important criterion in determining the proportion of the total schedule displacement that this airline should be assigned. Nonetheless, we have to take also into account the fact that different slot requests inflict different values of schedule displacement on the system. For example, slot requests pertaining to coordination time intervals with heavy traffic volumes (in terms of requests) contribute much more strongly to the total schedule displacement as compared to requests in intervals during which the airport experiences low demand or off-peak conditions. In the light of the above, it can be reasonably argued that a more fair allocation of available slots to airlines' requests would entail that the carriers are assigned a share of the total schedule displacement which is proportional to their "contribution" to this displacement.

In that end, we introduce and model the notion of "marginal schedule displacement", which can be defined as the incremental schedule displacement caused by each slot request. The computation of the marginal schedule displacement of each slot request is based on the single-objective scheduling model proposed by Zografos et al. (2012) and performed in two stages. In the first stage, we solve the model by minimizing the

total schedule displacement without the given slot request. At the second stage, we solve the model once more to obtain the respective total schedule displacement value after including the given slot request. The difference of the values derived from the objective function among the two subsequent computation stages signifies the marginal schedule displacement as a result of accommodating the particular slot request. The intuition is that, in the presence of congestion, each slot request causes an additional schedule displacement that eventually "penalizes" subsequent slot requests. Having computed the marginal schedule displacement of each slot request, we extend the modeling formulation provided by Zografos et al. (2012) with a fairness constraint aiming to ensure a fair allotment of marginal schedule displacement to each airline, depending on the actual marginal displacement imposed to other users.

4.1 Proposed Model

The model is defined for a set of 5-minute coordination time intervals $T = \{0, \dots, n-1\}$ defined per day and a set of calendar days D for the whole scheduling period. The set of requested movements M comprises pairs of movements (arrivals and departures), with each movement m pertaining to series of slots over several weeks. The parameters a_m^d denote the days on which each movement operates, taking value one if movement m operates on day $d \in D$, zero otherwise. The cost of allocating movement $m \in M$ to slot $t \in T$ is defined as $f_m^t \geq 0$ and calculated as $|t - t_m|$, where t_m expresses the slot originally requested for m. The allocation of movements (m) to coordination intervals (t) is determined through binary decision variables (x_m^t), which take value one when movement m is allocated to coordination interval t, and zero in all other cases.

Airport capacity is modeled by a set of capacity constraints C and is determined by capacity values u_c^{ds} for day d and coordination interval $t \in T_c$, with $T_c = \{t \in T | s \leq t \leq -t_c + 1\}$. By $t_c > 0$, we denote the duration of the constraint's check, while by $T_c^s = \{t \in T | s \leq t \leq s + t_c\}$, we denote the set of consecutive coordination slots over which the constraint is active. This rolling capacity requires that the movements allocated to consecutive time intervals within T_c^s should not be greater than the capacity value u_c^{ds}. Furthermore, b_{mc} defines the units of capacity consumed by a movement m and assumes the value one if the movement is an arrival and the constraint applies to arrivals only or total movements, and zero otherwise (the same applies in the case of departures). Additionally, $t_{ad} \geq 0$ represents the minimum turnaround time for each pair of movements $P\{a \in M, d \in M\}$, where arrival a corresponds to departure d. In the case of the fairness constraint, let w_m be the marginal schedule displacement caused by a requested slot for a movement m and M_i the (series of) slots requested by airline (i), while $g_i = \frac{\sum_{m \in M_i} w_m}{\sum_{m \in M} w_m}$ is the proportion of the total marginal displacement attributed to the ith airline.

minimize

(1) $$\sum_{m \in M} \sum_{t \in T} f_m^t x_m^t$$

subject to

(2) $$\sum_{t \in T} x_m^t = 1, \qquad m \in M$$

(3) $$\sum_{m \in M} \sum_{t \in T_c^s} a_m^d b_{mc} x_m^t \leq u_c^{ds}, \qquad c \in C, d \in D, s \in T_c$$

(4) $$\sum_{t\in[0,k)} x_d^t + \sum_{t\in[k-t_{ad},n)} x_a^t \leq 1 \{\alpha, d\} \in P, \qquad k \in [t_{ad}, n)$$

(5) $$(1-\varepsilon) g_i \sum_{m\in M} \sum_{t\in T} f_m^t x_m^t \leq \sum_{m\in M_i} \sum_{t\in T} f_m^t x_m^t \leq (1+\varepsilon) g_i \sum_{m\in M} \sum_{t\in T} f_m^t x_m^t, \qquad \forall i$$

$$x_m^t \in \{0, 1\}, m \in M, t \in T, \varepsilon \in (0,1)$$

The objective function (1) expresses the minimization of the total schedule displacement (that is, the minimization of the total absolute difference between the requested and allocated slots). Constraint (2) implies that every movement must be allocated to exactly one slot. Constraint (3) ensures that total movement consumption cannot exceed the declared capacity of the airport. Turnaround time constraint (4) enforces the limitation that a departure movement must be scheduled at least a specified number of slots past the respective arrival movement. In constraint (5), $g_i \sum_{m\in M} x_m^t f_m^t$ is the share of displacement received by airline (i), which is analogous to its share in total marginal displacement. That way, we enforce the displacement received by an airline to lie within $\pm\varepsilon\%$ of that share. The proposed model conforms to the IATA's framework giving priority to slots requested by airlines enjoying the status of "grandfathered rights". Once the model is solved for the slots that come under the first priority class, capacity constraints are updated on the basis of the outcome and the model is solved again for the subsequent priority classes.

5. CONCLUSIONS & FURTHER RESEARCH

The strategic scheduling of airport slots constitutes an emerging and challenging stream of research with the potential to offer quick improvements in the process of allocating scarce airport resources and building a viable flight schedule. In this paper, we have presented a modeling extension to the single-airport slot scheduling problem developed by Zografos et al. (2012) which incorporates simultaneously schedule efficiency objectives with fairness considerations. We particularly introduce fairness considerations expressed in terms of the marginal schedule displacement, that is, the incremental schedule displacement imposed by each slot request to other users. The underlying motivation is that each slot is requested at times with different peaking (or off-peaking) characteristics, and therefore may have differing effects on displacement suffered by other airport users. Therefore, the proposed model aims to ensure that each airline absorbs its "fair share" of the total marginal schedule displacement exerted onto the system in the form of the proportion of airline-specific marginal schedule displacement over total marginal schedule displacement. The herewith presented research work is currently in progress. As part of ongoing steps of this research, the proposed model will be applied and solved for a small, regional airport in Greece with the use of real-world scheduling data obtained from the Greek slot coordination authority. The numerical results will be thereafter compared against those obtained by models that do not incorporate fairness objectives in order to assess the "cost" of fairness with respect to scheduling efficiency.

Future research directions involve the investigation of different metrics or expressions of fairness in conjunction with other – and probably new – considerations such as resource utilization or even environmental (e.g., emissions) objectives. Last but not least, although there have been recent research efforts exploring the strategic slot scheduling problem at network level, there is still ample room for further research and improvements in terms of both efficient modeling formulations and robust solution approaches capable of dealing with the inherent complexity and size of the airport network problem.

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Demand Covering Problems with Facilities' Interaction

Maria Michopoulou
Department of Business Administration (Patras) TEI Western Greece,
1 Megalou Alexandrou,26334, Patras

Ioannis Giannikos
Department of Business Administration (Patras) University of Patras, 26504

Abstract

The general problem of locating facilities that serve a given set of customers is essentially strategic in nature for almost every company or organization. The process of finding appropriate locations (sites) implies a long term investment, since it typically includes land property costs and high construction expenses, while it also functions as an indicator of the customers' preferences for the particular sites that are chosen. Thus, locating facilities could have a huge impact on the effectiveness, competitiveness and vitality of any firm or organization. Typically, covering models do not take into account the quality of the services provided as a feature of the facility or the interaction between facilities and demand. This paper examines several reformulations of the basic models that may incorporate the quality of services provided by each facility and the ability to meet demand after multi-site co-operation. These formulations were tested on a series of instances from the 40 problems in OR Library (Beasley 1990). In particular, the computational times and the quality of the solutions were examined in a variety of problems with different number of customers and different topological features.

KEYWORDS

Location Analysis, Cooperative cover, Covering Problems

1. INTRODUCTION ON COVERAGE

The general problem of locating facilities that serve a given set of customers is essentially strategic in nature for almost every company or organization. The process of finding appropriate locations (sites) implies a long term investment, since it typically includes land property costs and high construction expenses, while it also functions as an indicator of the customers' preferences for the particular sites that are chosen. Thus, locating facilities could have a huge impact on the effectiveness, competitiveness and vitality of any firm or organization.

The literature on coverage problems is quite rich; for a review the reader is referred to Berman et al (2010b); Schilling et al (1993); Daskin (1995); Current et al (2002); Plastria (2002). Note that under the standard coverage framework, only one facility (namely the closest one) determines whether a customer node is covered or not. As discussed in Berman et al (2010a) this 'individual cover' assumption may not be appropriate in many potential application areas.

The basic idea of all covering problems is that customers who are within a certain predefined ''service standard'' of a facility, are considered adequately served, while those who are not within those limits are considered not being served at all. The service standard of a facility is typically defined in terms of distance or time. Covering problems are most often, but not exclusively, found in the context of emergency facilities. In particular, it may be required that each member of the population (or, at least, a certain large proportion of it) must be within reach of an emergency facility, such as a fire station, hospital or emergency repair service depot. The distribution of perishable goods, including the delivery of hot pizzas, can also be optimized with the help of these models. Two different types of covering models are distinguished in the literature: The

original location set covering models minimize the number of facilities required to cover each customer at least once, while the maximal covering location problems maximize the number of customers reached, given that a fixed number of facilities are available.

2. THE CLASSICAL COVERING PROBLEM

In this section we introduce the following generalization of the covering problem whose objective is to maximize the number of covered demand points with p available facilities. The general format of these problems is:

$$x_j = \begin{cases} 1 \text{ if locating a facility at site } j \in X \\ 0 \text{ otherwise} \end{cases}$$

$$y_i = \begin{cases} 1 \text{ if node } i \text{ is covered}, i \in C(x) \\ 0 \text{ otherwise} \end{cases}$$

Let:
X be the location space, such that (X,N) is a metric space
C(x) be the set of covered demand points

The problem is:

$$Max \quad \sum_{i=1}^{n} w_i y_i$$

Subject to:
$\Sigma x_j = p$ for $j \in X$
$\Sigma x_j \geq y_i$, $i \in \mathbb{N}$
x_j , $y_i \in \{0,1\}$ $i \in \mathbb{N}$, $j \in X$

However this version of the coverage model is simplistic in the sense that it does not take into account the quality of the coverage offered or the possibility of cooperation among facilities. Consider a situation where servers emit a signal that dissipates over distance. A demand point is covered if the signal it receives is sufficiently strong, i.e., if it exceeds a certain threshold the area where the signal exceeds the threshold thus defines the coverage radius of the facility. The signal can either be physical (warning sirens or cell phone towers) or non physical (emergency system applications)

For example, in many cases (including light, sound, and microwave signals), the signal emitted by the source dissipates proportionally to the square of the travel distance and the signal received at a demand point is the sum of the signals from all sources. In such cases, the facilities can be viewed as cooperating to provide coverage. It may not be necessary to have a facility located near a demand point to ensure coverage, as long as the combined signal strength at this point is large enough. We refer to models with this type of coverage objective as “cooperative cover” models.

3. THE COOPERATIVE COVERING PROBLEM

As an example consider the location of transmission towers servicing cell phones the probability that a connection between a tower and a cell phone can be established decreases with the distance at 2 km distance the probability is 95%, at 2.5 km it is 80% and at 3km is 75%.

A cell phone is considered covered by the tower if the probability of establishing a connection is at least 95%. Consider that a cell phone is in 2.5km from the closest tower and 3 km from the second closest. By traditional models this cell phone in not covered. However the probability that a connection can be established is 1-(1-0,8)(1-0,75)=0,95 and this cell phone is actually covered. This underestimation leads to requiring twice as many facilities as are actually needed if the cooperative behavior is considered. In order to alleviate these weaknesses the discrete maximal covering problem is formulated as follows.
The cooperative covering problem (CCP) was introduced in Berman et al (2010a). It considered the following mechanism of coverage. Each point j emits a signal that decays over distance according to some known non negative and non increasing function of distance ϕ(d)= $1/d^2$ .The CCP can be formulated as follows. Each demand point i N is affected by the sum of the signals from all source points, that is, the total signal at i is given by $\sum_{j=1} \varphi(d_{ij})$ The signal at the demand point must exceed a certain threshold T in order for the demand to de covered, that is, demand point i $\in$ N, is covered if and only if $\sum_{j=1} \varphi(d_{ij}) \geq T$ for every point.

<u>Notation</u>

N be the set of nodes
w_i be the weight associated with node i $\in$ N
d_{ij} distance between nodes i $\in$ N and j $\in$ P
T be the threshold for coverage

<u>The problem</u>

The problem is formulated as integer programming problem for a discrete location case – that is when the set of potential facility locations is discrete (that is from a finite set of locations). The cooperating maximum location problem with p point sources is given by

Decision Variables:

$$x_j = \begin{cases} 1 \text{ if locating a facility at site } j \in X \\ 0 \text{ otherwise} \end{cases}$$

$$y_i = \begin{cases} 1 \text{ if node i is covered, } i \in C(x) \\ 0 \text{ otherwise} \end{cases}$$

Problem:

$$Max \quad z = \sum_{i=1} w_i y_i$$

st

$$\sum_{j=1} \varphi(d_{ij}) x_j \geq T y_i \qquad \text{(A)}$$

$$\sum_j x_j = p$$

$x_j \in \{0,1\}$ $y_i \in \{0,1\}$ για κάθε *i,j*∈N

ϕ(d)=$1/d^2$

T=0,01p-10^{-6}

The distance decay function can be considered as an indication of quality. In general, function $\varphi(d_{ij})$ can take any form, expressing the quality of coverage offered by server j at demand point i. Typically, covering models do not take into account the quality of the services provided as a feature of the facility or the interaction between facilities and demand.

4. ALTERNATIVE FORMULATIONS

This paper examines several reformulations of the basic models that may incorporate the quality of services provided by each facility and the ability to meet demand after multi-site co-operation. In the initial model the constraint $\sum_{j=1} \varphi(d_{ij})x_j \geq Ty_i$, is stating that the total signal that client i receives from the facilities j must be at least T threshold.

4.1 Problem Formulation 1

In this formulation constraint (A) is changed to

$D_i \geq Ty_i$

The signal received by each client i is not the total signal but the strongest one. This different formulation that we examined concerns the case where coverage is not the sum of all signals but the strongest signal provided to client i when it is compared to other signals.

To this effect we need to introduce a new variable Di, which expresses the strongest signal received by customer i.

The complete model is formulated as follows:

Problem: $Max \quad \sum_{i=1}^{n} w_i y_i$

st

$D_i \geq \varphi(d_{ij})x_j$

$D_i \geq Ty_i$

$\sum_j x_j = p$

$\phi(d)=1/d^2$

$T=0{,}01p-10^{-6}$

$D_i \geq 0$

$x_j \in \{0,1\} \qquad y_i \in \{0,1\}$ για κάθε $i,j \in N$

4.2 Problem Formulation 2

In the second (2) formulation the coverage that received by each client i is the weakest one. The variable D_i, now expresses the most weak signal received by customer i.

Problem: $Max \quad \sum_{i=1}^{n} w_i y_i$

st

$D_i \leq \varphi(d_{ij})x_j$

$D_i \geq Ty_i$

$\sum_j x_j = p$

$\phi(d)=1/d^2$

T=0,01p-10^{-6}

$x_j \in \{0,1\}$ $y_i \in \{0,1\}$ για κάθε *i,j*∈N

These formulations were tested on a series of instances from the 40 problems in OR Library (Beasley 1990). In particular, the computational times and the quality of the solutions were examined in a variety of problems with different number of customers and different topological features. The computational experiments were performed with AIMMS program (version 3.14x86). In all problems an optimal solution was found. In all instances even with n 500 AIMMS found the optimal solutions in a short time (problem formulation 1). In problem formulation 2 an optimal solution is also found but the solving time to these cases was longer.

5. CONCLUSIONS

The discrete cooperate covering model provides a new definition of coverage. A series of alternative formulations were tested in 40 test problems ranging from 100 to 900 nodes and between 5 and 200 facilities. These formulations were solved with CPLEX within the AIMMS modeling environment. As future work we can experiment with different assumptions of the quality function that will express different perceptions of quality. Furthermore, we can experiment in designing a more sufficient algorithm that will solve problems faster.

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The logistics role in community resilience: a case example of a community based social partnership in Greece

Maria Drakaki
Department of Automation Engineering, Alexander Technological Educational Institute of Thessaloniki P. O. Box 141, GR-57400, Thessaloniki, Greece

Gyöngyi Kovács
Humanitarian Logistics and Supply Chain Research Institute (HUMLOG Institute), Hanken School of Economics Arkadiankatu 22 P.O.Box 479, 00101 Helsinki, Finland Helsinki, Finland

Panagiotis Tzionas
Department of Automation Engineering, Alexander Technological Educational Institute of Thessaloniki P. O. Box 141, GR-57400, Thessaloniki, Greece

Abstract

The various organisations included in social partnerships jointly address gaps in their society and community. Some social partnerships are planned from the top, other, grass-root partnerships are deeply rooted in their communities. Such grass-root, community based partnerships are based on the principles of self-organisation, yet logistically, this can bring many challenges. This study therefore focuses on the logistical aspects of a community based social partnership in Greece, and the contribution of this partnership to community resilience. In such a context, logistical activities are performed by the membership base of various non-governmental organisations in a manner of "collective action" rather than the commercial sector. Interestingly, community resilience refers to a capacity for collective action, hence organising logistical activities in this fashion ultimately contributes to community resilience.

This study focuses on self-organisation, and a resultant community based social partnership (CBSP) in Greece, with members from the private, public and civic sectors, in the midst of a financial crisis. In the context of logistics, a conceptual model has been developed linking the partnership with self-organisation, social capital building, and community resilience. The partnership has been analysed both in terms of its process related dynamic properties and measured outcomes. Research method was based on both formal and informal interviews, written communication with various members of the partnership and secondary data analysis. Topics included operational organisation and process description of the actions, information regarding the logistics of the various actions, such as transportation, warehousing and distribution of in kind donations; accountability; relationships between partners; links to social capital attributes. Community impact to social assets, health and well-being has been shown. Measured outcomes include numbers of collected and disseminated food and medicine and provision of health services.

KEYWORDS

Community based social partnership, logistics, community resilience, financial crisis, self-organised emerging networks, disaster management.

1. INTRODUCTION

The self-reliance of communities has been frequently emphasised from various directions: Disaster management approaches stress how communities are "on their own" for the first hours and days after a disaster has occurred, before international aid can at all arrive. Development aid intends to move away from aid dependence towards building local capacity and facilitating trade and growth. Community participation in the disaster relief efforts has been seen as a benefit in humanitarian supply chain design (Gaillard, 2010; Matopoulos *et al*., 2014). In the humanitarian logistics (HL) context, effective disaster relief can be achieved with collaboration between humanitarian organisations, governments, civil society, the military and businesses (Tomasini and van Wassenhove, 2009). Local humanitarian partnerships are thus formed each time a disaster occurs between actors that would not have an incentive to collaborate otherwise. Furthermore, sustainable disaster relief requires development of resilient communities, thus partnerships may exist beyond the disaster response phase to collaborate with local communities.

Community resilience has become the holy grail of both disaster management and development aid, and how better to create resilient communities than developing the idea of self-reliance (Shuman, 2013)? Whether prepared for this or not, fact is that often, communities are on their own when facing various crises or disasters. Community resilience relates to collaboration and effective coordination of all stakeholders, i.e. public, private and civic sectors and individuals, within their social and economic systems (Stewart *et al*., 2009). Therefore, it can be defined as an adaptive process which integrates stakeholders' capabilities in ways that lead to positive adaptation after a disaster (Norris *et al*., 2008). Cutter (2016) has pointed out that community resilience can be seen as the social dynamics and interactions within the community and the social capital that is important in enhancing connectivity and action. Logistics and supply chain management are backbones to community resilience in that they enable the material, information and financial flows necessary for any activity. Thus the community resilience to crisis approach in this paper focuses on logistics, emphasizes self-reliance and self-organisation. It integrates the definitions given by Stewart *et al*. (2009) and Norris *et al*. (2008) while it also infers active citizen participation, social interactions and social capital.

This study focuses on a resultant community-based social partnership (CBSP) in Greece in the midst of a financial crisis. By now this crisis constitutes a disaster, according to UNISDR's (2007) definition of a disaster, in that it constitutes a "serious disruption of the functioning of a community or a society involving widespread human, material, economic or environmental losses and impacts, which exceeds the ability of the affected community or society to cope using its own resources". In the 2013 UN Human Development Report, Greece is in place no. 27, 9 places below its no. 18 place in the 2008 report. Greece's section report of the statistical office of EU shows that the unemployment rate, in the first quarter of 2012, was 26.6%, and the youth (aged 15-24) unemployment rate for the same time period was 59.6%. Consequently, by 2012, 1,945,010 people received aid from soup kitchens and free medical services offered by non-governmental organisation (NGO) Apostoli in 2012.However, delivery of the aid was made possible in large due to a grass-root partnership, a CBSP. This paper focuses on CBSPs, emerged in an effort to mitigate the effects of the crisis, with the case example of one such ongoing partnership in Greece, named "All together, we can" ("All together, we can", 2013). The partnership is a grass-root, community managed self-organised national network, with members from the private, public and civic sectors, providing voluntary actions in the context of alleviating the community distress caused by the GFC. Self-organisation brings also further challenges with it, primarily in the area of logistics, and assigning volunteers for various logistical activities (Falasca & Zobel, 2012). Therefore the study also aims to shed light on the logistical challenges of this partnership. The presented CBSP is described for the first three years since its formation, however it is an ongoing partnership. Research method was based on both formal and informal interviews, written communication with various members of the partnership as well as secondary data analysis.

2. A CONCEPTUAL MODEL

Formation of wider partnerships as an organisation model for local socio-economic development involves traditional social partners, public sector agencies, private businesses, and civic sector organisations, such as NGOs, community and voluntary organisations or any combination such as public-private partnerships or private-NGOs partnerships (e.g. Nelson and Zadek 2000). Different terms are used for these wider partnerships which address these challenges such as new social partnerships or cross-sectoral social partnerships (Nelson and Zadek, 2000; Selsky and Parker, 2005). Innovation is a key characteristic, required to explore new ways of handling the socio-economic issues addressed by the partnership, such as when e.g. private sector services are delivered by non profit organisations. The partnering process implies working towards common objectives; mutual trust; a willingness to work together, shared responsibility and accountability; and access to policy making. As such the partnering process relates to social capital dimensions, i.e. trust and collective action.

In contrast to cross-sectoral social partnerships that can be formed to address social issues as well, CBSPs highlight also the role of individuals as volunteers. In other words, CBSPs emphasise, and draw on, social capital, which Putnam (2000) defined as "connections among individuals-social networks and the norms of reciprocity and trustworthiness that arise from them." According to Putnam, social capital facilitates coordination and cooperation among community members on issues of shared concern. A shared risk and/or crisis seems to be a catalyst for individuals' sensitisation, and participation in the CBSPs. Social capital

facilitates the formation, and self-organisation of CBSPs. For the presented CBSP, the shared risk is the loss of community's social cohesion, through poverty, caused and aggravated by the financial crisis. Self-organisation is another important characteristic of CBSPs. Resilient communities exhibit self-organisation characteristics by using social networks (e.g. Holguin-Veras et al., 2012). In conclusion, we adopt Drakaki and Tzionas' (2017) definition of a CBSP: A CBSP is "a grass-root, self-organised, social network that involves combinations of public, private and civic sectors, with members engaging in voluntary, mutually beneficial, innovative relationships at national level, sensitising individuals to participate in actions, in order to jointly respond to a shared risk or crisis".

3. "ALL TOGETHER, WE CAN" CBSP

The initiative started in late 2009, before the creation of the partnership, and grew substantially by early 2010. It was initiated by the media industry sector of the private company Radio & Telecommunications Enterprises S.A (SKAI). SKAI launched a national media campaign addressing its audience to participate in actions so that society's social cohesion remains intact. The name of the partnership, "All together, we can", is representative of its purpose, i.e. all stakeholders, including individuals, contribute as they can, so that the community's collective action can mitigate the effects of the crisis. The media campaign was advertised through radio, TV, web stations, and print of SKAI, in all available trailer time, to promote weekly actions in sectors such as society, health and education. In 2010 the CBSP was formed. The structure of the partnership is shown in Table 1.

Table 13 Structure of the "All together, we can" CBSP

Type of partnership	Network
Responsibilities of participants	Dependent on their resources
Decision making	Depends on the action
Communication	Dedicated website. National media campaign of SKAI
Implementing partners (IPs) in action for the society- food collection	SKAI- sector: media industry, Apostoli, Church of Greece with regional Dioceses, local supermarkets, the military, Greek government- Ministry of Education
IPs in action for society- collection of goods for children in need	SKAI, NBG, Eurobank*
IPs in action for the society- clothes collection	SKAI, Church of Greece with regional Diocese, the military
IPs in action for society- collection of goods for children in need	SKAI, NBG, Eurobank*
IPs in action for health- medical services to children in need	SKAI, Doctors of the World Greece (MdM Greece), Vodafone, 25 municipalities in Attica and Thessaloniki area
IPs in action for health- collection of medicine	SKAI, Apostoli, Athens and regional Medical Association, local medical authorities, certain hospitals**
Non regular action in action for the society – collection of goods for the flood stricken countries of Serbia, Bosnia & Herzegovina and Croatia in 2014	SKAI, Serbian Embassy, Hellenic Red Cross
Non regular action in action for health- Donation of 2000 HPV vaccine shots to public clinics in 2014 (for treatment of young uninsured girls)	SKAI, GlaxoSmithKline

Data covers the period 1/2010-7/2014; * Collaboration with the partnership took place in the first year; ** Certain hospitals joined in 2014.

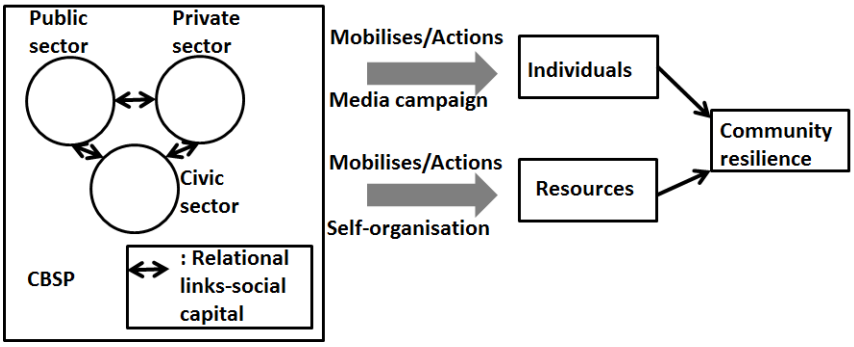
A conceptual model of the CBSP is shown in Figure 1. As indicated there, the CBSP mobilised both individuals, and resources that are relevant to foster community resilience, not just based on the partnerships as listed in Table 1 but also broader from the civic sector and society.

3.1 Logistics of the CBSP

In order to know what to deliver, humanitarian supply chains, also in this case, need to assess both who is in need and of what. This is typically called "needs assessment" in the humanitarian context, and it extends to a complex exercise of determining who is vulnerable yet not capable to support themselves, as well as the exact

quantities, forms, shapes, timing and locations of demand. Based on this, needs can be matched with supply, and deliveries can be organised.

Figure 14 A conceptual model of a CBSP



3.1.1 Needs/Demand Assessment

The CBSP responds to demands from Dioceses of Greece, various institutions and organisations, social services departments of municipalities. Additionally, Ministry of Education provides lists of students in need and the Ministry of Health provides lists of uninsured people. The needs assessment is done for each action separately by the IP in charge for the needs assessment of the relevant action. Thus, e.g. MdM Greece does the needs assessment for the provision of medical services to children in need, however the IP usually collaborates with the municipality for the event location. The eligibility criteria, such as required documentation for proof of low-income family or uninsured family, are released on the partnership's website during each action's media campaign and checked for each child by the volunteer doctors during the action, in order that aid reaches the most vulnerable.

Table 2 Operational organisation of main regular actions for society and health

Type of action	In kind donations /Services provided	Coordinator	Organiser	Frequency of participation/ Action locations
Society-food collection	Long duration packaged food products, such as rice, spaghetti, olive oil; essential personal *hygiene products*	SKAI	SKAI in collaboration with Apostoli and/or with Church of Greece with regional Dioceses	Continuous action/ 2,000 collaborating supermarkets
Society-collection of goods for children in need	Collection of school supplies, clothes, shoes, toys, easter candles	National Bank Greece (NBG) *	NBG in collaboration with SKAI	Three times a year. Three actions per time period/ At least 4 different spots, in Athens, Thessaloniki and big cities
Health – collection of medicine	Medicine, either new or stored at home in good conditions, not expired	SKAI	SKAI in collaboration with Apostoli and Athens and regional Medical Associations	Weekly basis in at least two municipalities/ Churches and municipal buildings. 70 municipalities participated
Health-medical services to children in need	Free medical examinations, diagnostic tests, dentist test, free medicine treatment; diagnostic care, vaccination	MdM Greece, Vodafone, 25 municipalities in Attica and Thessaloniki area	MdM Greece	8 actions per month delivered in 4 weekends/ In Attica and Thessaloniki areas

Data covers the period 1/2010-7/2014; * Since September 2013.

3.1.2 Community involvement

The operational organisation of main regular actions for society and health are shown in Table 2. As indicated there, food, medicine, and non-food items were collected from the community, and deliveries were scheduled

according to the specificities of the items and their demand. Much attention was paid to the quality of collected items; which could otherwise be a main problem in material convergence especially in light of in-kind donations (Kunz et al., forthcoming).

The resources (physical, human organisational) provided by the CBSP as well as the partnership's community impact are shown in Table 3. The analysis follows the resource division of local community resources as in Matopoulos et al. (2014).

Table 3 Resources provided by the CBSP and partnership's community impact

Type of resource	Description	Community Impact
Physical	Depending on the action (e.g. medicine, medical supplies and equipment, mobile medical unit, drivers; logistics companies for transportation, transportation vehicles, warehouse)	● Reinforcement of social cohesion ● Provision of services and in kind donations to meet beneficiary needs ● Community capacity building ● Trust (between partners in individual actions and between partners and beneficiaries
Human	Volunteers (e.g. doctors, administrative personnel, journalists, reporters, personnel for e.g. receiving, sorting or transporting in kind donations); staff/paid personnel (e.g. Information technology, warehouse and logistics employees), marketing and communication departments coordinators	● Community social capital/ Relationship building ● Citizen sensitization ● Volunteerism ● Example outcomes In terms of collected goods:
Organisational	National media campaign; marketing and communication departments; logistics companies; social pharmacies; social groceries Information and communication Decision making taken within each action Warehousing; transportation; distribution	2012: 3,226,600 daily meals – close to the year distributed meals by Apostoli (Apostoli delivered 3,600,000 daily meals in 2012) 16/6/2012-1/7/2013: 491,000 medicinal products

Importantly, the impact on the community is not only one in terms of the aid being received, but further impacts can be traced in light of reinforcing the social cohesion of the community, and in building local capacity – which are the aims of also community resilience.

4. CONCLUSIONS

The purpose of this paper is to focus on the logistical aspects of a community based social partnership in Greece, and the contribution of this partnership to community resilience. The case example CBSP in Greece, emerged in response to the community distress caused by the financial crisis. The partnership is a grass-root self-organised national network, with members from the private, public and civic sectors, that sensitises the audience, individuals, via a national media campaign to participate in voluntary actions for the community in sectors such as health, nutrition and education. A shared risk, i.e. loss of society's social cohesion, and the partnership's national media campaign have been catalysts in motivating the audience to participate in the actions, whereas the leading company is a media sector company. In the context of logistics the CBSP's contribution has been analysed both in terms of its operational organisation, structure, resources, relationship building, social capital and measured outcomes. A conceptual model has been developed linking the partnership with self-organisation, social capital building, and community resilience. Analysis of similar European or national CBSPs can help to formulate policy responses for community resilience.

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A Decision-Making Framework for Sustainable Supply Chain Management of Perishable Goods

Volha Yakavenka[1]
[1]Aristotle University of Thessaloniki, Greece
[1]vyakaven@auth.gr

Ioannis Mallidis[2]
[2]Aristotle University of Thessaloniki, Greece
[2]imallidi@auth.gr

Dimitrios Vlachos[3]
[3]Aristotle University of Thessaloniki, Greece
[3]vlachos1@auth.gr

Eleftherios Iakovou[4]
[4]Texas A&M University, Texas, US
[4]eiakovou@tamu.edu

Abstract

Sustainability in supply chain management (SCM) refers to a holistic process that involves multiple synergies and interactions between various supply chain (SC) stakeholders, while suggesting a set of principles that can be employed for economic, environmental, and social optimum decision-making approaches. For perishable products, the impact of SCM on their quality is critical, since ineffective SCM practices may lead to increased storage and transportation times which may in turn affect their quality as well as quantity due to inappropriate maintenance practices that rise the amount of product waste due to their perishable characteristics. Specifically, for food products, issues of "food safety and security" emerge, that can even affect human health. Under this context, the purpose of the paper is to provide a decision-making framework that assigns aspects of business ethics to the sustainable management of the supply chain of perishable products, and involve the provision of fresh, price and environmentally friendly products to the consumers. In order to address this issue, we will develop and employ multi-criteria (cost, time and emissions minimization) mixed integer linear programming (MILP) model, and further apply it in a realistic case study for deriving managerial insights.

KEYWORDS

Decision-making, Supply chain, Sustainable management, Perishable goods.

1. INTRODUCTION

Sustainable supply chains are characterized by a limited environmental impact across all supply chain echelons, support economic growth through strengthening the competitiveness of the involved stakeholders, and further promote social issues. However, sustainability in SCM of perishable goods does not only involve economic, environmental, and social efficiency, as addressed in a plethora of research efforts, but should be incorporated in a framework of "business ethics", which involves a set of moral values and objectives that focus on the provision of quality products to the final consumer. For perishable products, the impact of ineffective SCM practices on their quality is critical, as they can lead to increased storage and transportation time which could affect the products' "freshness" due to their perishable characteristics. Specifically for food products issues of "food safety and security" emerge that can even affect human health. Thus, the sustainable management of perishable product SCs extends to the entire scope of the corporate activity, academic research, and social life as it deals mainly with the well-being of human. Therefore, the concept of sustainability is particularly relevant to real world problems and plays a pivotal role in the fundamental process of corporate decision-making since consumers are keen on issues associated with ethical corporate practices that focus on the preservation of social interest.

The consideration of product perishability in the design of multi-echelon supply chain puts additional complexity to the decision-making process, as time now plays an important role in the preservation of the product's quality. The shelf life of a plethora of products is short enough and in many cases the duration of the “trip” from collection to consumer points occupies a considerable part of this limited time period, during which physical and physiological properties of products undergo changes and may lead to product loss and

waste. Reducing food loss and waste across supply chains is of critical importance. In the EU, food waste along the supply chain has been estimated at approximately 88 million ton, or 173 kg per capita per year, or 720 kcal per person per day (European Parliament, 2016). According to European Parliament (2013), in Greece food waste represents 80 kg per capita per year. Food is wasted across the entire supply chain because of consumers' responsibility and inadequate supply chain management. The results of different studies indicate that up to 35% of the overall food waste in the distribution/retail sector is avoidable.

In this context, the purpose of this paper is to quantify the aspects of business ethics to the sustainable management of the supply chain of perishable products through the development of a novel methodological framework that follows the strategic-decision making process and incorporates the development of a multi-criteria (cost, time and emissions minimization) mixed integer linear programming (MILP) decision- making model. This model decides on: (i) the optimal locations and capacities of distribution facilities; (ii) the optimal selection of the types of transportation modes employed from the supply points to the DCs. The optimization criteria involve the transportation costs, times and emissions of the alternative transportation modes employed and the DC leasing, operating costs, time and emissions.

The rest of the paper is organized as follows: in Section 2 we present the literature review, Section 3 presents the proposed methodological framework, while Section 4 sums up the findings of this research.

2. LITERATURE REVIEW

Sustainability in the supply chains has been studied since the 1990s. Despite this fact the research efforts on three pillars of sustainability are not proportionate. If there is a plethora of studies on economic aspect and fewer on its interactions with environmental performance, then the social one is the weakest and becomes relevant from 2014 as soon as social factors drive or sustain all development outcomes (Tuljak-Suban, 2016). In addition, none of the studies concerning sustainable development proposes a holistic and comprehensive research on design and management of supply chain of perishable goods simultaneously balancing all sustainability components: environmental, economic and social. A lot of these studies elaborate on issues regarding the number, location, capacity and operation of distribution centers/production facilities in a generalized form (Mallidis et al., 2012) and do not consider specific characteristics and conditions for transportation, storage and processing of perishable products within the network. However, it is impossible to devise a solution suitable for all kinds of supply chains and products. Therefore, consideration of perishability in the supply chain management has received increased attention in research works (Govindan et al., 2014).

Distance between the different regions still plays a crucial role in logistics of temperature sensitive products where time and delivery conditions are an issue of special importance. The minimization of delivery and holding time is one of the main problems in the transport and storage of fresh products since their prices, quality and quantity decrease over time that has a negative economic impact on all the participants of supply chain. Despite, a considerable number of works regarding distribution networks that deal with the transportation and storage of temperature-sensitive products (Hsu et al., 2007; Broekmeulen et al., 2009; Minner et al., 2010; Jia et al., 2011) many of the proposed network design models ignore time limitations for distribution of such specific products within the network.

Transportation scheduling and routing decisions as well as allocation and inventory decisions have some differences in the cold chain and traditional supply chain. Consequently, some modifications in the current models, or development of new models is required (Bozorgi et al., 2014), where one of the significant features of the cold chain models particularly the expiration date limitation should be considered (Voughan, 1994). Meanwhile, Apte (2010) underlines the great significance of time in the management of food supply chain. The author concludes that decision-makers should consider time in order to minimize fresh product supply chain network's vulnerability to disruption. Hence, transportation routing and mode selection decisions in relation to time windows are of high importance (Lemma et al., 2014).

In this direction, Rong et al. (2011) present an MILP model that aims to minimize the total costs for the planning of food production and distribution with a focus on product quality, introducing the maximum planned transport lead time and storage time limits. Firoozi et al. (2013) formulate and solve an integrated inventory location model for perishable commodities by investigating the effect of lifetime on the objective function that minimizes the total annual costs. Different research works that focus on inventory and routing problems in addition to, or instead of, the cost function with respect to temperature-sensitive products and taking into account limited time window are conducted by Osvald et al. (2008), Olsson et al. (2010), Amorim et al. (2012), Kouki et al. (2013). Nevertheless, the environmental issues have been considered along with the cost for the supply chain and especially supply chain management of perishable goods research quite recently.

Numerous studies in recent years focus on the emissions generated in different echelons of the supply chain (James & James, 2010; Dekker et al., 2012; Chaabane et al., 2012). James & James (2010) identified a mutual effect of cold chain and climate change and this work is the most recent comprehensive paper addressing cold supply chains and emissions specifically. A methodological framework for the design of green agrifood supply chains is presented by Iakovou et al. (2012), while a comprehensive critical review on sustainability issues in designing and operating of agrifood supply chain is studied by Tsolakis et al. (2014), Bozorgi[2] et al. (2014) develop a non-linear inventory model for perishable items that considers holding and transportation unit capacities for the cost and emissions objective functions but neglects time limit conditions.

It is possible to conclude that only the balanced implementation of the three pillars of sustainability in decision-making process can be sufficient for the supply chain management of perishables since their quality, quantity, timeliness and accessibility determine the quality, duration and safety of life. Despite the fact that there are plenty of studies that examine the impact of time parameters on various supply chain management policies, there is a lack of integrated systemic approaches for the design of sustainable supply chains that incorporate the shelf lives of their products in their decision-making process. This paper aims to overcome these issues by developing a novel easy-to-use methodology that will enable to balance economic goals with social and environmental dimensions.

3. METHODOLOGICAL FRAMEWORK DESCRIPTION

We consider a multinational company that supplies a Market with perishable products that are characterized by low shelf life durations (i.e. fruits, vegetables, etc.). We assume that the Market consists of a number of Regional Markets where the demand is allocated in the region's capital. All cargo is transported from one distant Loading Point in reefer containers by different modes of transport (multimodal transportation system), into the market through a number of Entry Points located in the Market's borders, and then to centralized Distribution Centers established within the market's premises. Transportation from the Loading Point to the Entry Points, can occur by deep sea shipping vessels, ferryboat, railway and truck transportation, while from the Entry Points to the Distribution Centers and then to the retail stores by truck and rail transportation.

However, the design of such supply chains is constrained by the shelf life duration of the products distributed, leading to an increased complexity of the whole design process. To address this issue we propose a methodology that consists of a two-stage supply chain network design process. The first stage "pre-process" determines the routes of the supply chain, along with the associated transportation modes employed, which lead to total transportation and storage times that are higher than or equal to the examined products' shelf life. These routes are then excluded from the examined network structure. In the second stage, the classical network design problem is addressed which decides on: (i) the selection of the entry points; (ii) the choice of transport means; (iii) the selection of the distribution centers; and (iv) the determination of the associated flows between the nodes of the supply chain under study. The optimization criteria are the supply chain's total transportation and DC operating costs and the network's total transportation and DC operating CO_2 emissions. The second stage involves the application of a Mixed Integer Linear Programming.

After the completion of the basic mathematical models we develop appropriate computational tools required to perform calculations and export numerical results for certain values of the parameters that will enable the

practical use of the model through its application in realistic case study. For this purpose the algorithm for solving linear problems is developed in specific software environment (Lingo). Applicability of the proposed model is illustrated in the realistic case of a supply chain connecting Greece with the north-eastern european region since representation of geographic coverage and different climate zones are essential for export of perishable goods (fruits). Evaluation of the case study's outcomes is realized from an economical, environmental and social efficiency point of view. The main outcome that derived from this evaluation, indicate that the CO_2 emissions' optimal solution also provides time and cost efficient solutions.

4. CONCLUSIONS

This paper focuses on the concept of sustainable supply chain management of perishable goods. The main idea of the proposed decision-making framework stands on the way that economic gain, environmental issues, food security issues and time limitation are jointly considered and evaluated in order to serve the need of sustainability. We base our approach on the hypothesis that the integrated decision making will result overall in improved decisions compared to the decision making taking only one of these aspects into account. The consideration of product perishability in the design of multi-echelon supply chain puts additional complexity to the decision-making process, as time now plays an important role in the preservation of the product's quality. The analysis of the literature showed that the sustainable supply chain management decisions for perishable goods along with the traditional problem of the identification of the optimum configuration of the network based on its total cost minimization should also consider the environmental aspect and products' expiration date limitation. For this reason, we propose a two-stage methodological framework for the optimal design of temperature controlled supply chains, which assists in identifying the cost-environmental-social (time) tradeoffs on supply chain of perishable goods design. The design process itself is accomplished through the development of the classical Mixed Integer Linear Programming methodology. The proposed decision-making methodology is illustrated in the realistic case study.

ACKNOWLEDGEMENT

This paper proposes a decision-making framework that assigns aspects of business ethics to the sustainable management of the supply chain of perishable products in order to involve the provision of fresh, price and environmentally friendly products to the consumers.

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The Impact of Additive Manufacturing on Pharmaceutical Supply Chain Network Configuration

Konstantinos Tziantopoulos
Aristotle University of Thessaloniki,
School of Economic Sciences
Faculty of Law, Economics and Political Sciences Building,
54124, Thessaloniki, Greece
ktzianto@auth.gr

Michael A. Madas
University of Macedonia,
School of Information Sciences
Department of Applied Informatics
156, Egnatia Str., 54636, Thessaloniki, Greece
mmadas@uom.gr

Abstract

Additive Manufacturing (AM) constitutes an increasingly adopted technological solution that enables "on-demand" fabrication of customized products, using a variety of metallic, polymer or ceramic materials, with significant implications on supply chain configuration and performance. Several industrial applications of AM have been already brought forward in the aerospace, automotive, spare parts and healthcare sectors. AM applications in healthcare, and particularly in drug production, have been shown to deliver substantial benefits in the pharmaceutical supply chain by enabling on-demand and distributed production, reduced lead times, as well as personalized dose drugs and tailored release profiles. The objective of our paper is to assess the impact of AM adoption on drug tablet production and the supply chain reconfiguration opportunities under different AM production cost scenarios. For this purpose, we propose a MILP model formulation which aims to minimize a total cost function consisted of AM facility investment costs, production costs for primary and secondary manufacturing, as well as transportation costs, subject to network connectivity, production capacity, demand fulfillment, and flow conservation constraints. The proposed model is demonstrated at a small problem instance involving a 4-echelon pharmaceutical supply chain network for theophylline Active Pharmaceutical Ingredient (API) tablets.

KEYWORDS

Additive Manufacturing, Pharmaceutical Supply Chain, Facility Location, Network Configuration.

1. INTRODUCTION

During the last few years, Additive Manufacturing (AM) has raised the increasing interest of the research community (Norman et al. 2017; Emelogu et al. 2016), market actors and media (Smith 2015; Kadet 2017; Meyer 2015), highlighting the disruptive effect and radical benefits of AM in a wide range of business sectors and applications. AM constitutes an increasingly adopted technological solution that enables the "on-demand" fabrication of customized products, using a variety of metallic, polymer or ceramic materials, with significant implications on supply chain configuration (e.g., shorter, more collaborative and decentralized) and performance (e.g., reduced lead times and inventory, increased customization, form postponement, service level improvements). Nowadays, industrial AM has become a mature technology and an increasing number of industries adopt and apply AM to their manufacturing processes. Daimler AG transformed its production process for 30 genuine spare parts for Mercedes-Benz trucks in AM, Siemens uses AM for rapid repair of gas turbine burner tips and General Electric produced 19 3D-printed fuel nozzles for each LEAP Aircraft Engine. Interestingly, 98% of hearing aid shells worldwide are fabricated using AM (CTA and UPS 2016), while recently Aprecia Pharmaceuticals used AM to manufacture Spritam, an FDA[1]-approved 3D printed drug tablet.

[1] U.S. Food and Drug Administration Federal Agency

Existing quantitative research on Supply Chain Management and AM focuses on spare parts (Khajavi et al. 2014; Liu et al. 2014; Li et al. 2016), manufacturing (Chiu and Lin 2016; Scott and Harrison 2015; Chen 2016; Barz et al. 2016), as well as the medical sector (Emelogu et al. 2016). In the pharmaceutical supply chain context, an increasing number of researchers have recently focused on exploring opportunities to produce 3D printed drug tablets (Norman et al. 2017). On-demand and distributed production, personalized dose drugs, multi-API tablets and tailored release profiles signify the most important benefits of AM in drug production. Being a technology that has only recently reached its maturity phase towards medium to large-scale adoption, there has been very limited research aiming to assess in a quantitative way the implications of AM in pharmaceutical supply chain management and configuration. In this paper, we aim to assess the impact of AM adoption on drug tablet production and the supply chain reconfiguration opportunities under different AM production cost scenarios. For this purpose, we propose a MILP model formulation which aims to minimize a total cost function consisted of AM facility investment costs, production costs for primary and secondary manufacturing, as well as and transportation costs. The proposed model is applied at a small problem instance involving a 4-echelon pharmaceutical supply chain network for theophylline Active Pharmaceutical Ingredient (API) tablets.

2. PHARMACEUTICAL AND DRUGS SUPPLY CHAIN

The pharmaceutical industry, representing a $600 billion market globally (2009) and 15.4% of total healthcare expenditures (Mousazadeh et al. 2015; Kelle et al. 2012), is a capital- and research-intensive industry growing on average at a rate of 4-6 per cent annually (Narayana et al. 2012). Although profit margins are high, amounting even to 30% in some cases, these are partially justified by exceptionally high R&D and drug development costs (Savage et al. 2006). Indeed, R&D expenditures reached $67.4 billion in 2010, representing about 18% of sales revenues. Furthermore, the average cost of a new drug has been $1.3 billion (Laínez et al. 2012), while the large majority of new drugs may be never approved or commercialized. The Pharmaceutical Supply Chain (PSC) constitutes a rather long, complicated and globalized supply chain. It encompasses a complex of processes, operations and multiple actors involved in the discovery, development and manufacture of drugs and medications (Shah 2004). Furthermore, it essentially consists of several different and geographically dispersed stakeholders and echelons increasing the complexity of supply chain operations (Bhakoo and Chan 2011). More specifically, a typical pharmaceutical supply chain includes the following echelons: i) raw material acquisition, ii) primary manufacturers, iii) secondary manufacturers, iv) warehouses and distribution centers, v) wholesalers, vi) hospitals and retailers and vii) end customers/consumers. Pharmaceutical products are manufactured in two stages, namely: i) primary manufacturing for Active Pharmaceutical Ingredient (API) production and (ii) secondary manufacturing for formulation and packaging. In both echelons, production velocities are low, while quality control and assurance activities recur at several production stages due to strict quality standards. As a result, it is not unusual for the overall supply chain cycle time to reach even 300 days (Shah 2004). On the other hand, difficulties in ensuring high supply chain responsiveness (Shah 2004) are accompanied by high demand uncertainty and unpredictability in conjunction to demand for exceptionally high customer service levels (Singh et al. 2016) because of the direct impact of pharmaceuticals on health and safety.

The pharmaceutical supply chain traditionally responded to these demanding requirements by keeping high inventory levels (Candan and Yazgan 2016), amounting to 30–90% of annual demand in quantity (Shah 2004). Additional factors such as the wide variety of materials (e.g., API), long production times, flows of large quantities of products with short life-cycle and the high production of wastes exert further pressures on the economic viability of the pharmaceutical supply chain (Candan and Yazgan 2016). On top of research-intensive efforts towards new drug development, industry players have recently collaborated with the research community with the aim to bring forward the deployment of innovative manufacturing technologies. Drug production through Additive Manufacturing signifies an industry-wide challenge since it enables the manufacturing postponement of drug production and provides economically affordable customization opportunities. Most importantly, AM offers on-demand, decentralized manufacturing at short lead times, hence promoting high product availability, customer service levels and increased responsiveness of the supply chain as a whole. At the outset, AM can act as a catalyst in the pharmaceutical supply chain on the grounds

that it is expected to reconfigure the drug production sites and the entire supply chain network configuration. The assessment of the potential impact of AM adoption on the PSC network configuration is examined in the section that follows.

3. PSC NETWORK RECONFIGURATION THROUGH AM ADOPTION

In this section, we aim to evaluate the optimal design and operation of a global multi-echelon pharmaceutical supply chain network for a specific API in order to investigate how AM adoption may reconfigure it. The supply chain network consists of primary manufacturing industries (PM), secondary manufacturing industries (SM), distribution centers (DCs) and customer zones (CZs). API and drug tablets can be produced at various primary and secondary manufacturing plants at different sites around the world. Each production site has a fixed capacity. Furthermore, tablets can be produced through AM at AM facilities (AMf) placed in DCs. The establishment of AM facilities incurs a fixed investment cost. The packaging of tablets may take place either in SM plants or AM facilities. Distribution centers are subject to upper and lower bounds of material handling capacity, while they can be supplied from more than one SM plants and can supply more than one CZ. The distribution network within each customer zone goes beyond the scope of this study. Transportation costs are estimated based on the quantities of products transported from source to destination nodes, as well as the distances between nodes. The main decisions pertain to the number, location and capacity of AM production facilities. The objective of this problem is the minimization of the total annual cost of the PSC network. Primary and second manufacturing locations, DC locations, customer zones, capacities, yearly demand, unit and fixed production costs of the API and the drug tablets and unit and fixed transportation costs are given. A MILP model was developed and implemented in GAMS 24.7.1.

3.1 Proposed Model

Nomenclature

Indices/sets

P Primary Manufacturer (PM)
M Secondary Manufacturer (SM)
R Distribution Centers (DCs)
K Customer Zones
F AM facility capacity

Variables

Q_{pm} quantity of products transferred from p to m
Q_{mr} quantity of products transferred from m to r
Q_{rk} quantity of products transferred from r to k
Q_{pf} quantity of products transferred from p to f
Q_{fk} quantity of products transferred from f to k
P_p units produced in plant p
P_m units produced in plant m
P_f units produced in AM facility f

Parameters

C_p production cost in PM site p per unit of product (kg)
C_m production cost in SM site m per unit of product (tablet)
d_{pm} distance from PM p to SM site m
d_{mr} distance from SM site m to DC r
d_{rk} distance from DC r to customer zone k
d_{pf} distance from PM p to AM facility f
d_{fk} distance from AM facility f to CZ k
C_{inv} fixed AM facility establishment cost
C_{PAMf} unit production cost in AM facility
C_{TPMp} unit transportation cost of PM products

C_{TSMdp} unit transportation cost of SM products
C_{TSMfp} fixed transportation cost of SM products per product

Binary variables

$$X_f = \begin{cases} 1, & if\ an\ AM\ facility\ of\ capacity\ level\ l\ at\ location\ f \\ 0, & if\ not \end{cases}$$

Objective Function

The total costs (TC) of the SC network include:

- AM facility investment cost

$$InvC = \sum_f C_{inv} X_f \tag{1}$$

- Production cost of primary and secondary manufacturing products

$$ProdC = \sum_p C_{PIM} P_p + \sum_m C_{PSM} P_m + \sum_f C_{PAMf} P_f \tag{2}$$

- Transportation cost of primary and secondary manufacturing products

$$TranspC = \sum_p \sum_m C_{TPMp} d_{pm} Q_{pm} + \sum_p \sum_f C_{TPMp} d_{pf} Q_{pf} + \sum_m \sum_r (C_{TSMdp} d_{mr} + C_{TSMfp}) Q_{mr} + \sum_r \sum_k (C_{TSMdp} d_{rk} + C_{TSMfp}) Q_{rk} + \sum_f \sum_k (C_{TSMdp} d_{fk} + C_{TSMfp}) Q_{fk} \tag{3}$$

Thus, the overall objective function is:

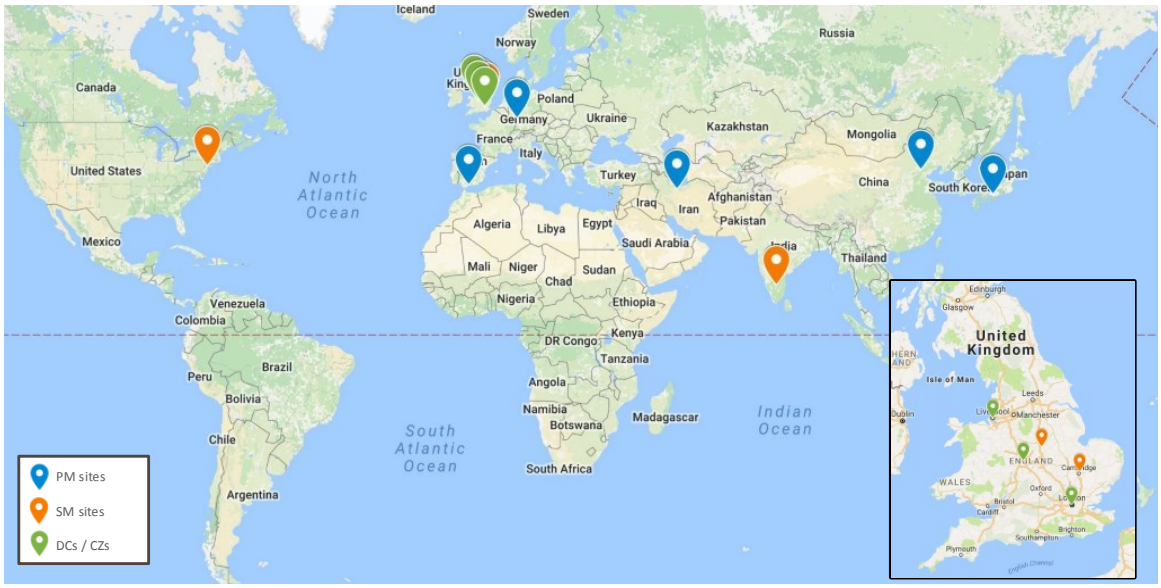
$$Min(TC) = InvC + ProdC + TranspC \tag{4}$$

The constraints of the model pertain to network structure constraints for the transported products, material balance constraints in each node, production capacity constraints, demand fulfillments constraints, as well as non-negativity constraints.

3.2 Illustrative Example

The herewith presented example demonstrates the proposed model in an illustrative theophylline (API) supply chain network. The network consists of 4 echelons. There are 5 primary manufacturing plants (PM1-PM5) and 4 secondary manufacturing plants (SM1-SM4) worldwide (Figure 2).

Figure 2 Pharmaceutical SC nodes



The capacity of each PM plant is 1.250 kg of Theophylline API and of each SM plant is 7.000.000 tablets. Furthermore, there are 3 DCs (DC1-DC3), one in each customer zone. Each DC is a potential AM facility location (AMf1-AMf3), which operates as a secondary manufacturing facility to produce drug tablets. The customer zones are 3 (CZ1-CZ3). The first customer zone contains the north counties (an administrative and geographical demarcation) of England, the second one contains the central counties and the third one contains the south counties. The annual total demand of Theophylline in England was 20.5 m tablets per year or 5.2 tons of API for the period Aug/2015 - July/2016. Data were collected from the NHS business Services Authority[2] and pertain to the number of tablets consumed and the API content. The average demand of each customer zone is estimated as the corresponding proportion of its population, multiplied by the annual total demand. The 3D printed theophylline tablet was produced through the AM machine "Makerbot Replicator® 2X", while the investment cost for "Makerbot Replicator® 2X" was found to be 2.300€ in Amazon.com. The purpose of this example is to evaluate the impact of AM tablet production on the pharmaceutical supply chain network configuration. Therefore, we apply the quantitative model for different AM production costs. (Table 15). AoT is the ratio between the AM production cost over Traditional Manufacturing (TM) production cost. In particular, a value of AoT=10 means that producing through AM is 10 times more expensive than producing through Traditional Manufacturing (TM).

$$AoT = \frac{\text{AM production cost}}{\text{TM production cost}}$$

For a large AoT (=10), none AM facility is located and the supply chain network remains as-is. SM4 is far away from the primary manufacturing sites and the customer zones. Hence, it is not feasible to produce at SM4. When the AM production cost is 7, 5 or 2 times higher than TM production cost, AM machines are located in AM1 site, which is away from local pharmaceutical industries (SM2 and SM3), while production in SM1 is not feasible anymore. When AoT=1, AM machines are located in AM3, while production in SM3 is not feasible. Furthermore, production cost in SM2 and transportation cost are still less than investment cost and production cost in AM2. Finally, AM becomes the single feasible production method when AoT=0,5.

Table 15 Results of the proposed model

AoT	10	7	5	2	1	0,5
PM1	✓	✓	✓	✓	✓	✓

[2] The data provided is based on England Community Dispensing only by pharmacy contractors, appliance contractors, dispensing doctors and items personally administered by doctors.

PM2	✓	✓	✓	✓	✓	✓
PM3	✓	✓	✓	✓	✓	✓
PM4	✓	✓	✓	✓	✓	✓
PM5	✓	✓	✓	✓	✓	✓
SM1	✓					
SM2	✓	✓	✓	✓	✓	
SM3	✓	✓	✓	✓		
SM4						
AM1		✓	✓	✓	✓	✓
AM2						✓
AM3					✓	✓
Obj.F. (€)	34.725.340	33.633.850	33.486.590	33.245.230	33.142.850	33.077.950

Overall, we observe that while AM production cost decreases, AM machines are located in more sites. As a result, AM may deter further escalation of the manufacturing offshoring trend of the last, hence repatriating production facilities from low-wage countries (e.g., Asia). This, in turn, will affect the supply chain network configuration, because production facilities will tend to be placed closer to their markets/customers, reducing the total network echelons, transportation distances and lead times.

4. CONCLUSIONS AND FUTURE WORK

The pharmaceutical supply chain faces demanding requirements stemming from long lead times, high production and inventory costs and the need for exceptionally high product availability and customer service levels. Additive Manufacturing can act as a catalyst in drug production and deliver substantial benefits in terms of manufacturing postponement, economically affordable customization opportunities, on-demand, decentralized manufacturing at short lead times, as well as increased responsiveness. In doing so, AM is expected to reconfigure the drug production sites and the entire supply chain network configuration. The main purpose of this paper was to examine the feasibility of producing 3D-printed drug tablets through AM for different AM production costs and assess the impact of AM adoption on the PSC network configuration. Therefore, we developed a MILP model and demonstrated the proposed model to the theophylline PSC, where the manufacturing sites are located worldwide, while the distribution centres and the customer zones are in England, UK. Based on the analysis of results, it becomes clear that AM becomes a feasible production method when AM production cost decreases over TM production cost at a level of 7 times higher than TM production cost at maximum. Overall, as AM production cost decreases further, more and more production facilities will repatriate from low-wage countries and will be located closer to their markets, hence reconfiguring the supply chain with fewer echelons, as well as shorter transportation distances and lead times. Future research work may extend the model with inventory cost considerations. Furthermore, stochastic demand, reduced risk and lead times, as well as certain aggregation/centralization strategies of AM facilities may need to be further addressed in future research. Finally, the assessment of potential environmental impacts (e.g., less material waste, carbon footprint of transportation operations) merits further research investigation.

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Adoption of Digital Currencies: The Companies' Perspective

Ioanna Roussou
University of Macedonia
Department of Applied Informatics
156 Egnatia str., P.C. 54636
Thessaloniki, Greece

Emmanouil Stiakakis
University of Macedonia
Department of Applied Informatics
156 Egnatia str., P.C. 54636
Thessaloniki, Greece

Abstract

In recent years, technological innovations, economic changes, and a host of monetary and political issues conduce to the gradual spread of the adoption and the use of digital currencies. The interest for digital currency as a new means of transaction has increased, as traditional currencies have become fiat and due to the increasingly lack of the public confidence in the credibility of financial institutions, leading to new ways of transactions without third party mediation. Bitcoin is the first decentralized cryptocurrency system that appeared in 2009 and since then many other cryptocurrencies have been created (altcoins) based mainly on Bitcoin's technological infrastructure. This paper aims to present the results of the first online academic survey about the actual use of digital currency by companies and freelancers globally, with an emphasis in the European Union, where Greece belongs. Considering digital currency as a pioneering technological innovation, a combination of Diffusion of Innovations (DOI) Theory (mainly Innovation Decision Process Model - IDPM) and Technology Acceptance Model (TAM) has been applied. The goal of the survey was to investigate the actual use of digital currency, as a means of transaction by companies and how it is affected by the constructs of Perceived Ease of Use, Perceived Usefulness, and Perceived Security directly and other constructs indirectly, according to the research model. Based on the responses provided by 254 companies and freelancers the results exhibit that the penetration of digital currency usage is in increasing progress. Will the companies include digital currencies as a new mode of payment in their marketing strategies? This survey's results are useful for entrepreneurs, stakeholders of digital currencies in every business sector, banks, financial institutions, users of digital currencies, digital currencies experts, scientists, and policy makers.

KEYWORDS

Digital currencies, Bitcoin, Blockchain, DOI, TAM.

1. INTRODUCTION

Digital currency, starring bitcoin, is now widely recognized by the scientific and business community as a pioneering technological innovation, which is sometimes referred to as disruptive innovation, because it contributes to the shaping of a new market and network, changes the current structure of the market and the financial system gradually, displacing the previous value systems. Essentially the most important innovation is the Bitcoin protocol and the blockchain technology. According to Antonopoulos (2014), the bitcoin currency is the first application of this innovation.

Apart from the technological innovations, the economic changes and a host of monetary and political issues in recent years conduce to the gradual spread of the adoption and the use of digital currencies. Although Bitcoin was launched from the USA and the variables that affect its value are associated with the American economy (Wijk, 2013), the financial crisis in Europe is the one that brought digital currency to the forefront (Saito, 2013).

Thus, a particular scientific and research interest arises and the need to investigate whether digital currencies will be disseminated, accepted and adopted to such an extent as to constitute a trading instrument; either in conjunction with the traditional currencies and the conventional payment systems; either alone. This academic survey aims to cover the research gap by addressing to companies and freelancers, as the majority of the research has been addressed to individuals *(users or non-users of digital currency)*.

According to Metcalfe's law (1993, as reflected by Gilder), innovations based on a network have an additional advantage. Thus, the adoption of digital currency by companies is essential for the expansion of digital currencies among users worldwide not only for remittances, but also for consumption or investment. According to Tasca (2016), the payment network more closed to Bitcoin is Western Union rather than VISA, MasterCard or Discover, as it is a network used more for remittances or relatively large transfers of money from person to person instead of consumptions. Accepting digital currencies as an additional payment option would be a marketing tool for companies that will help them to stand out, while each company should set against the risks with the benefits.

2. CHOICE AND COMBINATION OF THEORIES

The two keywords of the notion of digital currency that match with the combined application of DOI theory and TAM are «innovation» and «technological».

DOI theory and TAM have many common constructs and complement each other in order to investigate the adoption of IS / IT (Lee et al., 2011). For example, the feature Complexity (DOI) is similar to the factor Perceived Ease of Use (TAM) and researchers indicate that the constructs used in the TAM are a subset of the Perceived Characteristics of the Innovation of DOI. Previous studies have successfully integrated the two theories, providing good results (Sigala et al., 2000; Chen et al., 2002). Therefore, the combination of these two theories is aimed to utilize the characteristics of both and could provide more integrated responses to the questions than each model individually (Wu & Wang, 2005; Chen et al., 2002).

In the survey's questionnaire, initially the respondents are invited to reply mainly as representatives on behalf of the company they work and then by expressing their personal views. As aforementioned, the survey is addressed to companies primarily and the notion of the person is regarded as an integral part of the company. Individual's attitude and intention towards the use of the digital currency, does not mean that will be adopted and applied by the company. Companies, as Decision Making Units according to IDPM, may take a decision that is not always aligned to the personal beliefs and perceptions of their personnel. So, the reason for examining the personal views of the respondent in conjunction with the company's views is to include the individual's opinion about digital currency, in accordance to the company's decision on one hand, but regardless the decision that the company has made on the other hand. In this way, the research approaches both organized business structures and the individual, as an integral part of these structures, which scientifically is considered particularly important. The combination of the two models also contributes to this approach, as the TAM responds mainly to individuals, while the DOI theory to individuals but also to organizations, companies, social groups, and countries.

2.1. Digital Currency

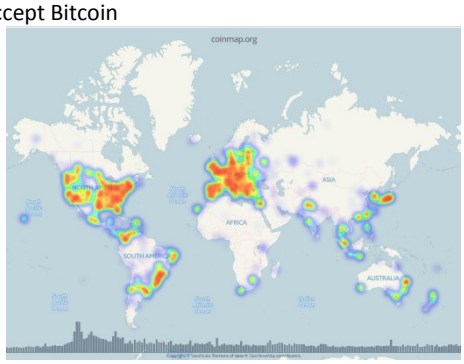
Wagner (2014) defines digital currency as the currency that is stored and transferred electronically. There is often a misunderstanding and mistaken use of the terms digital currency, virtual currency, and e-money. Virtual and cryptocurrencies are types of digital currency. Nowadays, in our increasingly cashless society, traditional currencies are bank money held on and transacted through computers, so they are also considered digital money, often referred to as "electronic money". Besides, IS innovation and technology have been used for decades in order to achieve a transition from a cash-base global economy to a cashless one (Wonglimpiyarat, 2015). Virtual currencies have taken various forms, starting as currencies that the consumer uses in online games and social networks and evolving in payment instruments which are accepted in environments offline or in "real life". Cryptocurrencies are mediums of exchange that rely on cryptography, in order to secure transactions and control the creation of new units. Bitcoin is the first decentralized cryptocurrency system that appeared in 2009 and since then many other cryptocurrencies have been created *(altcoins)* based mainly on Bitcoin's technological infrastructure.

3. METHODOLOGY

3.1 Sample and Data Collection

The survey ran online 9 months (April 2016 – January 2017) and gathered a sample of 254 responses. It was circulated globally, with an emphasis in the European Union, where Greece belongs, as although Bitcoin was launched from the USA and the variables that affect its value are associated with the American economy (Wijk, 2013), the financial crisis in Europe is the one that brought digital currency to the forefront (Saito, 2013), as aforementioned. Figure 1 shows the world map of places that accept Bitcoin:

Figure 1 World map of places that accept Bitcoin



Source: https://coinmap.org/#/world

Reaching all the companies globally or even in the EU or Greece and achieving a random and truly representative sampling was impossible (Groves, 1989); however, efforts were made to gather the greatest possible sample.

At first, the link of the questionnaire was planned to be sent selectively to mailing lists from EU companies among all sectors *(31 lists, total 10,762 recipients, of which 6,064 Greek recipients)* collected from Business Chambers, Professional Associations, and websites. Having specified the sampling frame, the link of the questionnaire was sent to the above recipients via the Google Forms application, two Gmail accounts, two MailChimp accounts and contact forms of companies' websites gradually and in parallel.

Additionally, the link was posted on Social Media *(Twitter, Reddit, selected LinkedIn Groups, Google+ Communities, Facebook Communities)*, forums and platforms related to the topic *(bitcointalk.org, European Digital Currency and Blockchain Technology Forum (EDCAB), pureoverlock, Diginomics Forum, Forum Bitcoin)*. Thus, a worldwide penetration was achieved.

The delivery rate of the survey link was affected by: a) the accuracy of the contact information and the updating degree of the mailing lists of the companies and b) the rules and guidelines of the used email clients, social media, blogs, forums, and platforms that had to be followed in order to achieve the diffusion of the survey's link. Many times servers blocked the delivery of the emails that were sent with the link of the questionnaire to the companies, as they considered it as spam or junk mail. Thus, the link was also transformed to qr-code and sent sometimes in this form alternatively.

The questionnaire was anonymous and was not limited to be answered by only one person from each company. The correspondents were asked to complete a structured questionnaire (scaled or multiple-choice questions). It consisted of four sections: the 1st section aimed to obtain general information about the company, the 2nd section aimed to record the company views about digital currency and constitutes the main section, the 3rd aimed to record the respondent's views about digital currency and the last one the prospects of the digital currency, according to the respondent. Five-point Likert scales were used in 14 of a total 31 questions. A follow-up and reposting procedure was conducted many times.

Finally, although some feedbacks mentioned that the questionnaire was too long to complete and demanded incentives in order to fill it, it is acknowledged that no incentive was given.

4. CHARACTERISTICS OF THE SAMPLE AND RESULTS

The main descriptive characteristics and results of the research are summarized below. The findings from Figure 2 show that the majority (42%) of the respodents were from Southern European Union, followed by 23% Outside European Union, 18% Nothern European Union, and 17% Central European Union. This is reasonable as the survey started to diffuse among greek companies and freelancers, who have responded with a good rate (30%) at a survey held by a greek university. The majority of the responding countries Outside EU were USA (10%), followed by Australia (3%), Canada (2%) and with a smaller percentage Mexico, Serbia, Switzerland, Russia, Azerbaijan, Belize, Brazil, Guatemala, Hong Kong, Iceland, India, Japan, Nigeria, South Africa, and Ukraine.

In the 2nd section of the questionnaire, respondents were required to choose between two cases: (i) the case of adoption of the digital currency as a means of transaction by the company and (ii) the case of non-adoption of the digital currency that led them to a different set of questions. The findings depicted in the Figure 3 resulted that the majority of the respondents (57%) have not adopted the digital currency as a means of transaction, while the rest (43%) have adopted the digital currency.

Figure 2 Headquarters' location

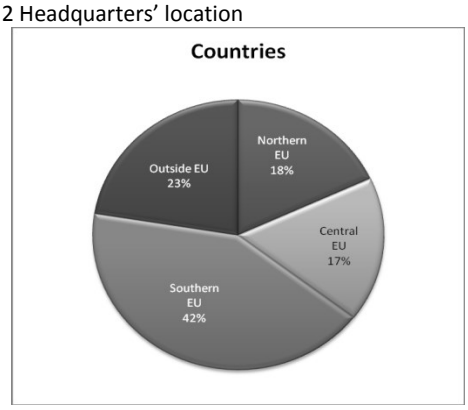


Figure 3 Actual use of Digital Currency

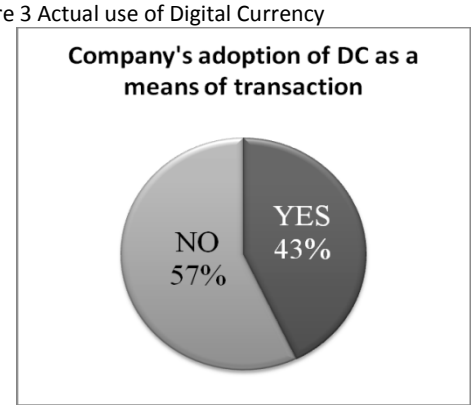


Figure 4 shows that the majority (17%) considered as the most important reason for adopting digital currency the freedom in payments, followed by 12% the ease of use and the low cost of transactions, 10% because they wanted to keep up with the technological developments, 9% because they wanted to approach new customers seeking transactions in digital currency and gain a competitive advantage, 7% because of the speed of transactions, 5% because of the company customers' requests and because they wanted to improve the company's image and by smaller percentages for the rest possible reasons *(increasing sales turnover, control avoidance by central organizations, transparency of transaction and rules, adoption of digital currency by competitors, non-imposition of taxes, and coping with the economic crisis).*

Figure 5 shows that the majority of the respondents (39%) believe that digital currency will be used in conjunction with traditional currencies, followed by 28% who believe that it will be used more than nowadays; 19% believe that it will dominate the e-payment methods, while 6% believe it will disappear.

Figure 4 Main reasons for adoption

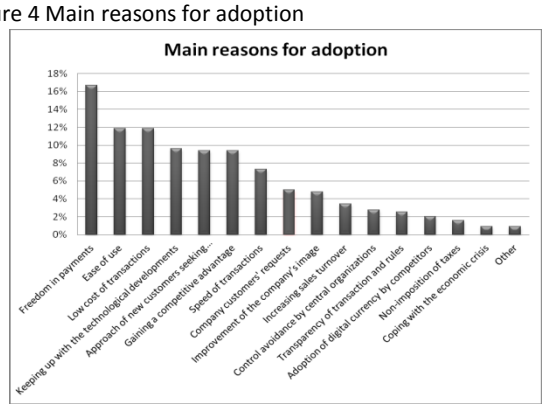


Figure 5 Future means of transaction

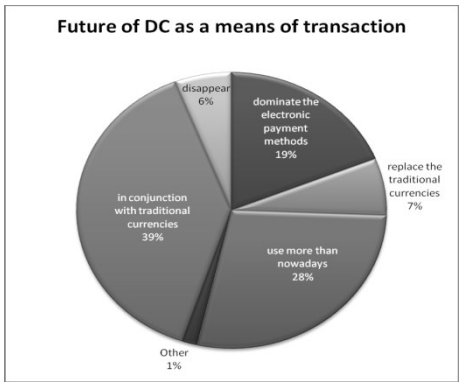


Figure 6 illustrates that the majority (15%) believe that the main internal reason *(company's perspective)* for not adopting the digital currency as a means of transaction is the lack of motivation to use

the digital currency, followed by 13% that believe the reason is the lack of adequate information about its functioning, 12% the incompatibility with other company's systems, 11% believe that reasons are the ignorance about its further utilization, unavailability of suitable software, lack of suitable infrastructure, 10% consider as reasons the lack of experience/difficulty in managing e-transactions and non-acceptance of innovations by the company, and 7% the company's lack of familiarity with technology.

Figure 7 illustrates that the majority (14%) believe that the main external reason *(perspective of the means)* for not adopting the digital currency as a means of transaction is that it is not widespread to the general public, followed by 12% that believe the reasons are the high volatility in exchange rate, the lack of legislative / institutional framework, and the governmental restrictions, 11% believe the reasons are the security problems, the complexity of transactions, and the biased perceptions against DC; finally, 10% consider as reason the connection to underground economy and 7% the large energy costs (in case of mining).

Figure 6 Company's perspective for non-adoption

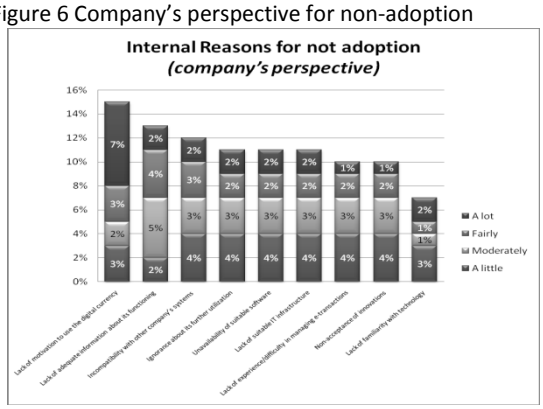
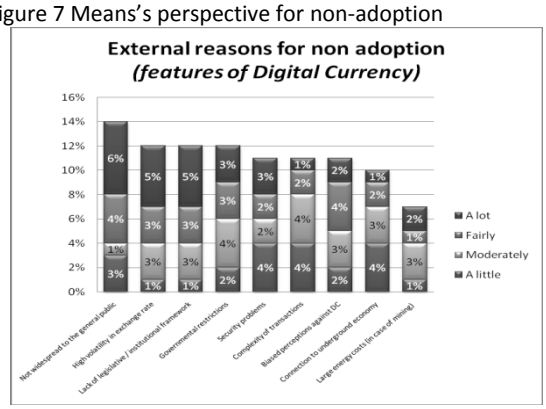


Figure 7 Means's perspective for non-adoption



5. CONCLUSIONS

Digital currencies regarded as a technological innovation depict similar characteristics with other innovations, e.g. Internet or email, concerning their adoption. They are still in their infancy; however, they seem to move gradually from the early adoption stage to the early majority stage. Digital currencies are used nowadays not only for remittances, but also for consumption and investment. Nevertheless, it is still early to answer whether they achieve a mass adoption and results show that they will coexist with traditional currencies and payment systems for the next years. The factors that should be taken into account in order to establish digital currencies as a means of electronic payment are: (i) clearer legal framework at international level, (ii) features that will improve ease of use in order to become more user-friendly even for groups of people that are not so familiar with technology, (iii) greater security from cyber attacks, and (iv) training in digital currency use. Apart from the economic and business effects of the use of digital currencies, blockchain technology seems to have a lot of potential uses in many business sectors, i.e. music industry, real-estate, etc. Future research could focus on the effects from the evolution of the use of digital currencies and blockchain technology in certain business sectors.

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Cloud Computing Adoption and E-government

Nanos Ioannis
University of Macedonia
156 Egnatia str., Thessaloniki, Greece

Misirlis Nikolaos
University of Macedonia
156 Egnatia str., Thessaloniki, Greece

Manthou Vicky
University of Macedonia
156 Egnatia str., Thessaloniki, Greece

Abstract

Cloud computing is one of the latest ICT innovations, offering many advantages and leading to the digital transformation of private and public organizations. Despite the advantages, initiatives for cloud computing adoption in public administration are in early stage and relatively slow, comparing to initiatives for adoption in private organizations, due to various influencing factors. At the same time, academics and practitioners indicate that cloud computing not only has the potential to offer significant advantages in the public sector, but is expected to be a fundamental part of e-government strategy in the upcoming years. The aim of this paper is to investigate the relationship between cloud computing and e-government, to highlight the importance of cloud computing adoption in public administration and to offer insights on the way that cloud computing can contribute to the successful deployment of e-government services. Through the study of relevant theoretical models and frameworks, enabling and inhibiting factors for cloud computing adoption in the public sector are identified, classified and analyzed. Furthermore, initiatives that have taken place so far in Greece in the area of cloud computing and e-government are presented. The paper contributes to the knowledge domain of cloud computing adoption and e-government and indicates fields that can be further researched in this area.

KEYWORDS

Cloud computing adoption; e-government; public sector.

1. INTRODUCTION

Cloud Computing represents the emergence of a new computing paradigm (Vaquero et al, 2008; Cegielski et al., 2012), while at the same time it is a potential and rapidly developing issue for the evolution and innovation of the IT sector (Castells, 2001). Despite the plethora of definitions in bibliography, it is difficult to find one-single definition that describes cloud computing precisely. According to Sultan (2011), cloud computing is “a model of delivering a range of IT services remotely through the Internet and/or a networked IT environment”. The European Network and Information Security Agency (ENISA, 2011) defines cloud computing as an "on-demand service model for IT provision, often based on virtualization and distributed computing technologies”. A more complete and widely used definition, is provided by the National Institute of Standards and Technology (NIST, 2011), which defines cloud computing as “a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction". Cloud computing offers significant advantages and can be applied to various sectors of the economy, leading to the digital transformation of private and public organizations. Therefore, and according to recommendations from several European bodies, countries should include cloud computing adoption as an integral part of their e-government strategies.
The aim of this paper is to further investigate the relationship between cloud computing and e-government, by highlighting the importance and the advantages of cloud computing adoption in the public sector and offering insights on the way that cloud computing can contribute to the successful deployment of e-government services. Models and characteristics of cloud computing are presented and advantages from cloud computing adoption in the public sector are analyzed. Recommendations for the selection of the proper cloud computing model are provided, and possible factors that may inhibit cloud computing

adoption are highlighted. Finally, initiatives that have taken place so far in Greece in the area of cloud computing and e-government are presented.

2. CLOUD COMPUTING AND E-GOVERNMENT

2.1. Cloud computing characteristics and models

According to Sosinski (2011), the features-characteristics of cloud computing that are identified in the various definitions and distinguish cloud computing from other computing models, are:

- *On-demand self-service*, where the client organization can obtain and use cloud computing resources as needed, without the intervention of the service provider at any time.
- *Broad network access*, where cloud computing resources are accessible over the network by heterogeneous client platforms and regardless location and type of device.
- *Resource pooling*, where the cloud provider's physical and virtual computing resources (i.e., storage, processing, memory, and network bandwidth) are pooled and utilized by multiple tenants at the same time.
- *Rapid elasticity*, where cloud computing resources can be scaled in and out automatically, whenever needed and as required.
- *Measured service,* where the cloud systems automatically monitor, control, optimize and report the usage of resources; thus, providing transparency for cloud providers and clients-users.

Taking into account the previous characteristics, cloud computing models can be categorized in: *a) deployment models*, which refer to the structure of the cloud, its features and the users who have access to it and *b) service models*, which refer to the type of services offered (Sosinski, 2011; Hsu et al., 2014).

a) Deployment Models

- Private Cloud: Computing services offered only to selected users (members of a community) either over the Internet or a private internal network.
- Public cloud: Computing services offered by third-party providers over the public Internet, making them available to anyone who wants to use or purchase them. They may be free or sold on-demand, allowing customers to pay only per usage for the CPU cycles, storage, or bandwidth they consume.
- Community Cloud: This model is designed for a specific use by a set of users who have the same views and needs on issues such as security, politics, etc.
- Hybrid cloud: This model is a combination of two or more cloud models. It may be private, public, or community-based. It can be used by different kinds of entities that actually use and share the same given technology.

b) Service Models

- Infrastructure as a Service (IaaS): provision of infrastructure such as networking, storage, servers, virtual machines and operating systems.
- Platform as a Service (PaaS): provision of tools and hosting options for users to design, develop and manage their own applications (middleware), without the ability to control the underlying physical infrastructure such as the servers or operating system.
- Software as a Service (SaaS): use of software applications which support business related processes, from email messaging to ERP, CRM and SCM systems. In this type of service, users don't have control over application design and do not need to install software applications in their PCs.
- Everything as a Service (XaaS): the XaaS Model (where X stands for everything) is a collective term referring to a series of things like "X as a service" or "everything as a service" (Mladenow et al., 2012). This acronym refers to an increasing number of services such as IT infrastructure, platforms, software, databases, and other IT resources provided over the Internet and can be accessed remotely (Winkler, 2011). XaaS is the essence of cloud computing (Busch et al, 2014).

2.2. Cloud computing adoption in the public sector

Despite their bureaucracy, rigid structures and low degree of innovation adoption, public administration authorities and governments have began to use some cloud computing services or consider to do so in the upcoming years (Zwattendorfer & Tauber, 2013), in order to achieve cost reduction (to conform with tight and reduced budgets) without cutting essential services, increased utilization of human resources, highavailability, scalability and efficiency of systems and services, and provision of improved services to citizens (Craig et al., 2009). Additionally, cloud computing can contribute, in the long run, to lower Total Cost of Ownership (TCO) and reduction in the overall carbon footprint of IT. Moreover, according to OECD's Recommendation on Digital Government Strategies (OECD, 2014) "today's technology is not only a strategic driver for improving public sector efficiency, but can also support effectiveness of policies and create more open, transparent, innovative, participatory and trustworthy governments". Therefore, cloud computing not only has the potential to offer significant advantages in the public sector, but is expected to be a fundamental part of e-government strategy in the upcoming years and lead to the digital transformation of governments (Microsoft, 2017).

However, initiatives for cloud computing adoption in public administration are in early stage and relatively slow, comparing to initiatives for adoption in private organizations, due to various influencing-inhibiting factors such as lack of awareness about cloud computing, lack of standards that will ensure compliance-compatibility with existing systems, internet availability and bandwidth, fear of loss in IT control, switching costs, immature cloud providers market and risk in the selection of the appropriate cloud provider, data integrity, security and privacy and concerns about operations and systems continuity (Buyya et al., 2009; Paquette et al., 2010; Zissis & Lekkas, 2011; Alshomrani & Qamar, 2013; Shin, 2013).

According to El-Gazzar & Wahid (2015) and Schneider & Sunyaev (2016), the decision for cloud computing adoption in public sector requires an extensive and systematic analysis about the appropriate cloud deployment and service model that will be selected, taking into account the characteristics, advantages and disadvantages of each model. Moreover, it requires proper analysis of requirements and priorities of the specific public authority, the overall IT workload and the applications that will be migrated into cloud. Finally, issues concerning security, privacy, integrity, availability and compliance to existing laws and regulations should be examined (ENISA, 2011).

As far as cloud deployment models are concerned (private, public, community and hybrid), the European Agency for Network and Information Security (ENISA, 2011) recommends the use of "private cloud" and "community cloud" models, as they allow more control and incorporate more security and privacy features.

Zwattendorfer & Tauber (2013) state that the dominant cloud deployment model for governmental services is the so-called "G-Cloud", a combination of "private" and "community" cloud model, that offers better compliance possibilities with national regulations and legislations than public clouds. The "public cloud" model could be deployed in the case of non-sensitive data and low risk e-government applications, mainly due to its low cost. The "hybrid cloud" model (e.g. combination of private and public cloud) can also be adopted by public organizations, but it usually requires data separation, as sensitive data should not be stored in a public cloud.

Regarding the adoption of cloud service models (IaaS, PaaS, or SaaS) by a public authority, all models are acceptable (Zwattendorfer & Tauber, 2013). For example, the IaaS model can be used to archive eGovernment data or backup. The PaaS model could be applied to the development of custom public domain applications in the cloud. In this case, specialized public sector services may include specific national or regional services such as tax or electronic delivery of services or simple services of submitting applications to be processed by public authority's back-office. Finally, the SaaS model could be used within collaborative frameworks, workflow management systems of electronic documents, business and citizen information services, or any other "X" service model (Nedev, 2014).

2.3. E-government and ICT implementation in Greece

The European Commission eGovernment Action plan, the Digital Agenda for Europe and the European Cloud Computing Strategy have set the effective exploitation of the benefits of information and communication technologies (ICT) as one of their main goals, where the use of cloud computing is being promoted for the creation of more agile, trusted and transparent administrative services.

In this context, Greece has deployed a national E-Government Strategy for the upcoming years, where the main vision is "in the next years using ICT as a catalyst of development andmodern governance tool, the Greek Public Administration, will regain the trust of societyand become moreefficient and productive by providing citizens, and business user – centriconline service that will be constantly upgraded" (European Commision, 2017a). According to the action plan for E-government, the most important technologies that will be adopted include IaaS and SaaS, so as to make the best use of governmental cloud technologies (G-Cloud) though the completion of catalyst projects (eGov Now, IT Public Policy, etc).
However, according to the European Digital Economy and Society Index (European Commision, 2017b), which measures progress of member states in internet connectivity, human capital, use of internet, integration of digital technology and digital public services (e-government), Greece ranks 26th and did not make much progress compared to other EU member states. Especially in the area of Digital Public Services, Greece has made a slight progress, but is still lagging from other European Countries.
There are several barriers that hinder efficient implementation of ICT actions in Greece, thus leading to the low digital maturity of the country. According to studies carried out by the Foundation for Economic & Industrial Research (2014) and by Accenture in cooperation with the Hellenic Federation of Enterprises (2017), these barriers are:
Policy-driven limitations

- Lack of national digital vision and limited political willing to stimulate digital growth and e-government
- Inefficient mechanisms of horizontal government schemes
- Discontinuity of adopted policies at every governmental change
- Delay in the deployment of a national e-government strategy, with clear tactics, metrics and monitoring frameworks.
- Outdated laws and regulations about data protection, that do not follow the rapid pace of technological progress.

Weaknesses related to technical design and planning

- Lack of interoperability and interconnection among the information systems of the public sector
- Lack of a common architecture in public sector computing, absence of common standards and compliance policies for ICT use
- Complexity and lack of simplification in the relevant institutional and regulatory framework

Obstacles to efficient implementation of ICT adoption

- Time-consuming public procurement processes (due to significant delays in the stages of tendering, auctions, awarding etc.) overcoming the lifecycle of procured ICT products/services, resulting thus the introduction of old-fashioned products and services
- Lack of efficient monitoring, evaluation and feedback in ICT activities
- No motivation to public servants serving in ICT roles to be engaged in the process
- Lack of expertise in public servants serving in ICT roles to effectively support the process.

2.4. Initiatives for cloud computing adoption in Greece

G-Cloud
Greek G-Cloud, a 15M€ undergoing project for the development and creation of a private governmental cloud that is based on the Iaas service model, providing hosting infrastructure for information systems of General Secretariat of Information Systems (GSIS) and other governmental agencies (Επιτελική Δομή ΕΣΠΑ, 2017). The most recent implementation within the G-Cloud, is the Integrated Healthcare Information System for the allowance of healthcare subsidies (in total 680M€ annually) to over 200.000 beneficiaries, through a network of about 1.400 active users – employees in municipal and regional authorities all over the country. The previous infrastructure was outdated and could not support efficiently the volume of users and daily transactions, and the risk of system failure and data loss was very high. After migrating to the cloud, the risk of system failure is eliminated, the availability and response time is higher, the productivity of users is increased and the overall provision of services to citizens is improved (Business News, 2017).
Storm Clouds

Concerning the adoption of cloud computing in municipalities, the municipality of Thessaloniki participated in the European Project Storm Clouds (http://storm-clouds.eu), together with the city of Águeda (Portugal) and Valladolid (Spain). The project focused on exploring the shift to a cloud-based paradigm for deploying services that public authorities currently provide, based on their internal ITC infrastructure. The aim of the project was to define useful guidelines on how to implement the process of moving applications to the cloud, by suggesting a model that consists of four stages for the cloud migration process. These stages include actions regarding (a) the selection of applications/services to be migrated to the cloud, (b) addressing technical or procedural challenges, (c) migration to the pre-production cloud and (d) moving applications to the production cloud (Panori et al, 2016).
In the case of Thessaloniki, the political priority was to cloudify applications related to entrepreneurship and quality of life in the city of Thessaloniki, such as:

- Improve My City: enables the citizens to report non-emergency local problems such as potholes, illegal trash dumping, faulty street lights, etc., through web, Android and iOS applications.
- Cloud Funding: Supports local communities to collect money for social and charitable purposes.
- City Branding: Promotes the identity of the city using virtual tours while connects the commons with local shops and services providers.
- Virtual Mall: Enables every commercial enterprise located in the city center to create its own virtual shop.

The application that was finally selected was the Virtual City Mall. Although the initial numbers of participating enterprises (62) and users-visitors (3.893) were satisfactory (for a pilot project like this) and promising, the project seems to be abandoned, possibly due to obstacles to efficient implementation of ICT adoption (as mentioned above). The initial web link for the application (https://smartcity.thessaloniki.gr/index-en.html) cannot be reached anymore, and through the municipality's portals (http://thessaloniki.gr and https://opengov.thessaloniki.gr) there is no evident-working link to the Virtual Mall. However it should be noted that, according to Panori et el. (2016), it was a pilot project and the results should be received as a helpful experience for municipalities or other public authorities that are willing to adopt cloud computing for e-government applications in the following years.

3. CONCLUSIONS

Cloud computing represents a new paradigm shift for e-government, since it enables the digital transformation of public authorities through the use of innovative and cost-effective models and services. However, initiatives for cloud computing adoption in public administration are still in early stage, especially in Greece, due to various influencing-inhibiting factors such as policy-driven limitations, weaknesses related to technical design and planning and obstacles to efficient implementation of ICT adoption. The decision for cloud computing adoption in the public sector requires an extensive and systematic analysis about the appropriate cloud deployment and service model that will be selected, taking into account the characteristics, advantages and disadvantages of each model. Moreover, it requires proper analysis of requirements and priorities of the specific public authority and careful selection of the applications that will be migrated into the cloud, taking into compliance with regulations as long as data security and privacy issues. In Greece, as in other European Countries, cloud computing will be an integral part of e-government strategy in the following years and some initiatives for cloud computing adoption have already been implemented (G-Cloud, Storm Clouds). The experience from these pilot projects is expected to act as a guide for future cloud computing implementation in the public sector, together with further theoretical and empirical investigation on appropriate models-frameworks and critical success factors.

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Assessment of the Internet market in Greece; The case of Mushrooms and Truffles

Zacharoula Andreopoulou
Aristotle University of Thessaloniki
Dept. Forestry & Natural Environment, p.Box 247, p.c. 54124

Agni Kalfagianni
Aristotle University of Thessaloniki
Dept. Forestry & Natural Environment, p.Box 247, p.c. 54124

Stefanos Tsiaras
Aristotle University of Thessaloniki
Dept. Forestry & Natural Environment, p.Box 247, p.c. 54124

Georgios Tsekouropoulos
Alexander Technological Educational Institution of Thessaloniki, Greece, Accounting Dept

Abstract

This paper studies the Internet market of mushrooms and truffles in Greece. Mushrooms and truffles are found in normal diets since antiquity and also as a delicacy, because of their texture and highly desirable taste and aroma. The cultivation of mushrooms in Greece started in the mid-sixties. During the last ten years, the need of the production of cheap nutritious food, led to the fast development of the mushroom and truffle cultivation sector. The Internet provides a stable communication infrastructure to citizens and businesses and has augmented business opportunities. The research focus on registration and assessment of SMEs located in Greece and operating in field of mushrooms and truffles, with emphasis on the classification of their business websites in groups according to their marketing and digital characteristics and functions. Through Electronic Data Interchange organization is digitally and methods are automated. E-services concerning business and commerce and lately mobile services, applications and tools have achieved very fast acceptance and high visibility, combined with many modern digital techniques and devices. An increasing number of agribusinesses are looking to the Internet as a marketing, management, service, and coordination tool gaining momentum in the everyday marketing trying to have win-win deals. With the alternative marketing channel of the Internet, we already find agribusiness trying to promote mushrooms and truffles through the Web.

KEYWORDS

Internet, e-commerce, market, SME, cluster analysis, mushrooms, truffles

1. INTRODUCTION

Mushrooms and truffles are fleshy plants that belong to fungi group. They usually grow in cool and moist places and they are mostly found in pastures, meadows and woodland (Sulman et al., 2011). The importance of mushrooms and truffles was known since antiquity, but the cultivation of them started around 600 A.D. in China (Chaube, 1995; Tripathi, 2005).

The new trend of environmentally friendly products has increased the demand of them (Lober and Misen, 1995). Also, the new fashion of mediterranean diet, organic farming, natural medicine, aroma – therapy has increased the number of the demand of forest products (Pettenella et al., 2005). Furthermore, selling forest products, such as mushrooms and truffles, can be a much more relevant source of income instead of wood and although they are conceder as " secondary products" they are in fact the first source of revenue for forest managers (Merlo & Croitoru, 2005).

Internet provides a stable communication infrastructure to citizens and businesses and has augmented business opportunities. Enterprises started to participate in the internet society as it offer a vast amount of benefits and is a mean that is ready to serve clients all over the world 24 hours per day 7 days per week in a low cost (Andreopoulou et al., 2008). Through Internet enterprises can enable transactions in an e-environment, share information (Tsekouropoulos et al., 2008) and enhance their communication with

clients (Andreopoulou et al., 2009a). Moreover, ICTs can become a powerful carrier for energy consumption, gas emission and environmental pollution (Andreopoulou, 2016)

E-commerce consists of the distributing, buying, selling, marketing, and servicing of products or services over electronic systems such as the Internet and other computer networks. It is an innovation that changes the traditional ways of doing business as it provides a new marketing tool and potential customers for a firm worldwide (Eszes, 2010; Andreopoulou et al., 2009b). An increasing number of agribusinesses are looking to the Internet as a marketing, management, service, and coordination tool gaining momentum in everyday marketing trying to have win-win deals.

This paper studies the Internet market of mushrooms and truffles in Greece. The research focus on registration and assessment of SMEs located in Greece and operating in field of mushrooms and truffles, with emphasis on the classification of their business websites in groups according to their marketing and digital characteristics and functions.

2. MATERIALS AND METHODS

For the aim of this study 23 firms locate in Greece and having only Greek products were examined qualitative and quantitatively (Table 1). According to the "Similar Web" those Small Medium Enterprises were selected because they had less than 5.000 visitors, which is the basic rank of these websites. Also, we conducted the pages that a user visits daily and the time that he spends on them. The geographical region was examined and a correlation between the pages per visit and the seconds spend on them was done. It was also taken under consideration the number of languages of a website.

The examined qualitative parameters had to do with the richness of a website (giving information about location and goals of enterprise), the importance of information (that should be exact, complete and up to date), the navigation design, the value of time of customers, the existence of newsletter, product details and promo shop. At the end held a regression analysis between these variables held with pages per visit and seconds per day.

Table 2 SMEs participated in the research (Brand – Facebook profile)

A/A	Brand	Website
1	Dirfys' Mushrooms	http://www.manitariadirfis.gr/index.php#
2	Filyra Workshop of Traditional Flavors	http://www.filyrafoods.gr
3	Hydnon trufles and more	http://www.hydnon.com/#
4	Gerakonas Farm	http://gerakonasfarm.blogspot.gr
5	Troufaplus	http://www.troufaplus.com/sections/about-us%3Flocale=el.html
6	Arosis	http://www.arosis.gr
7	Kyknos	http://kyknoscanning.com/el
8	Fashion fruit	http://www.fashionfruits.gr
9	Mushroomproduct of Grevena	http://www.tomanitari.gr
10	Biofarm	http://www.biofarm.gr
11	Troufa.net	http://www.troufa.net
12	Forest garden - truffles & mushrooms	http://www.dasokipos.gr
13	Tro…fino	http://www.trofino.com.gr
14	Mushroom - Truffle (Giorgos Sergiannidis)	http://www.troufa-ser.gr
15	Mushroom Kechagias	http://manitaria.com.gr
16	SKO	http://www.skosa.gr/el
17	e- troufa	http://www.e-troufa.gr
18	Mushrooms Of Kolindros	http://www.manitariakolindrou.gr
19	FungiHellas	http://www.fungihellas.gr/el/
20	Rare Mushroom Production Center	http://www.spaniamanitaria.gr
21	Mashroom Chatzipaulou	http://www.manitariachatzipaulou.com.gr
22	Porcini (Mushrooms Hellas)	http://www.porcini.gr/el/αρχική-

23	Truffle of Pieria	σελίδα/ http://www.troufa-pieria.gr

3. RESULTS

Through the analysis of data the following table was conducted (Table 2), showing the geographic region of the location of Small Medium Enterprises (SMEs). The majority of SMEs related to mushrooms and truffles are located in Macedonia (around 52%), then Central Greece, Peloponnese, Thrace and Thessaly follow.
The 2 quantitative variables were distributed normally. Mean pages per visit were around 3 and mean seconds per day were around 1 minute and a half (Table 3).
These variables were relatively correlated and the Pearson correlation coefficient wae 0.3 and the statistic significance p was 0.086 (Table 4).

Table 16 Geigraphical Region of SMEs as it derived from the location of the enterprise.

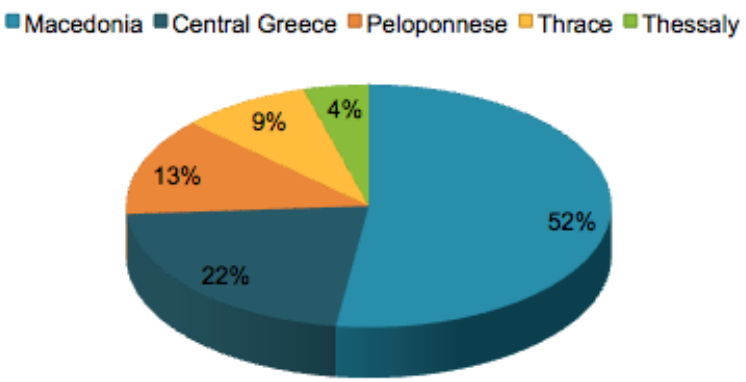
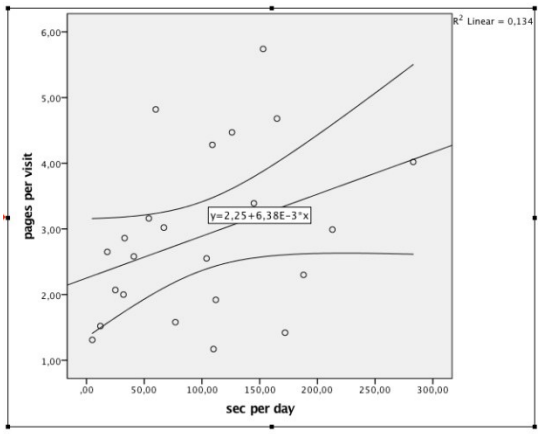


Table 3 Mean pages per visit and Mean seconds per day

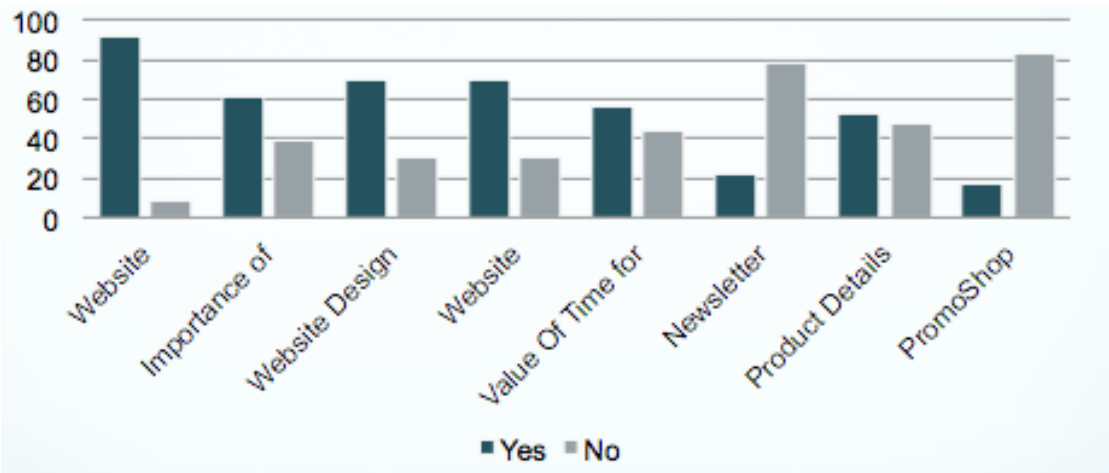
	Mean	Std Deviation
Pages per visits	2,8913	1,2674
Sec per day	100,1739	72,7096

Table 4 Correlation between pages per visit and seconds per day.



The 52% of websites was available in 2 languages (English and Greek), while a 9% was only in English and 35% was only in Greek. Only one website was available in 4 languages.
A vast majority of websites offers important information of the SMEs and their goals (Table 5). The first four variables, as seen in the Table 5, show that most of the websites are user friendly, but the last 2 show that they don' t make promotional actions and they don' t have newsletter.

Table 5 Qualitative data.



The regression analysis on between qualitative and quantitative variables showed none statistical importance. Websites with product details had 0.073 pages per visit more than those who had not. This correlation significance is 0.148 (Table 6).

Table 6 Correlation between pages per visit and product details.

Model	B	P
Product details	0,773	0,148

4. CONCLUSIONS

Macedonia has a large number of Small Medium Enterprises for Mushrooms and Truffles. As mentioned above, almost 1 and a half visitors are spending daily to those websites and an average of 3 pages in every website is visited in a visit. To the majority of the websites the most common language is Greek and English. As it concerns the quality of a website, 91% of them are giving important information about companies and their goals, 80% of them did not support a Newletter service and don' t have promotional offers through their e-shops.

Small Medium Enterprises should pay more attention to their websites. Web managers should reconstruct the majority of the websites regarding to their augmentation of quality, visitors convenience and promotion of their products. This reconstruction, it is believed that it will increase the number of visitors and it will empower sales.

ACKNOWLEDGEMENT

We hope that this study will permit stakeholders involved with mushrooms and truffles to attain win - win deals with customers. Moreover it is proposed as a Future research issue the examination of the same SMEs through social media networks; it would be fruitful to Questionnaire sellers for details of their sales.

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Neural network based methodology for predicting energy consumption in public and environmental management

Georgios N. Kouziokas[3]
School of Engineering, Department of Planning and Regional Development, University of Thessaly
gekouzio@uth.gr

Alexander Chatzigeorgiou
Department of Applied Informatics, University of Macedonia
achat@uom.gr

Konstantinos Perakis
School of Engineering, Department of Planning and Regional Development, University of Thessaly
perakis@uth.gr

Abstract

Artificial Intelligence has been applied in various scientific sectors the recent years, with the development of new technologies and methodologies for constructing artificial neural network models. In this research, the application of Artificial Intelligence is studied for developing neural network forecasting models in order to predict the final energy consumption which covers the energy consumption in industry, transport, households, public administration, commerce and other sectors. The energy consumption forecasting can be very valuable in adopting management practices regarding the energy management and also in designing and planning national energy strategies. Several topologies were examined in order to develop the optimal artificial neural network forecasting model. The results showed that the proposed methodology can provide energy consumption predictions with a very good accuracy which can be very valuable in public and environmental management since they can be used in order to help the authorities at adopting proactive measures in energy planning and management.

KEYWORDS

Artificial Intelligence, Energy Management, Environmental Management, Neural Networks, Public Management.

1. INTRODUCTION

Information and Communication Technology has an advanced role in promoting a better public decision-making and in the implementation of technology-enabled practices in order to improve the management strategies. The increased amount of data in public administration, the latest years, has led public authorities to adopt new information systems and technologies in order to deal with several kinds of complex issues in a more computerized way (Dunleavy et al., 2006; Kouziokas, 2016b, 2016c).

Artificial intelligence has been used by various researchers as an advanced tool for predicting data in several sectors of public management such as environmental management (Kouziokas, Chatzigeorgiou, and Perakis,2016), public transportation (Kouziokas, 2016a) and decision support systems (Cortès, Uet al., 2000; Efendigil, Önüt, and Kahraman, 2009).

Various researcher have studied the application of artificial neural networks in energy consumption forecasting (Azadeh, Babazadeh and Asadzadeh, 2013; Ekonomou, 2010; Khoshnevisan et al., 2013; Khosravani et al., 2016; Zeng et al. (2017). Ekonomou (2010), has used artificial neural networks to forecast long-term energy consumption prediction in Greece. The results have been more accurate compared with the ones produced by a linear regression model. Khosravani et al. (2016), have studied the comparison of neural network prediction models regarding energy consumption. The results of the research have shown a very good prediction accuracy. Zeng et al. (2017), have applied a back-propagation neural network in order to develop forecasting models to predict energy consumption. The results have shown a very good prediction accuracy.

[3] Corresponding author.

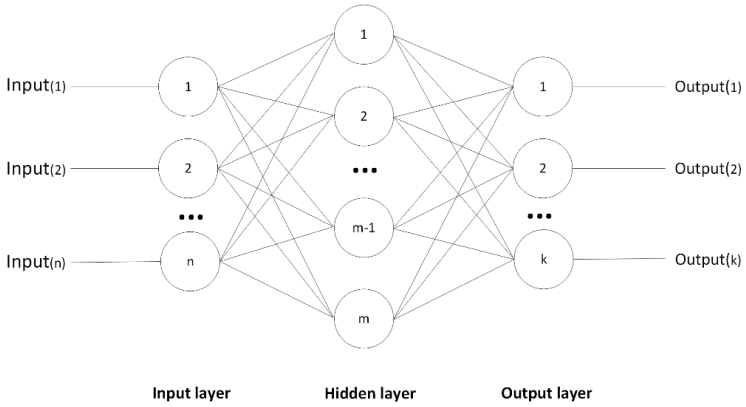
In this research, the application of neural networks forecasting models is investigated for predicting the final energy consumption covers the energy consumption in industry, transport, households, public administration, commerce and other sectors. This study, takes into consideration multiple factors that affect energy consumption levels, and tests multiple network topologies in order to find the optimal forecasting model. In the following sections, the materials and methods, the results and the discussion are described.

2. THEORETICAL BACKGROUND

2.1 Artificial neural networks

The Artificial Neural Networks (ANNs) can be defined as artificial computational systems that simulate the neural structure of the human brain. A neural network processes the information from the input parameters. The input information traverse through the established neuron connections and after been processed, the output results are computed according to the input (Svozil et al., 1997). The Artificial Neural Networks (ANNs) were implemented in this study in order to forecast the values of the energy consumption. In a feedforward multilayer neural network, the neurons between the layers are connected only in a forward direction and the typical structure consists of an input layer, an output layer and a hidden layer. Each layer is composed of neurons (Koskela et al., 1996). A Feed Forward Multilayer Perceptron (FFMLP) was implemented in this research, as it is considered as the most appropriate for time series issues according to the literature. The structure of a typical feed forward neural network is shown in figure 1.

Figure 17 The structure of a typical feed forward neural network is shown in this figure, where n is the number of neurons in the input layer, m is the number of neurons in the output layer and m is the number of neurons in the hidden layer.



2.3 Levenberg Marquardt Algorithm

In this research, the Levenberg Marquardt Algorithm was selected as the training algorithm for training the feedforward multilayer neural network, since according to the literature, it is one of the fastest learning algorithms compared to other algorithms (Lourakis, 2005). The Levenberg Marquardt algorithm combines the minimization advantages of two algorithms, the steepest descent algorithm and also the Gauss-Newton algorithm used for solving non-linear least-squares problems (Marquardt, 1963).

3. RESEARCH METHODOLOGY

The research methodology is divided into four stages: data collection, data preparation and cleansing, neural network prediction model development and the application of the optimal neural network model to predict the values of energy consumption. In the first stage, energy consumption data were collected and in the

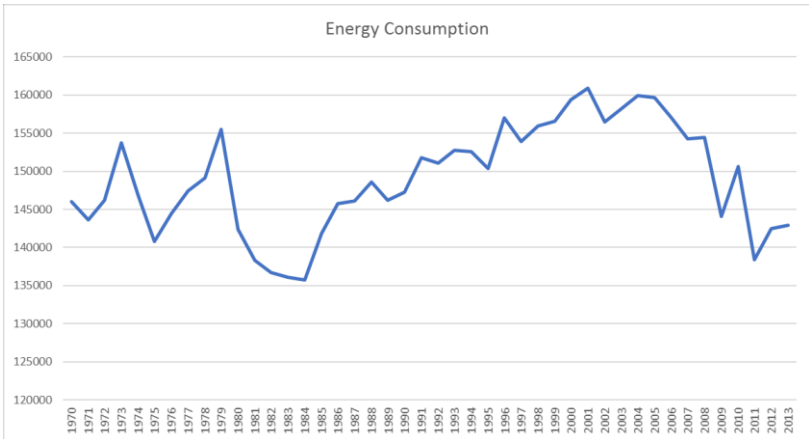
second stage the data were prepared and cleansed to feed the developed neural network models. In the third stage, several neural network structures were investigated so as to develop the optimal neural network prediction model. In the last stage, the optimal neural network model was implemented to forecast the values of the energy consumption.

4. RESULTS

4.1 Data collection and preparation

The data about energy consumption were retrieved from the official website of the UK Department for Business, Energy & Industrial Strategy for the UK. The data about population and the GDP (Growth Domestic Product) growth (annual %) were retrieved from the official website of the UK Office for National Statistics (ONS). The data that were collected for the time period from 1970 to 2013, were processed and prepared to be used as inputs in the Neural Network Models. The data were checked for gaps and duplicates.

Figure 18 Energy consumption in UK for the time period from 1970 to 2013.



4.2 Neural Network Models

According to the literature the influence population and the GDP (Growth Domestic Product) growth is very high energy consumption (Ramanathan, 2006; York, 2007). That is the main reason for selecting these factors as input variables in the developed neural network models. The artificial neural network models were developed and tested by utilizing as input parameters the prementioned factors that affect the levels of the energy consumption and also the historical values of the energy consumption. The input values are: the annual energy consumption, the population and the GDP (Growth Domestic Product) growth (annual %). The neural network output produces the forecasted values of annual energy consumption.
The data was divided into three different parts. 70% of the data was used as the training set, 15% as the validation set and 15% as the test set. The training data set was utilized so as to train the neural network with historical data. The validation set was utilized to evaluate the neural network model performance. The scaled conjugate gradient algorithm was used as the training algorithm

4.3 Optimum neural network model

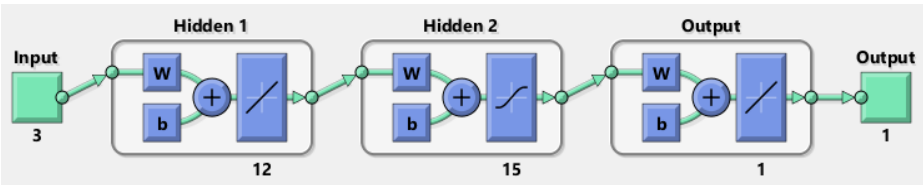
The performance of each tested forecasting model was used to find the best network topology. After testing several artificial neural network topologies regarding the number of the hidden layers and the nature of the transfer functions in the hidden layers, the optimal topology regarding the number of layers was the one

with one input layer, an output layer and two hidden layers. The most commonly used transfer functions were tested in the hidden layers: Log-Sigmoid Transfer Function (LSTF), Tanh-Sigmoid Transfer Function (TSTF) and Linear Transfer Function (LTF)). The optimal topology was found to be the one with 12 neurons and Linear Transfer Function (LTF) as the transfer function in the first hidden layer and 15 neurons and Tanh-Sigmoid Transfer Function (TSTF) in the second hidden layer as the transfer function. The optimum model was assessed according to the produced Mean Squared Error (MSE) among all the other constructed neural network models. The Mean Squared Error (MSE) was calculated by using the following equation:

$$MSE = \frac{\sum_{i=1}^{N} (y_{p_i} - y_{r_i})^2}{N} \qquad (1)$$

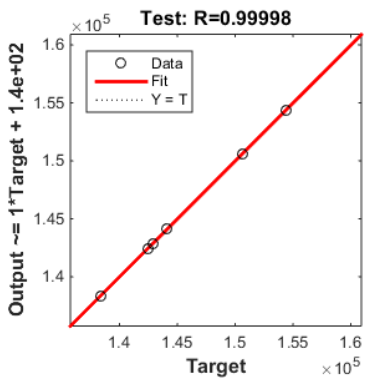
where y_{p_i} represents the predicted value, y_{r_i} represents the real value and N is the number of the output values. The Mean Squared Error (MSE) of the optimal network model was found to be 113.79 at epoch 7 and the Root Mean Squared Error (RMSE) was 10.67. The results have shown a very good forecasting accuracy. In figure 4 the neural network topology of the optimal model is shown.

Figure 19 The topology of the produced optimal artificial neural network model



The linear regression was used to evaluate the prediction accuracy of the optimal neural network model. The regression plot in figure 5 shows the relationship between the output values of the network and the target values of energy consumption. The R value shows the relationship between the outputs and targets. Figure 4 shows that the predictions are very accurate according to the R value of the test set (R = 0.99998).

Figure 20 The regression plot of the test set by using the optimal neural network model according to the minimum Mean Squared Error (MSE).



5. CONCLUSIONS AND DISCUSSION

In this paper, artificial intelligence was used in order to construct neural network models for predicting the levels of energy consumption which covers the energy consumption in industry, transport, households, public administration, commerce and other sectors. The results have shown a very good prediction accuracy of the values of the energy consumption that were selected to be predicted for the study area. The optimal

artificial neural network model was developed by investigating different network topologies in order to discover the optimal one and also by taking into consideration several factors that affect the levels of the energy consumption. This research takes into consideration multiple factors that affect energy consumption levels, as input factors, that have used neural networks to predict energy consumption, and tests multiple neural network topologies regarding the number of neurons in the hidden layers and the nature of the transfer functions so as to develop the best network prediction model.
The energy consumption forecasting can be very valuable in adopting practices regarding the energy management and also in designing and planning national energy strategies. The results have shown that the proposed methodology can provide energy consumption forecasts with a very good prediction accuracy which can be very valuable in public and environmental management since they can be used in order to help the authorities at adopting proactive measures in energy planning and management.

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Feedforward Neural Network Model in Unemployment Rates Forecasting in Public Administration

Georgios N. Kouziokas
School of Engineering, Department of Planning and Regional Development
University of Thessaly
gekouzio@uth.gr

Abstract

The application of Artificial Neural Networks in many scientific fields has been increased the last years with the development of new neural network technologies and techniques. In this study, Artificial Neural Networks are applied for building forecasting models in order to predict unemployment. A Feedforward Neural Network structure was used since it is considered as the most suitable in times series predictions. In order to develop the best artificial neural network forecasting model, several network topologies were examined regarding the number of the neurons and also the transfer functions in the hidden layers. Several economic factors were taken into consideration in order to construct the neural network based prediction models. The results have shown a very precise forecasting accuracy regarding the unemployment. The proposed technique can be very helpful in public administration at adopting proactive measures for preventing further increase of unemployment.

KEYWORDS

Artificial Intelligence, Economic Development, Neural Networks, Public Administration, Unemployment.

1. INTRODUCTION

The increased amount of public management information, the latest years, has led the public stakeholders to the adoption of new information systems and technologies so as to deal with public management problems in a more systematic way. Several studies showed the increased need for reforming public administration by implementing practices based on Information and Communication Technology (ICT) in order to promote advanced reformation in public sector (Dunleavy et al., 2006; Kouziokas, 2016b, 2016c).
Artificial intelligence methodologies have been implemented in many scientific fields. The development of new neural network techniques has increased the opportunity for adopting artificial intelligence in many sectors of public management.
Neural networks have been used by several researchers as a forecasting method in several issues of public management such as environmental management and decision making (Kouziokas, Chatzigeorgiou, and Perakis,2016), public transportation (Kouziokas, 2016a), decision support systems (Cortès, Uet al., 2000; Efendigil, Önüt and Kahraman, 2009) and in modelling and predicting the energy consumption (Azadeh, Babazadeh and Asadzadeh, 2013; Ekonomou, 2010). Also, several researchers have studied the application of artificial neural networks in predicting unemployment rates (Karathanasopoulos et al., 2015; Olmedo, 2014; Pelaez, 2006). Pelaez (2006), has implemented neural network prediction models in order to forecast the unemployment rates. The results have shown a very good prediction accuracy. Olmedo, (2014), has studied the implementation of nearest neighbor and neural network techniques in order to forecast the Spanish unemployment. The results have shown a very good prediction accuracy. Karathanasopoulos et al. (2015) have studied the combination radial basis neural networks and support vector regressions in order to forecast the US unemployment. The results have shown that this approach provides high accuracy in the results.

In this research, the implementation of artificial neural networks prediction models is studied for predicting the unemployment in UK. This research, takes into consideration multiple factors that affect unemployment rates, as input factors, and tests multiple network structures regarding the type of the transfer functions, the number of the neurons in the hidden layers in order to achieve the optimal forecasting results. In the following sections, the theoretical framework, the methodology and the results are discussed.

2. THEORETICAL BACKGROUND

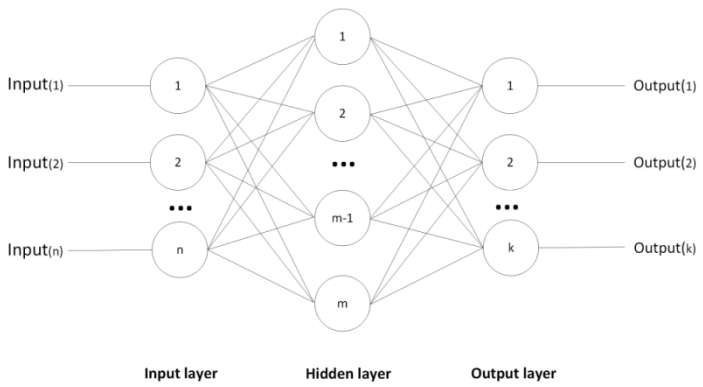
2.1 Artificial Neural Networks

Artificial Neural Networks (ANNs) are computing systems that simulate the structure of the brain system. A neural network elaborates data from the input parameters. The information traverses via connections to produce an output according to the input and the advantage is that they can model relationships of nonlinear nature (Basheer and Hajmeer 2000). Artificial neural networks are used in this study to forecast unemployment rates by taking into consideration several socioeconomic factors.

2.2 Multilayer Perceptron

A feedforward multilayer perceptron (FFMLP) was used in this study, as many researchers have shown that it is the most suitable for time series forecasting problems (Hornik 1991). In a feedforward multilayer neural network, the neurons between the layers are connected only in a forward direction and the typical structure consists of an input layer, an output layer and a hidden layer. Each layer is composed of neurons (Koskela et al. 1996). The structure of a typical feed forward neural network is shown in figure 1.

Figure 21 The topology of a typical feedforward neural network is illustrated in this figure, where n is the number of neurons in the input layer, m is the number of neurons in the output layer and m is the number of neurons in the hidden layer.



2.3 The Levenberg Marquardt Algorithm

The Levenberg Marquardt Algorithm was selected as the learning algorithm for training the feed forward multilayer neural network, since it is considered as one of the fastest training algorithms compared to other algorithms. The Levenberg Marquardt algorithm combines the minimization advantages of two algorithms, the steepest descent algorithm and also the Gauss-Newton algorithm used for solving non-linear least-squares problems (Marquardt, 1963).

3. RESEARCH METHODOLOGY

The methodology of this research is separated into four stages: data collection, data cleansing and preparation, neural network prediction model development, the use of the optimal neural network model in order to predict the unemployment rates. In the first stage, unemployment rates and data about socioeconomic factors that affect unemployment rates (GDP growth, population, growth of exports of goods and services) were collected and in the second stage the data were checked for gaps and prepared in order to feed the neural network models. In the third stage, several neural network topologies were investigated so as to develop the optimal neural network forecasting model. In the last phase, the optimal neural network model was utilized so as to predict the unemployment rates

4. RESULTS

4.1 Data collection and preparation

The data about the unemployment rates were retrieved from the official website of the UK Office for National Statistics (ONS). Also, the data about the population and the annual GDP (Growth Domestic Product) growth and the exports of goods and services (annual % growth) were retrieved from the official website of the UK Office for National Statistics (ONS). The data that were collected for the time period from 1971 to 2013, were processed and prepared to be used as inputs in the Neural Network Models. The data were checked for gaps and duplicates.

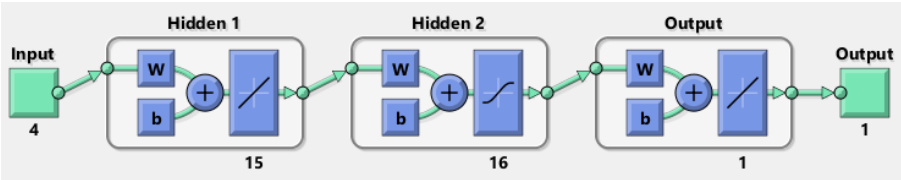
4.2 Neural Network Models

According to the literature several socioeconomic factors affect unemployment rates such as GDP growth, population, growth of exports of goods and services (Bayar, 2014; Ozughalu and Ogwumike, 2013). That is the reason for selecting these factors as input variables in the constructed neural network models. The artificial neural network models were developed and tested by using as input variables the above-mentioned socioeconomic factors that affect the levels of the unemployment rates and also the historical values of the unemployment rates.
The data was prepared and divided into three different parts. 60% of the primary data was used as the training set, 20% for the validation set and 20% for the test set. The training data set was utilized to train the neural network by using historical data. The validation set was used so as to assess the artificial neural network model performance. The Levenberg Marquardt Algorithm was used as the learning algorithm

4.3 Optimal neural network model

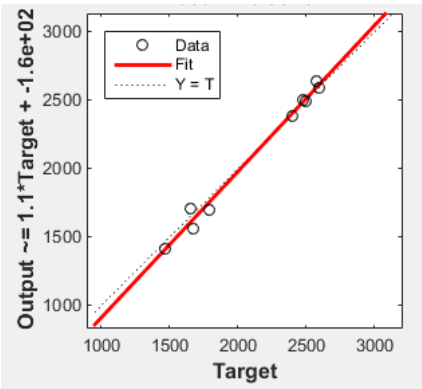
The optimal neural network model was discovered by testing the performance of every neural network model developed for different neural network topologies. After testing several neural network structures regarding the number of the hidden layers and the transfer functions of the hidden layers, the best topology regarding the number of layers was the one with one input layer, two hidden layers and an output layer. The most common transfer functions were tested: Log-Sigmoid Transfer Function (LSTF), Tanh-Sigmoid Transfer Function (TSTF) and Linear Transfer Function (LTF).
The optimal structure was found to be the one with 15 neurons and Linear Transfer Function (LTF) as the transfer function in the first hidden layer and 16 neurons and Tanh-Sigmoid Transfer Function (TSTF) in the second hidden layer as the transfer function.
The optimal model was evaluated according to the minimum Mean Squared Error (MSE) among all the other developed neural network forecasting models. The Mean Squared Error (MSE) of the optimal model was found to be 253.14 and the Root Mean Squared Error (RMSE) was 15.91. The results have shown a very good forecasting accuracy. In figure 2, the neural network topology of the optimal model is illustrated.

Figure 22 The topology of the produced optimal artificial neural network model.



Furthermore, the linear regression was utilized in order to evaluate the forecasting accuracy of the optimal neural network model. The regression plot in figure 3 shows the relationship between the output values of the network and the target values of unemployment levels. The R value shows the relationship between the outputs and targets. Figure 3 illustrates that the predictions are very accurate, according to the R value of the test set (R = 0.99462).

Figure 23 The regression plot of the test set by implementing the optimal neural network model according to the minimum Mean Squared Error (MSE).



5. CONCLUSIONS AND DISCUSSION

The application of artificial intelligence in many scientific fields has been highly increased the last years with the development of new neural network technologies and techniques. In this paper, artificial intelligence was used in order to develop neural network models for predicting the levels of unemployment. A Feedforward Neural Network structure was utilized since it is considered as the most suitable in times series predictions. Several socioeconomic factors were taken into consideration in order to construct the neural network based prediction models, such as GDP growth, population, growth of exports of goods and services, since these factors influence the levels of unemployment according to the literature (Bayar, 2014; Ozughalu and Ogwumike, 2013).

The results have showed a very good prediction accuracy of the levels of unemployment for the specific study area. The optimal artificial neural network model was developed by testing different network topologies. The proposed technique has shown better prediction results compared to other researches (Pelaez, 2006; Olmedo, 2014) and can be very promising in public administration at adopting proactive measures for preventing further increase of unemployment.

ACKNOWLEDGEMENT

The UK Department for Business, Energy & Industrial Strategy and the UK Office for National Statistics websites for retrieving the data.

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Evaluation of agricultural productivity by using multicriteria analysis: A case study in Central Macedonia in Greece

Theodore Tarnanidis,

PhD Student, Department of Business Administration, University of Macedonia, tarnanidis@uom.edu.gr

Jason Papathanasiou,

Assistant Professor, Department of Business Administration,

University of Macedonia, Thessaloniki, Greece, jasonp@uom.edu.gr

Maro Vlachopoulou,

Professor, Department of Applied Informatics, Dean of the School of Information Sciences, University of Macedonia, Greece, mavla@uom.edu.gr

Anna Kalioropoulou,

MSc, Department of Agricultural Economics, Aristotle University of Thessaloniki, Greece, physecon@gmail.com

Basil Manos,

Professor, Department of Agricultural Economics, Aristotle University of Thessaloniki, Greece, manosb@agro.auth.gr

Abstract

The agricultural sector in Greece provides a pivotal and opportunistic key success factor in fostering the country's entrepreneurial activity that hopefully will ultimately lead to the much desired sustainable growth and economic development. Thus, it is imperative for all decision-makers and stakeholders to know the efficient ranking and optimization of their operations management in rural areas. In doing so we used the methodology of PROMETHEE II multicriteria decision-making approach for the comparison of agricultural productivity and ranking the seven prefectures of Central Macedonia in Greece, based on productivity indicators of agricultural resources, like the gross return produced in each region. Data was collected for the period of 2013 to 2014. The results revealed that the prefecture of Pella surpasses on productivity the remaining six, while in the second and third place the prefectures of Imathia and Pieria follow. Finally, the validity of the specific ranking results is discussed and recommendations are given to the improvement of region' performance and productivity.

KEYWORDS

Mutlicriteria analysis, PROMETHEE, productivity of agricultural resources

1. INTRODUCTION

The specific research tries to evaluate the organization of agricultural production in the distinct departments of Central Macedonia. The methodology of PROMETHEE is used to achieve this goal. The study area taken the seven prefectures of Central Macedonia, which has a total area of 19,166 sq. km., and is 14.5% of the total surface area of Greek territories. The seven regional sections are the prefectures of Thessaloniki, Chalkidiki, Imathia, Kilkis, Serres, Pella and Pieria. Thus, the purpose of this study is to support decision makers in the unique production plans, by taking into consideration multiple criteria in planning, agricultural production. In this way the traditional case of a target criterion associated only with the profit maximization. The reason for using multicriteria analysis lies in the multiple objectives that make up farmers' preferences. Also, the MCDM approach helps simulate real decision-making processes and used to achieve better results in designing policies. In general, the multicriteria techniques with the use of PROMETHE Gaia method offer the possibility to carry out agricultural production on the basis of socioeconomic and environmental factors (Bournaris et al., 2013).

The multi-criteria analysis (or better aid) proposed for its suitability in the decision-making process regarding the design of agricultural production (Sumpsi et al, 1997; Amador et al, 1998) and with successful implementation in the depiction of real agricultural planning, either at farm level or at the level of geographical area or country (Manos et al., 2002a; Manos et al., 2002b; Manos et al., 2002c; Manos et al., 2006; Manos et al., 2010a; Manos et al., 2010b; Moulogianni et al., 2011; Bartolini et al., 2007; Gomez - Limon et al., 2002; Gomez - Limon & Riesgo, 2004; Gomez - Limon & Sanchez - Fernandez, 2010).

2. PROMETHEE II, METHOD

The methodology was used as a tool of comparison of productivity and ranking of agricultural regions based on productivity indicators of agricultural resources of the specific regions. Analytically, the methodology was applied for the comparison of productivity and the ranking of the seven prefectures of Central Macedonia in Greece, by examining five from the most important agricultural productivity indicators as the gross return produced per agricultural land in these areas. The indicators were estimated in a survey conducted at the seven prefectures in the period 2014-2016 in the framework of an MSc thesis (Kalioropoulou, 2016) at the Department of Agricultural Economics of Aristotle University of Thessaloniki.

The indicators used in the analysis are GR/AL, GR/VC, GR/LA, GR/FE,GR/TR
where:
GR=Gross return (thousand euros)
AL=Total agricultural land except set aside (thousand ha)
VC=Variable capital except labour and fertilizers (thousand euro)
LA=Labour (thousand hours)
FE=Fertilizers (ton)
TR=Tractors (number)

The main productivity indicators used in multicriteria analysis are presented in Table 1, and are analyzed with the use of the Visual PROMETHEE Software.

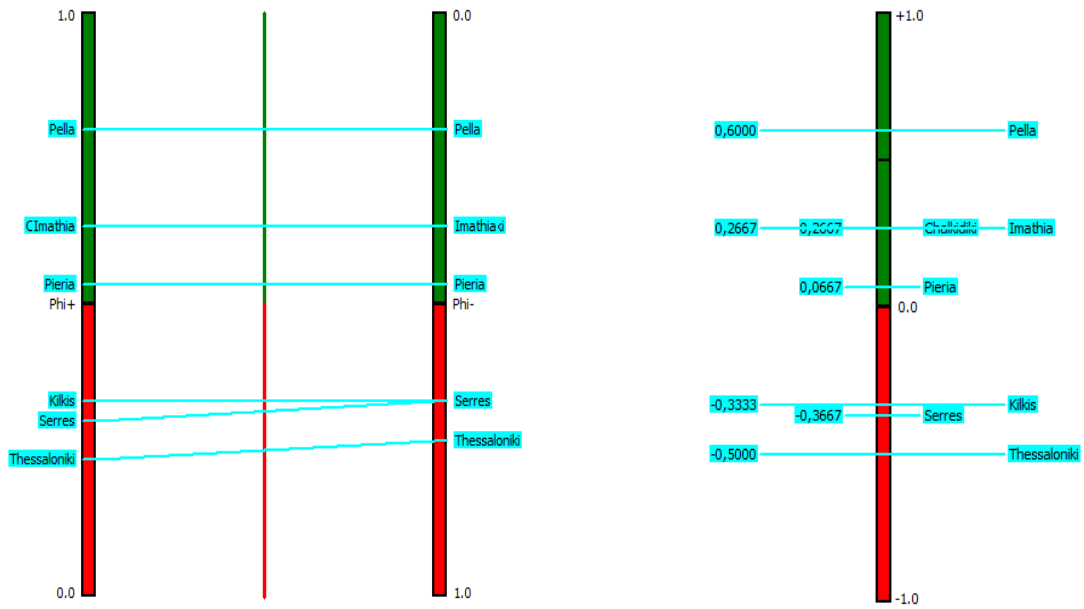
Table 1 Actions and criteria

Prefecture	**GR/AL**	**GR/VC**	**GR/LA**	**GR/FE**	**GR/TR**
Serres	1.360	4,8	13,1	6,2	14,1
Pieria	2.178	7,5	9,4	11,0	17,6
Chalkidiki	1.726	8,7	7,9	11,4	28,7
Kilkis	954	5,0	24,1	5,9	14,7
Imathia	4.088	5,7	11,6	9,4	30,2
Pella	7.622	7,6	12,2	12,2	23,7
Thessaloniki	1.321	4,4	19,8	6,2	13,9

3. RESULTS AND DISCUSSION

Figure 1, on the next page, depicts the partial and the complete rankings of the seven alternative actions

Figure 1 Partial & Complete ranking of alternatives



The above figure shows on the left the PROMETHEE 1 partial ranking of the actions according to Phi+. It clearly can be seen that the prefecture of Pella is preferred to all other actions. Also, this is justified by the PROMETHEES II complete ranking analysis (right figure). For example, the prefecture of Pella, has the high score on phi (0,6), followed by Imathia and Pella with phi score (0,266)

Figure 2 depicts the plane, where the vertical dimension gives the Phi net flow that identified in the complete ranking process.

Figure 2 Promethee Diamond

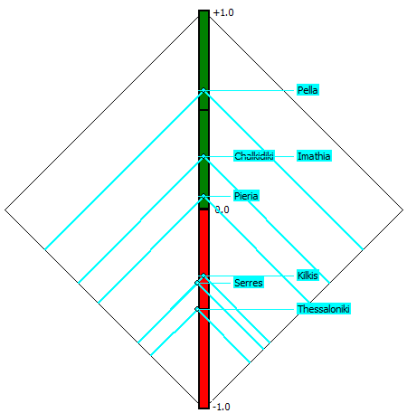
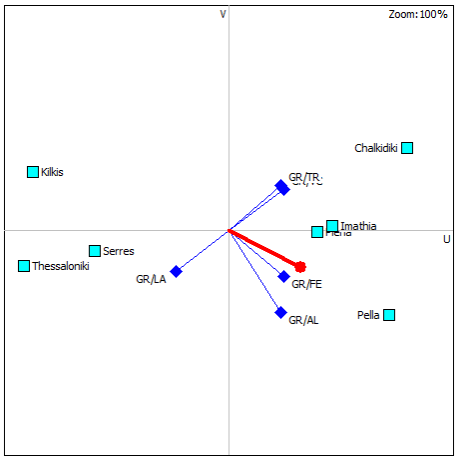
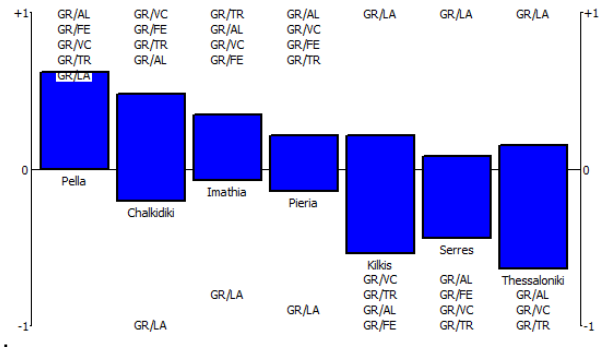


Figure 3 PROMETHEE GAIA PLANE



The Gaia plane in figure 3 shows, that the prefectures of Imathia and Pieria are very close to each other, they have similar actions, whereas the areas of Thessaloniki, Serres and Kilkis, are in the opposite directions and therefore, it can be concludes that they are different from the other actions

Figure 4 PROMETHEE RAINBOW



We can see in figure 4 that all the actions are drawn on a horizontal line by representing their position inside the phi flow scores ranging from +1 to -1. In the three regions (Pella, Chalkidiki, Imathia) the majority of the criteria contribute positively to their net flow scores

4. CONCLUSIONS

Although, the specific findings are based on few decision-making units in relation to the inputs and outputs, we managed successfully to differentiate the seven prefectures in an effective way and to propose a set of reference based on the effective units for better reorganization of production indicators.
An extension of this study could be the comparison and 51 Prefectures of the country. Such a comparison for similar inputs and outputs would offer better resolution, more efficient decision-making units and thus

maximize potential for more reliable measurement of actual profitability. The estimate of relative efficiency and an optimal set of reference on the basis of the most efficient units, will offer a more comprehensive assessment throughout. Moreover, according to the existing literature, the more units of decision-making in relation to the number of input-output tables, the better are the results achieved.

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Software design and development for spatial tillage allocation using the Revised Simos methodology combined with the Multicriteria Analysis Methods AHP and VIKOR

Athanasios Dragoslis
Department of Business Administration, University of MacedoniaThessaloniki, Greece
dragosli@uom.edu.gr

Jason Papathanasiou
Department of Business Administration, University of MacedoniaThessaloniki, Greece
jasonp@uom.edu.gr

Theodore Tarnanidis
Department of Business Administration, University of Macedonia Thessaloniki, Greece
tarnanidis@uom.edu.gr

Abstract

The applied socioeconomic policies of the last three decades enforced agricultural enterprises to abandon the traditional development techniques and adopt modern strategies oriented to the integration of Information and Communication Technologies (ICTs), the connection of agricultural production to the global market demands and the utilization of administrative tools that improve business process performance. This paper presents the development of a DSS for the support of decision making for spatial tillage allocation. The developed DSS integrates the weights' estimation methodology of revised Simos with the VIKOR and AHP multicriteria analysis methods and can be used to solve complex decision problems that have alternative solutions and are evaluated by using conflicting qualitative and quantitative criteria. Motivation for the development of this software is the creation of an auxiliary tool to assist the effort for the optimization of productivity and the minimization of the consumption of limited resources. The system's database stores data for 128 crops derived from the official publication "INDICATORS 2007" of the department of Development, Innovation & Rural Economy of the Administrative Authority of Central Macedonia. The rationale is structured upon three collaborative but functionally independent modules, one for each implemented method. Using the AHP and the Revised Simos modules, stakeholders can calculate the relevant weights for the evaluation criteria needed for VIKOR's application on data. The outcome is a ranking of the alternatives and a suggestion of the best compromise solution. The DSS was applied experimentally on a set of seven crops.

KEYWORDS

Tillage allocation, Multicriteria analysis, VIKOR, AHP, Revised Simos.

1. INTRODUCTION

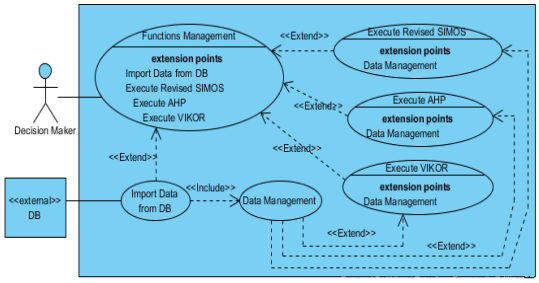
The applied socioeconomic policies of last three decades have led to the establishment of a globalized market system without frontiers, forcing business activity to adopt new organizational strategies. Therefore, agricultural enterprises have to abandon the traditional development techniques and induct modern strategies oriented to the integration of Information and Communication Technologies (ICTs), the connection of agricultural production to the global market demands and the utilization of administrative tools that improve the overall business process performance. This paper presents the development of a Decision Support System (DSS) for spatial tillage allocation supporting the design of agricultural policies. The drive for the development of this software is the creation of a tool to assist the optimization of productivity, in parallel with the minimization of the limited resources consumption. The suggested DSS is structured by three collaborative but functionally independent modules, integrating the weights estimation method revised Simos with the AHP and VIKOR multicriteria analysis methods. The DSS provides revised Simos and AHP methods for the calculation of the evaluation criteria weights that VIKOR uses for the multicriteria analysis and is designed to solve complex decision problems that have alternative solutions, which can be evaluated using conflicting qualitative and quantitative criteria [21]. The crop related data, which was derived from the

official publication "INDICATORS 2007" of the Department of Development, Innovation & Rural Economy of the Administrative Authority of Central Macedonia [1], is stored in a database and it is transformed in the appropriate form by stored procedures and triggers. The result of our system is a ranking of the alternative solutions and the suggestion of the best compromise solution. The paper is consisted by five sections. In second section we describe the architecture of the application. The third section is dedicated to the mathematical foundations of the methods that our DSS uses. In forth section we present the experimental application of the suggested DSS on a set of seven crops, using the functional combination of AHP with VIKOR. Finally, in fifth section we summarize the basic conclusions and we propose some ideas for further research on the tillage allocation problem.

2. APPLICATION ARCHITECTURE

The application is consisted by three functionally independent modules for the implemented methods, an auxiliary module which acts as repository for the temporary intermediate calculations and the main interface where the decision maker can select the desired crop data from the database and initiate the proper method execution sequence. The application's Use Case Diagram (figure 1) presents the available functionalities, the dependences among the modules and the potential control flow paths.

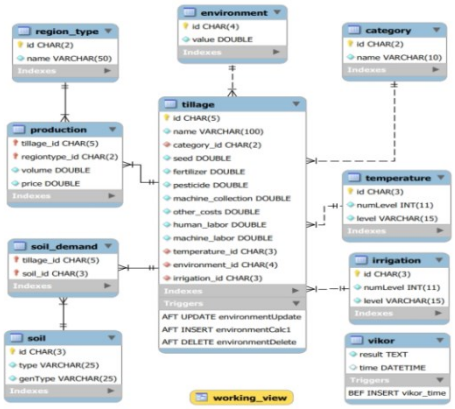
Figure 1 Use case diagram



2.1 Data Base ER

The main part of the crop related data derived from the statistical report "Indicators 2007 for the implementation of the Agricultural Structural Policy» that published by the Administrative Authority of Central Macedonia [1]. Additional data was extracted by the literature review of the agricultural field related bibliography [2], [19], [6], [7], [11], [12], [10]. Data is organized in a database consisted by ten tables and the necessary aggregating functions for the construction of the table "working_view", which is the information tank for the rational part of the application (figure 2).

Figure 2 Entity Relation Diagram



3. MATHEMATICAL FOUNDATIONS

3.1 Revised Simos

In 1990 J. Simos [16], [17]presented a method to assist stakeholders express their judgments about the importance hierarchy of a group of criteria in a specific context. Few years later, Figueira and Roy [5] revised the structure and the functionality of Simos' method in order to overcome some inconsistencies in accuracy and robustness. During the execution procedure the responsibility of the decision maker is to provide an ascending order of criteria levels with regard to their relevant importance and the value of the Z-ratio, which expresses how many times the most important level, is more important than the least important. The result of revised Simos is the calculation of the normalized weight for each importance level within a specific range (0-100). Revised Simos is an easy to use methodology that can manipulate effectively both quantitative and qualitative criteria and minimize the rounding distortion fault of the normalized weights. Considering the shortcomings, the obligation of decision makers to decide the order of criteria and the value of Z-ratio could be somewhat confusing especially for inexperienced stakeholders [21], [18].

3.2 AHP method

AHP was developed by T. Saaty as a mathematical technique for the confrontation of complex and unstructured decision problems. The objective of AHP is the comparative evaluation and the hierarchical ranking of the alternative solutions with regard to a group of criteria [13], [3]. In our software, AHP is used only for the computation of the ranking criteria weights that are going to be used in VIKOR. AHP is founded mathematically on the pairwise comparison technique through a numerical scale from 1 to 9 [13], [20]. The scalar values express the subjective opinion of the decision maker about how many times more important is one criterion in comparison to another (table1).

Table 1 AHP Importance Scale [14].

Scale	Definition
1	Equally important
3	Moderately more important
5	Strongly more important
7	Very strongly more important
9	Extremely more important
2,4,6,8	Intermediate values

The procedure begins with is the construction of the n x n pairwise comparison matrix P, where n is the number of ranking criteria. The value in cell represents the decision maker's opinion about the importance of criterion i in comparison to criterion j[13]. The second step refers to the computation of the primary eigenvector of P, which after normalization becomes the vector of the criteria weights.

For the eigenvector's calculation we use two suggested by Saaty [13], [14] mathematical notions, the arithmetic mean and the geometric mean. AHP is a flexible and easy to use methodology, especially when the decision maker is unable to assign directly weights to the criteria. The pairwise comparison technique enforces the comparison of all criteria concurrently, leading to a holistic consideration of weights assignment [23], [21]. However, AHP is a computationally expensive method with quadratic complexity and has scalability limitations. Additionally, the importance scale restricts the flexibility during the preference expression[23].

3.3 VIKOR method

VIKOR was developed by S. Opricovic in 1990 as a multicriteria analysis method to solve complex decision problems with many alternative solutions. VIKOR ranks the alternatives in regard to a set of conflicting qualitative and quantitative evaluation criteria and suggest the solution or the subset of solution that is "closest" to the "ideal" solution [21]. Measure of the "closeness" for the compromise ranking is a form of $L_p - metric$ that used as an aggregating function [22], [24], [15]:

$$L_{p,j} = \left\{ \sum_{i=1}^{n} \left[w_i \cdot \left(f_i^* - f_{ij} \right) \Big/ \left(f_i^* - f_i^- \right) \right]^p \right\}^{1/p} \quad ,1 \le p \le \infty,\ j = 1, 2, ..., m$$

where n is the number of criteria, m is the number of the alternative solutions, w_i the weight of the criterion i, f_i^* is the best and f_i^- is the worst value of criterion i for all alternatives and f_{ij} is the evaluation of the alternative j in regard to criterion i. The algorithm calculates the values $L_{1,j}$ as S_j, $L_{\infty,j}$ as R_j and $Q_j = v \cdot S_j + (1 - v) \cdot R_j$ to formulate the measures for the ranking. The alternative with the $\min_j S_j$ is the one with the maximum group utility (the rule of "majority") and the alternative with the $\min_j R_j$ is the one with the minimum individual regret of the "opponent" [8].The parameter v takes values in the interval [0, 1] and acts as weight for the manipulation of the strategies of maximum group utility and individual regret [9]. Finally, it creates the ranking lists S, R and Q in descending order and the proposed compromise solution is:

a) The alternative $A^{(1)}$ with the minimum Q value if:

   C1. *"Acceptable advantage"*: $Q(A^{(2)}) - Q(A^{(1)}) \ge DQ$, where $A^{(2)}$ is the second alternative in Q list and $DQ = 1/(1-m)$.

   C2. *"Acceptable stability in decision making"*: The alternative $A^{(1)}$ is also first in list S and/or R.

b) The alternatives $A^{(1)}$ and $A^{(2)}$ of Q list if only the condition C2 is not satisfied.

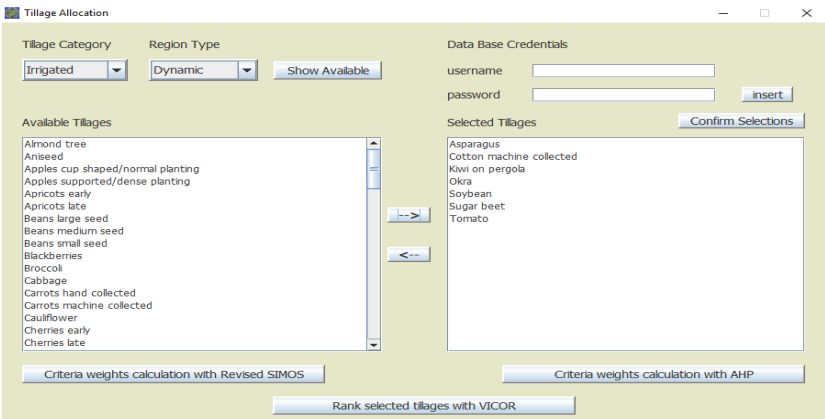
c) The alternatives $A^{(1)}, A^{(2)}, ..., A^{(M)}$ of Q list, for maximum M determined by the inequality $Q(A^{(M)}) - Q(A^{(1)}) < DQ$ if the condition C1 is not satisfied.

4. CASE STUDY

For our case study, we assume that we have to decide the suitable crops for a region with the following characteristics: "Dynamic" type, "Irrigated" category, "Loamy-Sandy" soil type and "Moderate/High" temperature (figure 3).Stakeholders of the agriculture sector suggested eight evaluation criteria: income (C1), cost (C2), human labor (C3) and machine labor (C4) in hours/acre, region temperature (C5), environmental

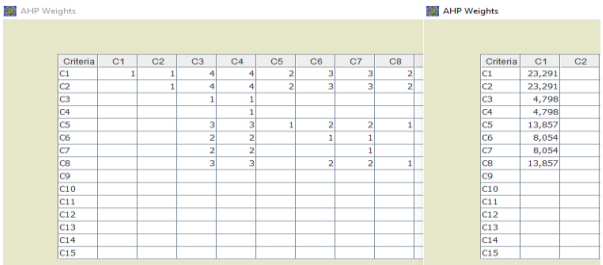
impact (C6), irrigation needs (C7)and crop soil demands (C8). The same stakeholders estimated the relevant importance between the criteria and AHP calculated the weights as shown in figure 4.

Figure 3 Crop selection



For the application of VIKOR's procedure on the imported data, we constructed the multicriteria analysis model as shown in Figure 5. The binary indication Min{0}/Max{1} in the second row of the upper table, is used to denote whether the corresponding criterion is to be minimized or to be maximized. The outcomes of the procedure are the three descending rankings S, R, Q and the compromise solution (table 3).

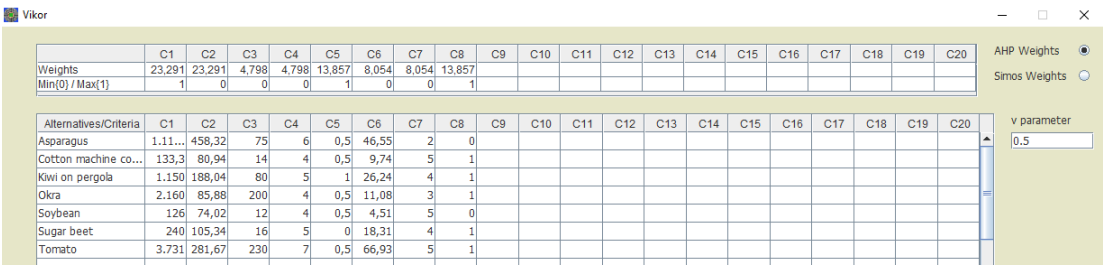
Figure 4 Crop selection



Criteria	C1	C2	C3	C4	C5	C6	C7	C8
C1	1	1	4	4	2	3	3	2
C2		1	4	4	2	3	3	2
C3			1	1				
C4				1				
C5			3	3	1	2	2	1
C6			2	2		1	1	
C7			2	2			1	
C8			3	3		2	2	1
C9								
C10								
C11								
C12								
C13								
C14								
C15								

Criteria	C1	C2
C1	23,291	
C2	23,291	
C3	4,798	
C4	4,798	
C5	13,857	
C6	8,054	
C7	8,054	
C8	13,857	
C9		
C10		
C11		
C12		
C13		
C14		
C15		

Figure 5 VIKOS's multicriteria model



	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15	C16	C17	C18	C19	C20
Weights	23,291	23,291	4,798	4,798	13,857	8,054	8,054	13,857												
Min{0} / Max{1}	1	0	0	0	1	0	0	1												

Alternatives/Criteria	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15	C16	C17	C18	C19	C20
Asparagus	1.11...	458,32	75	6	0,5	46,55	2	0												
Cotton machine co...	133,3	80,94	14	4	0,5	9,74	5	1												
Kiwi on pergola	1.150	188,04	80	5	1	26,24	4	1												
Okra	2.160	85,88	200	4	0,5	11,08	3	1												
Soybean	126	74,02	12	4	0,5	4,51	5	0												
Sugar beet	240	105,34	16	5	0	18,31	4	1												
Tomato	3.731	281,67	230	7	0,5	66,93	5	1												

For the application of VIKOR's procedure on the imported data, we constructed the multicriteria analysis model as shown in Figure 5. The binary indication Min{0}/Max{1} in the second row of the upper table, is used to denote whether the corresponding criterion is to be minimized or to be maximized. The outcomes of the procedure are the three descending rankings S, R, Q and the compromise solution (table 3).

Table 3 S, R, Q rankings and Compromise solution

Alternative	S rank	Alternative	R rank	Alternative	Q rank	Compromise solution
Okra	25.467	Okra	10.150	Okra	0.000	
Kiwi	34.854	Tomato	12.585	Tomato	0.309	Okra
Cotton	39.364	Kiwi	16.675	Kiwi	0.351	
Tomato	45.217	Sugar beet	22.554	Cotton	0.651	
Sugar beet	47.147	Cotton	23.244	Sugar beet	0.710	
Soybean	52.130	Soybean	23.291	Soybean	0.793	
Asparagus	71.016	Asparagus	23.291	Asparagus	1.000	

5. CONCLUSIONS

The current economic environment enforces agricultural enterprises to abandon the traditional organizational forms and adopt strategies oriented to the combination of the new technologies with the business processes design. In this paper we presented the development of a DSS for spatial tillage allocation, as a potential assistance tool for the optimization of productivity and minimization of resources consumption. The suggested DSS integrates the methods of revised Simos, AHP and VIKOR in a sequential procedure that can suggest the better crop choice under certain conditions. Future improvement of the suggested model could be achieved by enriching the analysis with more evaluation criteria like: stock market estimations for the future crop prices, predictions for the future crop demands, resources availability, required know how, satisfaction of agriculture professionals and strength of agriculture related business activity. In technical terms, integrating the suggested DSS with data mining techniques will help to the acquisition of timely data from arbitrary transaction databases. Additionally, an OLAP analysis subsystem could provide stakeholders with multi-grain information perspectives.

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A Nexus approach for Agricultural Sustainable Management

Vasiliki Mantzaropoulou1* Basil Manos1 Thomas Bournaris1 Stefanos Nastis1

1Aristotle University of Thessaloniki, Department of Agricultural Economics, Thessaloniki, Greece
*CORRESPONDING AUTHOR: VMANTZARO@AGRO.AUTH.GR

Abstract

The growing demand and scarcity of the natural recourses, as well as the climate change effects may have major implications on national and world security in terms of the water scarcity, drought, energy crisis, famine and land degradation. To address the problem, an intergraded approach (NEXUS) that encompasses the inter-connectedness of the main sectors of water, energy, food and land use is needed, to ensure thereby sustainable development by enhancing resource use efficiency, encouraging greater policy coherence and promoting investment options that co-balance benefits across these sectors.

The achievement of sustainable development calls for significant changes in current patterns of development, production and consumption and advocates, inter alia, the reduction of wasteful consumption of natural resources and the prevention of pollution, as well as socio-economically efficient policies and strategies.

This paper discusses the management options that may have a Nexus approach on the management of water, soil and waste, in order to enhance the sustainable intensification of agriculture, and contribute to the socio-economic development. It also examines various economic assessment methods which are used in the management process and decision making in the framework of sustainable development. Finally, the most appropriate operational research models and applications are proposed that promote the decision making in Nexus systems.

KEYWORDS

Water-energy-food nexus, Sustainable Resources management, Operational research methods and applications in agricultural management

1. INTRODUCTION

There is a globally growing demand for water, energy and food, which is expected to rise significantly in coming decades (Hoff, 2011), causing increasing competition between the limited resources, with socio-economic and environmental impacts (2011c FAO). To address the above-mentioned complex problem, is needed to understand the interconnection relationships between water, energy, food, land use and the climate by an integrated NEXUS approach, thus ensuring sustainable management of available resources in rural areas (Bonn Nexus Conference 2011).

Despite the fact that it has not recently been introduced the "NEXUS" concept, has emerged as a means of approaching socio-economic and environmental challenges in an integrated way and has been used in various areas, such as sustainable development and entrepreneurship (Sharmina, et al., 2016). However, due to the vastness of each researching area, referring to water, energy, food - combined with the complexity of the interconnection and interdependence between the recourses, the research contribution with regard to systems that focusing on decision making in the NEXUS concept framework is extremely limited.

For this reason, should be developed and implemented methodologies and tools, based on realistic decision process, that enable integrated analysis of NEXUS systems and contributes to sustainable management and rural development, by achieving a better policy-making procedures that leads to an optimum agricultural production plan (Manos B. et al.2013; Miralles-Wilhelm, 2016).

2. THE «NEXUS» APPROACH

Population growth on a global scale results in an unavoidable increase in competitiveness between vital resources (Tevar, A.D et al, 2016), water, energy and food. The "silo" approaches to these resources have led to unsustainable policy and development choices. (Weitz, 2014). There is, therefore, a need for a better understanding of the links between water, energy and food and their interdependence, as well as the adoption of an integrated approach to the management of these sectors, which includes an analysis of cross-sectoral interactions with a view to facilitating integrated planning and decision making (IRENA, 2015).

Today, international research organizations such as the International Food and Agriculture Organization (FAO), the National Institute of Food and Agriculture (NIFA), the International Renewable Energy Agency (IRENA), the International Institute for Sustainable Development (IISD), and other public or private organizations such as universities and researching institutes, either individually or in synergy with each other, or with other bodies, investigate the complexity, interdependence and impact of water, energy and food systems in order to draw conclusions that contribute to the sustainable management of existing and future challenges. EU economic policy and development strategy intends to accelerate a dynamic low-carbon and resource-efficient economy (G. Vlontzos et al., 2014), by integration of three fundamental pillars: the environmental, social and economic pillars. Particularly, the European Commission, adopting the New Sustainable Development Agenda (UN 2015), to manage the growing demand for water, energy and food (The ECC 2015), introduced a new framework for the development of policies, implemented by the European Union (DEVCO 2015), in order to address the complementary and competitive interactions of food -water-energy resources, encouraging the Sustainable Development Goals (post-2015 development agenda- Rio + 20 SD Conference 2012).

It is observed in literature review that the models and methods are mainly used to analyze individual systems (such as energy or irrigation water) and often focus on a single resource or find application at a macroeconomic level and generally relate to long periods of time (Miralles-Wilhelm, 2016). Generally, it can be seen, that haven't been developed sufficient research methods that respond to the integrated NEXUS approach, leading to realistic solutions and applied through multiple scales and different contexts (Leck, et al., 2015). It is therefore necessary to develop, through research, integrated analysis tools and conceptual models that aim to emerging "bottom-up" sustainable solutions (Bazilian, M., et al., 2011) that are instruments for supporting decision-making and strategic planning, especially for countries such as Greece, where the need for growth is imperative (KK Yumkella and PT Yillia, 2015).

2.1 TOOLS AND METHODS FOR ANALYZING THE NEXUS WATER-FOODENERGY SYSTEMS

The scientific sector has made progress in understanding and quantifying future challenges, but there are still questions about how knowledge can be better transposed to allow for informed decision-making in policy / decision-making. Therefore, there is a need for effective tools for accounting different resource allocation strategies and for understanding exchanges between different systems. Currently, there are several existing tools that address specific aspects of the nexus, from which the most typical are:

- WEAP (SEI, 2014 SEI (2014). Water evaluation and planning,
- LEAP (SEI, 2013 SEI (2013). Long range energy alternatives planning system.
- MuSIASEM (FAO, 2013 FAO (2013). An innovative accounting framework for the food-energy-water nexus,
- CLEWS (KTH, 2013 KTH (2013). CLEWs – climate, land, energy and water strategies to navigate the nexus,
- WEF NEXUS TOOL 2.0 (2015).

«WEAP (Water Evaluation and Planning) uses an integrated approach to water resource planning. LEAP (Long-range Energy Alternatives Planning System) is directed at energy policy analysis and climate change mitigation assessment. MuSIASEM (Multi-Scale Integrated Analysis of Societal and Ecosystem Metabolism) offers a method to characterize flows of different systems within society. CLEWS (Climate, Land, Energy and

Water Strategies) further develops an integrated systems approach to determine the interactions between interconnected sectors. WEF NEXUS TOOL 2.0 (2015) identifies the interlinkages among energy, water and food systems at multiple levels (international, national, regional, watershed, etc.) and provides sustainable resource management strategies governed by a scenario-based WEF nexus framework.» (Daher & Mohtar, 2016)

The tool is included in the review if it satisfies the following criteria:

- It covers all the three elements of the water–food–energy nexus (i.e., water and energy, food and energy or water and food).
- It allows for policy analysis at a national level.
- It is widely accessible and ready to be used or it has open access.
  According to the above concept is been selected a) WEF NEXUS TOOL 2.0 (2015), b) MuSIASEM.

2.1.1 MuSIASEM

The MuSIASEM approach, Multi-Scale Integrated Analysis of Societal and Ecosystem Metabolism, is a methodological framework that applies to analyzing the use of social resources and the generated environmental impacts. (Giampietro et al.,2009; Giampietro et al.,2000; Giampietro et al.,2003)

It is an important tool for integrated multidimensional analysis of changes in socioeconomic system characteristics, by conjoining quantitative information produced by different types of conventional models, different dimensions and scales of analysis. It is an innovative method of analyzing the interconnection between energy, food and water, as it allows the simultaneous integration of technical, economic, social, demographic and ecological variables into one metabolic model, even if these variables are defined in different dimensions, scales and hierarchy levels. This analysis model is built on the following concepts:

1) Multi-level/Multi-scale accounting
2) Multi-purpose grammar
3) Impredicative loop analysis

According to LIPHE-FAO technical report, there are six steps for implementation:

1) **Definition of the socio-economic system as a set of functional compartments essential to guarantee its survival, reproduction and adaptability**

Definition of all the compartments of society at all levels and every part be mutually exclusive and amenable to subdivisions practiced in national statistics. The socio-economic sectors can also be congregate into two macro-compartments expressing emergent properties, *hypercyclic and dissipative*, set only at a larger scale, to analyze the viability of the dynamic equilibrium of the interconnected flows of the resources-water, energy, food.

2) **Quantitative definition of the profile of investment of fund elements over the functional compartments of the system**

Involving definition of the relevant fund elements and quantification across the various functional compartments of the system, leading typically to creation of a dendrogram, in which the total amount of fund element is repeatedly split up at lower layers of hierarchical structure.

3) **Quantitative definition of the flows required forexpressing the functions**

Involving definition and quantification of the interconnected flows (food, energy, water, money), using a series of grammars that describe the internal loops associated with the supply and consumption of the flows.

4) **The multi-level, multi-dimensional matrix describing the metabolic pattern across hierarchical levels and dimensions of analysis.**

The defined and quantified elements from the previous steps are combined in a multilevel, multi-dimensional matrix. It is possible in this way to analyze an integrated system of non equivalent quantitive elements across different functional compartments, in different scales and dimensions.

5) **Checking the viability and desirability domain for the metabolic pattern (definition of the internal constraints of sustainability)**

Viability is checked by cross-verifying the stability of the dynamic budgets of the individual flows (food, energy, water, money),known as ‘‘Sudoku Effect’’ concept, and can be implemented on quantitative assessments referring to:(i)different levels and compartments and (ii)different dimensions of analysis.

6) **Checking the feasibility of the metabolic pattern in terms of resource requirement (supply side) and environmental loading (sink side) - definition of external constraints to sustainability**

The environmental loading of a metabolic pattern can be assessed by accounting the required biophysical flows and the corresponding flow of wastes. The environmental impact level assessment in spatial terms across scales should using GIS data.

Concluding, the MuSIASEM approach could be used to analyze the energy-water energy nexus as:

- ✓ It is a quantitative multi-criteria and multi-scale sustainability analysis, which using heterogeneous dataset across different dimensions and different scales of analysis, in a holistic view,
- ✓ It is a complex method, semantically open and able to be tailored to specific situations,
- ✓ It is focusing only on feasible scenarios and contribute to create integrated packages of indicators in line with specified conditions,
- ✓ It combines traditional socio-economic variables with GIS-based data, conjoining the environmental impacts with the socio-economic processes at multiple spatial scales.

2.1.2 WEF NEXUS TOOL 2.0

The water-energy-food NEXUS tool assesses different scenarios and consists of varying food self-sufficiencies, water sources, energy sources, and countries of import at multiple levels (international, national, regional, watershed, etc.) and provides sustainable resource management strategies. It calculates the “sustainability index” of each of different proposed scenarios and gives the opportunity to decide the importance of each system of water-energy-food nexus. Also enables systematic integration of policy preferences, comparison of possible scenario outcomes and consideration of respective resource requirements. Thus allowing comparison and cost-benefit analyses (Daher & Mohtar, 2015; Mohtar & Daher, 2016).

Despite the fact the structure of the tool is generic, the ‘local characteristics’ are specific to the area under study and contribute in defining the resource requirements for a given scenario and they are consist of information that describes the area under study,such as yields for different food products (ton/ha), water requirements (m3/ton), energy needs (kJ/ha or kJ/m3), and other items (Daher & Mohtar,2015).

According to IRENA (2015) report, the inputs required are:

- Data and local characteristics of food, water and energy systems
- Local production of food, water and energy (per type)
- Context-specific policy inputs

And the outputs are (http://www.wefnexustool.org):

- ➢ Water requirements (m3)
- ➢ Local energy requirements (kJ)
- ➢ Local carbon emissions (ton CO2)
- ➢ Land requirements (ha)
- ➢ Financial requirements (QAR)
- ➢ Energy consumption through import (kJ)
- ➢ Carbon emissions through import (ton CO2)

The WEF Nexus Tool 2.0 identifies the interlinkages among each system of energy, water and food nexus and assesses different resource allocation strategies by quantifying resource requirements and environmental impacts (Daher & Mohtar, 2015; Mohtar & Daher, 2016).

3. DISCUSSION AND CONCLUSIONS

There is a challenge to understand energy, water and food policy interactions, and addressing them in an integrated manner. Integrated evaluation models vary greatly concerning the NEXUS and the incentives to develop a new model follow the view of existing integrated resource assessment and processing. (M. Bazilian et al.,2011). The succession of a new initiative or program for food-energy-water (WEF) at local, national or international level is dependent on the power or impressiveness of technical innovation (IRENA, 2015). As a result, to implement sustainable strategies and policies, in the NEXUS framework should be available comprehensive tools:

- are inclusive and multi-scale;
- define and quantify interconnectivity between water, energy and food; and
- support development of an integrative strategy for holistic management and planning for the future of these resources.

The selection of the more suitable tool and method depends on the needed outputs, but on the available input information as well (Mohtar & Daher, 2016).

Concerning the WEF Nexus Tool 2.0 and MuSIASEM:

- ✓ All provided outputs are related to energy, water and food recourses
- ✓ All are widely accessible, and allow policy making at a national level
- ✓ All can be adapted to different contexts and geographies
- ✓ Provide also economic indicators and insights related to greenhouse gas emissions
- ✓ Only WEF Nexus Tool 2.0 is classified as simple tool. (IRENA, 2015).
- ✓ The complexity of the MuSIASEM approach is in line with reality (LIPHE-FAO, 2013)

In conclusion, the available tools and methods cannot provide the possibility of analyzing the whole range of systems at all levels and scales. This is due to the volume of information required, needing to be assembled and organized effectively, in order to be usable and because each methodological approach can assess only certain set of elements of given scenarios. Therefore, if more comprehensive approaches are required, combinations of these tools and methods should be applied in a view to offer qualitative holistic outcomes and answers to complex questions.

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Internet users' perceptions towards price comparison sites in greece

Christos Geranis*
Postgraduate at
University of Macedonia
156, Egnatia str., 5400, Thessaloniki, Greece
e-mail: cgeranes@gmail.com

Dr. Konstantinos Petridis
Adjunct Lecturer at
Department of Applied Informatics
University of Macedonia
156, Egnatia str., 5400, Thessaloniki, Greece
e-mail: k.petridis@uom.edu.gr

Dr. Maro Vlachopoulou
Professor at
Department of Applied Informatics
University of Macedonia
156, Egnatia str., 5400, Thessaloniki, Greece
e-mail: mavla@uom.edu.gr

Abstract

Price comparison sites are nowadays a significant source for online shoppers by providing access to information regarding the price and details of the product, reducing buyers' search costs and supporting their decision-making by providing price comparison possibilities, which is seldom present in the physical retail shopping context. The present research aims to investigate the factors, which may affect Internet users' intention to use a price comparison site. To achieve the goal of the study, factors regarding the features of price comparison and e-commerce sites were used. Data collection was performed by using convenience sampling technique in conjunction with snowball sampling technique, via an electronic questionnaire, which was distributed online, through email and the social network Facebook. Data from 200 students, who had all used at least once a price comparison site, were collected. Results showed that the perceived website image, as well as the users' overall satisfaction with the site, have a positive impact on their intention to use a price comparison site. The findings of the research can contribute both to the literature and provide valuable insight to price comparison sites, improving their services and increasing both their popularity and revenues.

KEYWORDS

Price comparison websites; Price comparison; Price comparison website characteristics; Intention to use.

JEL Classification Codes: L81, L86, P22

1. INTRODUCTION

The global economic crisis, which began about the middle of 2007 and the early 2008 (Havemann 2016; Shah, 2013; Bank of Greece, 2014) created the need to consumers for cheaper products. Thus, this need, combined with the development of the technology industry in Greece, brought Greeks closer to the use of new technologies to purchases both products and services. The economic crisis has managed to achieve both to turn consumers to online purchasing, where products are usually sold at lower prices than at the physical stores and to become more aware as consumers by conducting research before purchasing (Manifava, 2011). This need came to be fulfilled by the price comparison sites, which today are the primary information source, which consumers trust to obtain information regarding the products or services are seeking for (Kassimi, 2016).

Several price comparison sites have been launched in Greece, in the past few years. These sites allow the user-user to perform a customized search for products or services between a variety of electronic and physical stores to get personalized results. Through these sites, consumers can find information about the price of the goods or services they are looking for; they also have the opportunity to obtain information about the characteristics of the goods or services are searching for. This emerging technology, which allows consumers to make product comparisons, has been recognized as very important as it increasingly helps consumers to compare easier (Moukas *et al.*, 2000). The price comparison sites are aiming to reduce the searching cost, to help consumers with the decision making and to change the price perceptions (Jung *et al.*, 2014).

The present study aims to investigate, which factors may affect Internet users' intention to use a price comparison website.

2. HYPOTHESES DEVELOPMENT

The below table (Table 1) shows the hypotheses of the research, as well as the sources which lead to them.

Table 1 Regression Analysis

Hypotheses	Source
H1: The perceived ease of use of the site affects positively the user's intention to search a product via a price comparison site.	Abdeldayem, (2010); Ahn, *et al.*, (2007); Wallace & Barkhi, (2007); Chen & Teng, (2013); Wallace & Barkhi, (2007)
H2: The accuracy and up-to-date information of the searched goods, affects positively a user's intention to use a price comparison site.	Chen *et al*., (2012); Kim *et al.,* (2008); Aghekyan-Simonian *et al.,* (2012); Lee & Kozar, (2012)
H3: Finding better financial terms/deals positively affects a user's intention to use a price comparison site.	Chiu *et al.,* (2012); Thaler (1983; 1985), Grewal *et al*., (1998)
H4: The relationship between the purchase price and the value of the products/services positively affects the user's intention to use a price comparison site.	Thaler (1985), Grewal *et al*., (1998); Monroe *et al.* (1987)
H5: The better image/perception users have about a price comparison site, the more likely it is to use it.	Keller (1993); Merrilees & Miller, (2001);Wu, (2011); Martenson, (2007)
H6: The positive ratings an online user finds regarding a price comparison site, positively affects user's intention to use it.	Erkan & Evans, (2016); See-To & Ho, (2014); Cheung & Thadani, (2012); Jalilvand & Samiei, (2012)
H7: User's satisfaction by using a price comparison site affects their intention to use it again.	Devaraj *et al.* (2002); Moon, (2016); Belanche, *et al.,* (2012)
H8: The more experienced the user thinks that is an internet user, the more likely he is to use a price comparison site.	Hölscher & Strube, (2000); Román & Cuestas, (2008); Helander & Khalid, (2000); Geranis *et al.,* (2015)
H9: Familiarizing users with online shopping affects positively their intention to use a price comparison site.	Geranis *et al.*, (2015); Ling *et al.*, (2010); Chen & Barnes, (2007); Wan *et al.,* (2012), Chen *et al.,* (2014)

3. RESEARCH METHODOLOGY

The study's aimed population was all the price comparison sites' users. As the number of the population is too large to be clarified, the sample of the research consisted of 200 "Millennials," who used a price comparison site for at least once. Milesians were preferred to comprise the sample due to that the people born between 1980 and 2000 are the most technology familiar generation (Kariera.gr, 2016).

Data were collected by using an online questionnaire, which was distributed via by using both convenience sampling technique (Babbie, 2014) and snowball sampling technique (Babbie, 2014).

The questionnaire consisted of four parts. The first one consisted of questions regarding the usage and the frequency of the Internet and the online shopping. The second part consisted of 30 statements regarding the user's intention to use again a price comparison site, the perceived ease of use, the product information validity, the transaction value, the acquisition value, the website image, the e-WOM, as well as the satisfaction occurring from the website usage. The third part consisted of 8 statements measuring the respondents' level of expertise and the online shopping familiarity. The statements of the second and the third part were measured on a 5-point Likert scale. The factors being measured on the second and the third part were adopted from previous researches and adjusted, to fit the aim of the present study. The amount of the statements, as well as the study from which were adapted from, are shown in Table 2. The fourth part consisted of questions referring to the demographic characteristics.

Table 2 Amount and source of the statements

Factors		Statement Amount	Source
	Intention to use	4	Hartono, et al., 2014
Website characteristics	Perceived ease of use	3	Kim, 2012
	Information validity	3	Kim, 2012; Gao & Bai, 2014
	Perceived transaction value	4	Jung et al., 2014
	Perceived acquisition value	5	Jung et al., 2014
	Perceived website image	3	Mamoun et al., 2015
	Electronic Word of Mouth (e-WOM)	5	Cheung et al., 2009
	Satisfaction from website usage	3	Hsu et al., 2015
Users'experience	Perceived Internet usage experience	5	O'Cass & Carlson, 2012
	Online shopping familiarity	3	Hen & Barnes, 2007
	Total amount of statements	**38**	

4. RESULTS

4.1 Respondents' profile

As to gender, 41,5% of the sample were males, and 38% were females. Regarding the age, the majority of the sample (79%), were between 21 and 30 years old, single (94,5%), students (72%), and had as monthly income (55%) less than 300€. The majority of the sample uses the Internet several times per day (92%), the6% uses the Internet about once per day, the 1,5% uses the Internet 1-2 times per week, and only 0,5% uses the Internet 3-5 times per week. As to the experience on e-shopping the 48% of the sample purchased online since 1-3 years, the 31.5% since 4-6 years ago, the 12,5% less than a year ago and only 1% purchases online since ten years. Regarding the frequency of the e-purchases the 72% of the sample purchased online 1 to 3 times the past three months, before filling the questionnaire, 19,5% purchased online 4 to 6 times, 6% purchased online 7 to 9 times and 2,5% purchased online over ten times.

4.2 Factor Analysis

To test the structure validity of each factor, a confirmatory factor analysis was conducted, for each factor. According to the results all the factors were accepted, as the indicators Kaiser-Meyer-Olkin measure of sampling (KMO) were over 0,6, Bartlett's test of sphericity were at 1% significant level, the factor loadings were over 0,6, the eigenvalues were over 1. To check the reliability of the factors the Cronbach's a test was used, according to which all the factor are credible as the values of the a were greater than 0,7 or are slightly under it, in all the tested factors.

4.3 Hypotheses Check

In order to test the Hypotheses, a linear regression analysis was conducted among the independent variables Perceived ease of use, Information validity, Perceived transaction value, Perceived acquisition value, Perceived website image, e-WOM, Satisfaction from website usage, Perceived Internet usage experience, Online shopping familiarity and the dependent variable Intention to use a price comparison site. The results of the analysis showed that only perceived website image (β=0,194, t=2,469, p<0,05) and users' satisfaction occurring by the usage of the site (β=0,286, t=3,4, p<0,01)have a statistically positive impact on someone's intention to use a price comparison site. On the other hand, the factors perceived ease of use(β=0,076, t=1,018, p>0,05), information validity (β=0,026), t=0,334, p>0,05), perceived transaction value (β=0,016, t=0,205 p>0,05), perceived acquisition value (β=0,013, t=0,142, p>0,05), e-WOM (β=0,008, t=0,107, p>0,05), perceived Internet usage experience (β=0,032, t=0,417, p>0,05) and the e-shopping familiarity (β=0,032, t=0,411, p>0,05) do not have any statistically significant impact on someone's intention to use a price comparison site. Thus, only hypotheses 5 and 7 are confirmed.

5.CONCLUSIONS

This research contributes both to cover the gap that exists in the literature and to the price comparison sites, giving them valuable information about the users' intention. Results revealed that perceived website image and satisfaction occurring from the site have a positive impact on users' intention to use a price comparison site. Having a good image a site makes easier to users to recall it in their mind once they need to search for a product or service. By having a good image, a website can increase its popularity and users tend to trust and use more sites which are popular. This positive influence of the satisfaction that occurs from the usage can be attributed to the feelings of safety and security that users feel when they are satisfied with a site. Thus, users being satisfied with his previous researches, will recall in their memory the particular price comparison site when they need to search for a product or service.

On the other hand, the factors perceived ease of use, information validity, perceived transaction value, perceived acquisition value, electronic word of mouth, perceived internet usage experience, online shopping familiarity, were not found to affect the Internet users intention to use a price comparison website at a statistically significant level. These factors need to be re-evaluated to determine the exact reason for these results.

6. RESEARCH LIMITATIONS AND SUGGESTIONS FOR FURTHER RESEARCH

Despite the attempt to reduce the limitations while design it, the research is subject to certain limitations. Although both the sampling method and the size of the sample were satisfactory for the used statistical analysis and the fulfillment of the aim of the study, the results cannot be generalized from the sample to the population, as the sample consisted only of students. Another limitation of the research is that the factors that were used were adopted from researches regarding website usage and e-commerce and might do not perfectly match with the price comparison sites. Finally, the lack of researches on the price comparison sites makes difficult the comparison of the results.

Further research, is important to have a larger sample and include more factors that may affect users' intention to use apprise comparison site.

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Accounting information systems in higher education: Assessment of graduate students' level of knowledge regarding IT technology and its applications.

Karagiorgou Dimitra
PhD Candidate
Department of Applied Informatics
University of Macedonia
N. Egnatia Str.156
54006, Thessaloniki, Greece

Seretidou Dimitra
PhD Candidate
Department of Applied Informatics
University of Macedonia
N. Egnatia Str.156
54006, Thessaloniki, Greece

Stavropoulos Antonios
Associate Professor
Department of Applied Informatics
University of Macedonia
N. Egnatia Str.156
54006, Thessaloniki, Greece

Abstract

The current reality of the business world, commands that economists and especially accountants include in their daily routine contemporary and advanced information systems with which it is considered necessary that economists and accountants be familiar and well trained. In a recent large accounting education study, technology has been defined as one of the decisive factors of change affecting the modern enterprise dramatically and rendering the traditional accounting model anachronistic and obsolete. (Albrecht and Sack, 2000, pp.5 and 13).The lack of education of business schools comprises an obstacle to the normalization of new circumstances as there is no defined standard of necessary knowledge and the appropriate lessons learning technologies, are not included in the curriculum. However, this seems to be a problem plaguing the global educational community.

Awayiga, Onumah, & Tsamenyi, (2010), underline that over the last decades, accounting education has come under criticism for failing to meet the increasing demands and constant changes in the business environment. (McMahon, Gardner, Gray, & Mulhern, 1999), emphasize the need to embrace students' perspectives by planning to increase their use of computers and ensuring that all graduates are able to discover new technologies when entering the business world.

Accountants are involved in a wide-range of roles in business and it is important for them to possess IT knowledge and skills relevant to their roles to provide competent and professional services. However, the scope of IT is broad and not all IT knowledge and skills relate to an accountant's role. This raises the questions: what kind of IT knowledge and skills do accountants need? What are the entry-level IT skills and knowledge that educators should provide? (Godfrey & Tam, 2012). Educators have to cope with these issues constantly. (Cytron & Tie, 2001)

The purpose of this paper is to determine the level of IT knowledge of Financial Accounting students in Greece, identifying gaps and how these deficiencies affect the business career of graduates. The accomplishment of this purpose has been made through the method of a questionnaire which has been distributed to graduate students of educational institutions in order to evaluate their IT knowledges and skills. After processing and analyzing the data, we present the results and we are led to similar conclusions.

KEYWORDS

Information technology knowledge, accounting graduate students, accounting information systems, accounting information skills, accounting education.

1. INTRODUCTION

In recent decades, the development of information systems has had a huge impact almost all over the world. The economic environment in which professional accountants work is constantly changing and creating new requirements (P. l. Wessels, 2004). These changes also create new employers' expectations in relation to the skills and abilities of the graduate accountants. To become competitive and add value to this ever-changing

environment, professional accountants need to acquire those skills and capabilities that are relevant to market requirements. The goal of accounting science education should be that of producing professional accountants. (P. L. Wessels, 2005)

In the field of education, learning and handling computer skills in the field of Accounting Science is disputed as it has failed to fulfill the growing demands and the constant changes in the business environment (Awayiga et al., 2010). Albrecht & Sack, (2000), in their research in the United States of America concluded that trainee accountants' knowledge are inconsistent with the expectations of employers as they are obsolete and unrelated to market requirements. They note that the education system has failed to focus on developing a computer literacy class for graduate accountants in order to render them successfully competent with the profession of accountant.

The purpose of this work is to recognize those Knowledge and IT skills that are critical to professional accountants in order to be adequate in their working environment. Furthermore, the aim of this work is to present the level of knowledge in computer science of students of Economics and Accounting Schools in Greece. In order to achieve this goal, a questionnaire survey was conducted and students from two different universities were asked about their knowledge and skills in information systems. After processing and analyzing the data by the SPSS program, we present the results and we are led to similar conclusions.

2. LITERATURE REVIEW

It is necessary for a successful business to integrate IT into its basic processes. (Strong & Portz, 2015). IT skills are one of the subsets of the employability skills that are increasingly important in the higher education agenda (Stoner, 2009).

The following literature review focuses upon the development of accounting related knowledge and skills on information technology system in higher accounting education. (Senik, Broad, Mat, & Kadir, 2013). Many researchers examine whether an expectation gap exists between the knowledge or skills acquired by graduates in University curriculum and those expected and preferred by employers. (Albrecht & Sack, 2000).

Burnett, (2003) has conducted a research seeking the views of employers of accounting graduates on the technology skills that are considered crucial and important for new graduates to possess. In his study (Burnett, 2003), refers the top four technology skills for accounting graduates as 1) spreadsheet software, 2) windows, 3) word processing software and 4) World Wide Web. The technology skills that ranked form 5 to 10 were 5) information systems planning and strategy, 6) database software, 7) communications software (e.g. Outlook), 8) project management, 9) presentation software and 10) technology security and control.

Awayiga et al., (2010), conducted a research on knowledge and skills development of accounting graduates in Ghana and they culminated in remarkably similar results to those of the Burnett (2003) research. The study surveyed both graduates and employers of the graduates on their opinion on the importance of skills and knowledge for entry-level accountants. Technology skills identified in order of importance included 1) spreadsheet package, 2) database package, 3) presentation software, 4) technology management and budgeting 5) word-processing package, 6) communications software (Outlook), 7) electronic commerce, 8) World Wide Web and 9) Windows.

Additionally, Greenstein & McKee, (2004), perform a literature review through which they concluded on the identification of 36 critical information technologies. The continuance of their survey was to study 1000 accounting information systems and auditing academics and 1000 audit practitioners in America to define their self-reported IT knowledge levels and comprehensions about the best places to learn IT skills. After performing factor analysis, they found a relatively low level of knowledge of e-commerce and advanced technologies and audit automation constructs among both educators and practitioners, but found a relatively high level of knowledge of office automation and accounting firm office automation constructs. They also designated a potential "learning gap" between educators and practitioners that may occur in five of the 36 critical technologies that they examined (P. L. Wessels, 2005, p.94).

This literature review allows us to identify the gap that exists between the expectations of accounting employers (practitioners) and accounting graduates concerning IT knowledge and skills. Furthermore, we conclude that IT knowledge and skills are not obtained through formal studies alone. Hence, the objectives of the study were to determine whether or not students acquire knowledge and skills and to investigate

whether students' use of IT knowledge and concepts increased, which would be relevant on entering the business world after completing their studies (Papageorgiou, 2014).

3. RESEARCH QUESTIONS

In the present study, we examine if accountancy students feel they have relevant and up-to-date IT knowledge. In order to achieve this goal, we compare two educational institutions, namely the University of Macedonia (U1) and the Technological Educational Institute of Central Macedonia (U2) Achieving this, we examine if there are differences in the level of their knowledge in the information systems. Additionally, this study examines the hypothesis whether students and interns who have completed a traineeship have acquired more relevant and up-to-date IT knowledge than the present students and unemployed.

More specifically, the following two hypotheses are examined:

H1: Do students per institution have the same level of relevant and up-to-date IT knowledge?

H2: Do working students and those who have completed an internship, feel that that they have more relevant and up-to-date IT knowledge than the current students and unemployed?

4. METHODS

The present study benefits from the grounded theory approach which allows further investigation into the research area. This study aims to test the made hypotheses, as well as to explore the phenomena and be able to explain them through the data that were eventually gathered.

The data collection began by formulating a survey instrument which was designed in order to gather information about current Information Technologies and Accounting Information Systems (AIS). In order to achieve this effort, forty (40) IT knowledge areas were identified with a view to completing the process.

We have to mention that this study was built both on the Greenstein & McKee, (2004) and on the McKee T.E., (2000) Norwegian information technology study. Furthermore, we adopt additional technologies that were found on the Greenstein-Prosch, McKee, & Quick, (2008) information technology study and 6 additional technologies were formed on the current used Greek Accounting Information Systems.

The respondents were asked to rate the extent of their personal knowledge. In order to aim this goal a seven-point scale was used to assess their level of self-perceived knowledge. This scale varied from 1 (no knowledge) to 7 (expert knowledge) which is known as the Likert scale.

In order to obtain a more general understanding and comparison, attempts were made to gather data from various educational institutes. The majority of the schools were within the same university, in conjunction with another educational institute, the Technological Educational Institute of Central Macedonia. Finally, a total of 363 questionnaires were gathered and analyzed by the SPSS program.

5. RESULTS

5.1 Demographics

Observing the data of the present study, the total sample of respondents is 363, of which the 43.3% are male and the 56.7% are females. Their educational level is categorized by graduates and students of the University of Macedonia (U1) which consist the 83.2% and the Technological Institution of Macedonia (U2) which consist the 16.8%. The 338 persons who represent the 93.1% are undergraduate students, 3.6% are university/TEI graduates and 2.8% postgraduate graduates. A 86.8% state that they are students, 9.4% state that they are working students a 2.5% says they are doing internships and a 1.4% are unemployed.

5.2 Factor Analysis

5.2.1 Advanced Technologies

The first unit of the questionnaire includes the IT knowledge of Workflow Technology, Test Data, Cooperative Client/Server environment, Digital Communication, firewall software/hardware, User authentication System, EDI-traditional, EDI-wed based and Wireless Communication. Analyzing the number of responses through SPSS program, we conclude that the average value of all the above IT knowledge is **3.48** which means that all respondents have an average knowledge of advanced technologies which is close to the midpoint of the seven-point Likert scale.

5.2.2 Audit Automation

The second Unit of the questionnaire include the objects generalized audit software, Expert Systems, Embedded audit modules, Real-Time audit modules and simulation software. The SPSS analysis, leads us to an average of **2.43.** Therefore, it is concluded that most respondents barely know the IT knowledge of audit automation as the average is below the midpoint of 3.5 Likert scale.

5.2.3 Office Automation

This unit includes the objects of word processing, file and Folder Organization/File Management, Email, Electronic File Transfer and Storage, Internet search and retrieval, Image processing and electronic presentations. Analyzing the data, it is concluded that the average of IT knowledge is **5.45** which means that all respondents have a good knowledge of office automation and it is above the midpoint.

5.2.4 Database

This unit includes flowcharting/data modeling, Computer-aided systems engineering tools, and database design and installation. The average is calculated at **3.23** which means that the respondents have little knowledge of database skills as the level is below the midpoint.

5.2.5 Complex Systems

Complex systems include encryption software and enterprise resource planning. The average of **2.34** proves that the respondents have insufficient knowledge (very little) of complex systems as the level is below the midpoint.

5.2.6 Software

At the next unit we have the technologies of Software which include the skills of Electronic spreadsheets, SPSS program and EVIEWS program. Assuming that the above programs are basic tools for economic studies, it is logical that the particular knowledge become imperative for all students of the faculties that took part in the research. Looking the responses, we conclude that the knowledge level is below the midpoint as we have an average of **3.26.**

5.2.7 Operating Systems

This unit includes windows XP, Windows 10, Windows Vista, DOS, UNIX, and Linux. Analyzing the results, the **89.3%** said that they prefer to use Windows 10 and a **70.5%** prefer the use of Windows XP. We have to mention that a remarkable percentage of **95.9%** do not use or do not know UNIX.

5.2.8 Website Browsers

From the data analysis, a percentage of 93.4% respond that they prefer or know the use of Google Chrome while a 65.0% use or know Mozilla Firefox. On the other hand, a 99.2% respond that they do not use nor know Vivaldi.

5.2.9 Information Accounting Systems (IAS)

Analyzing the data, a **73%** respond that they have not been taught any of the simple logistic system, duplicate system, Preparation of Tax Declarations or Payroll system, while a **52.6%** respond that they have been taught simple logistic system. As far as the Portals of Public Administration are concerned, a **52.6%** responded that they have not been taught during their education to use any portal while a **98.1%** responded that they have not learned the portal SEPENET and YEKA in their workplace.

5.2.10 General Questions

A brief look at the general questions, we came up to a conclusion that the participants consider in a rate of **5.5** which is above the midpoint, that internship could help respondents to acquire more IT skills and knowledge regarding information accounting systems while a rate of **3.33** which is below the midpoint scale, believe that they do not have adequate IT skills and knowledge regarding Information accounting systems or they feel unprepared for the demands of the business environment.

5.3 Hypotheses analysis

5.3.1 Test of H1: Perceived IT knowledge level- Differences

Similarly to Greenstein-Prosch et al., (2008) we will define the Likert average of 3.5 as a benchmark. According the results, both University students (U1) and Technological Institute students (U2) declare that they possess the skills of **office automation to a satisfactory degree**, which seem to be the strongest point among all of the questions. The specific results are statistically significant as the **P-Value** is below 0.05, i.e. 0.001. Specific technology skills of office automation identified in order are:

1) Email (U1:6.25, U2:5.87), 2) Internet search and retrieval (U1:6,18, U2:5,64), 3)Electronic File Transfer and Storage (U1:5,64, U2:4,87), 4) Image processing (U1:5.37, U2:4,90), 5)word processing (U1:5,13, U2:4,69), 6)file and Folder Organization/File Management (U1:5,14, U2:4,59), 7) electronic presentations (U1:5,06, U2:4,51).

Based on the results, we could say that the weak point of the U1 and U2 students is the skills that are corresponding to the Complex Systems module. For both educational institutions the average grade is below the midpoint of 3.5 and specifically is 2.26 for U1 and 2.71 for U2. We also conclude that the specific results are statistically significant as the P-Value is below 0.05, i.e. 0.027.

5.3.2 Test of H2: Perceived IT Knowledge level comparing working students and internship with current students and unemployed

We continue with the second hypothesis of this research and we try to investigate if there is a difference at the level of IT knowledge between working students and those who complete an internship, with current students and unemployed. Analyzing the data, we observe that both groups that are mentioned above, declare that they have good knowledge of **Office automation**. In particular, the unemployed / students record an average index of **5.37** and respectively the trainees **6.00**. The standard deviation is at 1.13 and 1.04 respectively for the two categories while P-Value is 0,001 which means that the result is statistical significant as it is below 0.05.

As far as the other activities of "Audit Automation", "Databases", "Complex Systems" and "Software" are concerned, both categories of respondents state that they have little or average knowledge in the above objects, the largest weaknesses appearing at "Complex Systems". Slightly better grades present the working students and those who had an internship. With respect to the values obtained by the p-value, we observe that 4 of the 5 activities we examined, P-value is less than or equal to 0.005, which means that our sample is statistically significant and therefore, the assumption we made is correct.T activity of "Complex Systems" takes exception, where P-value is 0.293. Therefore, our case cannot be generalized in the above activity.

5.4 Internal reliability statistics - Cronbach' Alpha

The Cronbach's Alpha Internal reliability factor is calculated in the table below. Reliability is the ability of the scale-level questionnaire to produce the same results under the same conditions. A positive impact on the reliability index appears to be the expanded range of alternative Likert Scale responses used in the research with an acceptable average range of 7 ± 2 alternative responses, a range that the human mind is able to distinguish (Miller, G., 1955).

This index takes values at [0.1]. 0 is interpreted as a lack of reliability, 1 as a highly reliable scale. It depends on the number of questions on the scale. Prices above 0.7 are satisfactory, while values lower than 0.6 are considered unreliable. For very important studies, the factor should be greater than 0.9. As higher is the value of Cronbach's alpha, the greater is the credibility of internal cohesion.

In our case the Cronbach's Alpha coefficient is 0.896, i.e. very close to 0.9 which means that our sample is quite reliable and satisfactory.

Reliability Statistics

Cronbach's Alpha	N of Items
0,896	78

6. CONCLUSIONS

The present research investigates the issue of student's development of IT skills during their years of education. An appropriate learning context in the classroom and internship training were viewed as good approaches to develop IT skills.

Since there is no set standard curriculum for IT Knowledge in accounting education and a faculty, can teach whatever IT they want, we expected to see significant differences and we did.

Another consideration in interpreting the results should be that knowledge of all information technologies may not be necessary for many professionals in order to meet their responsibilities adequately. Many audit practitioners work in fields where some technologies may not be necessary or useful. Some of the information technologies may be necessary only for specific tasks.

7. FUTURE RESEARCH

This study provides a great basis for future researchers who may wish to further investigate which of these technologies are the most significant for Greek standards. Since the required IT skills seem to change over the years and across the cultures, a further research conducted through a collaboration of academics, professionals and public auditors could perhaps help to improve IT knowledge in accounting education and even predict which skills are to become the most useful out of the emerging technologies. If such collaboration does happen, not only do we locate the source of the dysfunction, but also we are able to amend a specific part of the accounting curriculum.

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Performance Evaluation of Routing Protocols for Big Data applications

Evangelos Balasas
Department of Applied Informatics, University of Macedonia Thessaloniki, Greece
mis1424@uom.edu.gr

Kostas E. Psannis
Department of Applied Informatics, University of Macedonia Thessaloniki, Greece
kpsannis@uom.gr

Manos Roumeliotis
Department of Applied Informatics, University of Macedonia Thessaloniki, Greece
manos@uom.gr

Abstract

In the last years, the rapid growth in network communications necessitates the deep knowledge of the process called routing. To be more specific, routes of information (packets) are held on the device called router, which is responsible for the optimal transmission of pieces of data (packets) from the source to the destination by using the routing protocols and routing algorithms, which cooperate for the search and the selection of the best path. There are two different types of routing process: static routing, which is done manually by the administrator of the network and dynamic routing, which is done automatically through the usage of routing protocols. Static routing protocol is used when network architecture is simple while dynamic routing protocols are used when architecture complexity increased. There are various types of dynamic routing protocols being widely used. The three categories of dynamic routing protocols are the distance-vector protocols like RIP, which uses the Bellman-Ford algorithm, the link-state routing protocols like OSPF, which uses the Dijkstra algorithm, and a hybrid type of routing protocol, like EIGRP, which uses an algorithm called Dual. In this paper, we will not only illustrate a comparative analysis of the characteristics and the metrics of dynamic routing protocols, but we will also compare the performance of different Interior Gateway routing protocols, like EIGRP, OSPF and RIP, in real-time applications Big Data, Video conferencing and VoIP, based on end to end packet delay, network convergence duration, packet delay variation and Jitter of VoIP by using Riverbed Modeller simulator. Our aim is to show how dynamic routing protocols perform in real time applications while some failures happen on different network links.

KEYWORDS

EIGRP, OSPF, RIP. QoS, Big Data

1. INTRODUCTION

Routing is called the process of sending packets from source to destination using the best path which is based on routing algorithms. Every routing algorithm uses some metrics, such as delay, bandwidth, cost and hope count in order to calculate and find the best route. After finding the best route, routing algorithms send an update to inform the routing tables in all network routers. Every router has information only about the network which is immediately connected to it. The above information is shared to neighbors only, and then it is shared throughout the whole network through routing protocols. Routing protocols determine the way of interaction among network routers and select the best routes between two nodes by distributing information. In this way, routers are informed about the whole topology of the network. There are two main categories of Interior Gateway routing protocols:

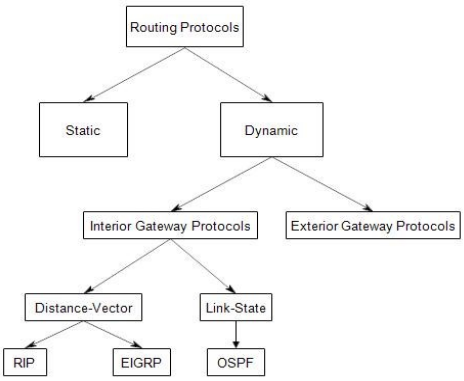
- Distance-Vector Protocols (RIP)
- Link- State Protocols (OSPF)

Moreover, there is one enhanced distance-vector protocol, called EIGRP, which defers from the other protocols of its category in the usage of algorithm (it uses Dual algorithm) and the metrics it uses to calculate and select the best path.

RIP (Routing Information Protocol) is a distance-vector routing protocol which makes use of Bellman- Ford algorithm and hop account as a metric to find the best route. It is mainly used in small networks due to the

small number of hops (only 15) it can count. It supports VLSM (Variable Length Subnet Masking) (only the RIPv2) and it has two versions, RIPv1 and RIPv2 [13].
OSPF (Open Shortest Path First) is a link-state routing protocol which uses Dijkstra algorithm and cost as a metric to find and select the best path. Also, OSPF has no limitations in hop count, so it can be used in large networks, and it supports VLSM.
EIGRP (Enhanced Interior Gateway Routing Protocol) is an enhanced distance-vector protocol which makes use of DUAL (Diffusing Update Algorithm) algorithm and composite metrics, delay and bandwidth to name but a few, to choose the best path. It supports VLSM and up to 255 hops [12].
Nowadays, the need of use of big data in networks has become a necessity and the proper selection of the right routing protocol for better transmission of big data on the network is of vital importance [9-11].

Figure 24 Types of Routing Protocols



2. RELATED WORKS

Many research has been made in the field of routing which evaluates the performance of the routing protocols in different network topologies. In the first research, the authors evaluated the performance of OSPF, RIP, IGRP and EIGRP in real- time applications, based on convergence, queuing delay, utilization and end-to-end delay with the usage of the OPNET simulator. They concluded that EIGRP performed better than the others routing protocols [1]. The authors of the second research illustrated a comparative performance analysis of three (OSPF, RIP and EIGRP) Interior Getaway Protocols in terms of HTTP page response, e-mail upload response time and network convergence, queuing delay, utilization and throughout. They ended up to the conclusion that EIGRP outperforms OSPF and RIP in their study [2]. Abdulkadhim simulated EIGRP, OSPF and RIP in OPNET simulator. He analyzed the protocols performance based on network convergence and convergence activity and he concluded that OSPF has much more convergence activity than RIP, while it has faster convergence time. Moreover, he showed that OSPF performs better than the other routing protocols while some link failure takes place on the network [3]. Ashoor analyzed the performance of link-state and distance-vector algorithms in a mesh network and presented an analysis of Dynamic routing protocols [4]. The authors of the next research presented a comparative performance analysis of OSPF and EIGRP based on Cisco Packet Tracer 6.0.1 simulator. They concluded that EIGRP performs better than OSPF in the terms of convergence time and delay [5]. Dey et al. illustrated a performance analysis and redistribution of OSPF, EIGRP and RIPv2 based on Cisco Packet Tracer simulator [6]. Another research done by Shewaye Sirika and Smita Mahajine presented in detail the characteristics of RIP.EIGRP and OSPF and simulated these routing protocols on two different simulators in order to compare their performance, OPNET and Cisco Packet Tracer. They decided that EIGRP is the best for fast convergence, RIPv2 is suitable for small networks, while OSPF is suitable for very large networks [7]. The authors of the next research presented a comparative analysis of EIGRP, OSPF and their combination for real time application on the OPNET simulator. They concluded that the combination of EIGRP and OSPF has a better performance than OSPF and EIGRP. Moreover, the research presented that the combination of EIGRP and OSPF perform better in the terms of packet loss, end-to-end delay and packet delay variation than both EIGRP and OSPF [8].

2.1 COMPARISON OF DYNAMIC ROUTING PROTOCOLS

The following table presents a comparative analysis of the features of RIP, OSPF and EIGRP routing protocols:

Table 25 Comparison of Dynamic routing protocols

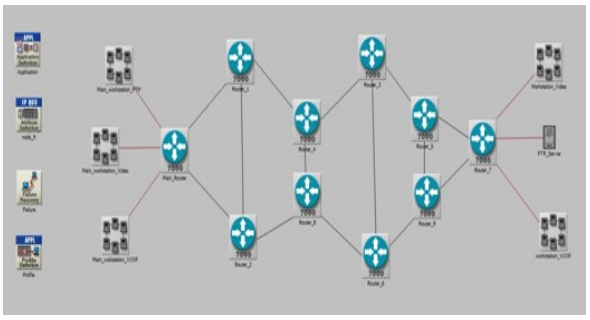
Features	Routing Protocols		
	RIPv2	**OSPF**	**EIGRP**
Interior/ Exterior ?	Interior	Interior	Interior
Type	Distance-Vector	Link-state	Hybrid
Administrative Distance	120	110	90 (internal) / 170 (external)
Hopcount limit	15	No limit	255
Convergence	Slow	Fast	Very Fast
Update timers	30 sec	Only when change occurs	Only when change occurs
Updates	Full table	Only changes	Only changes
Classful / Classless	Classless	Classless	Classless
Algorithm	Bellman-Ford	Dijkstra	DUAL
Supports VLSM	Yes	Yes	Yes
Default Metric	Hop cont	Bandwidth/ Delay	Cost

2.1.1 SIMULATION SCENARIO

In order to compare the evaluation performance of routing protocols (RIP, OSPF and EIGRP) for big data application, we create and implement one case with three scenarios in the same network topology. Moreover, the comparison is based on convergence duration, video conferencing packet end-to-end delay, jitter of voice and voice packet end-to-end delay. The network composed of the following configuration services and network devices:

- Application configuration
- Profile configuration
- Failure – Recovery configuration
- QoS Attribute configuration
- Cisco 7000 Routers
- PPP_DS3 Duplex Links
- Ethernet 1000 BaseT Duplex Links
- Application Server
- Ethernet workstations.

Figure 2 Network topology using OPNET Simulator



The Application definition object is set to support FTP Big Data, Video Conferencing (High Resolution Video) and Voice Conferencing (PCM Quality Speech).Also, the Profile definition object is set to support and define the applications (FTP, Video Conferencing and VoIP) and the Failure – Recovery object is set to define the failure and recovery time.

In order to compare to a greater extent the three routing protocols in_real time application we use one case in three scenarios configured with RIP, OSPF and EIGRP respectively. The simulation run time was set to 1200 seconds (20 minutes) and two situations were set in Failure – Recovery object to illustrate the performance of those routing protocols. In our case two links failure took place at the same time.

Table 2 Double Failure Case

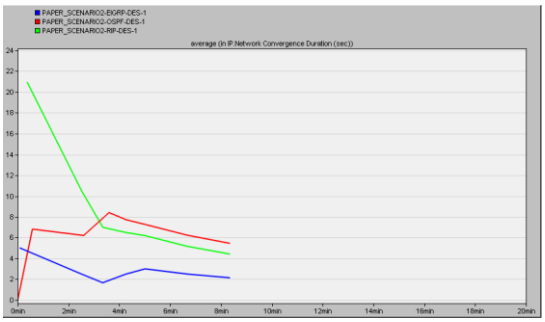
Link	Double Failure Case	
	Time (sec)	Status
Main_Router-> Router_1	150	FAIL
Main_Router-> Router_1	200	RECOVER
Main_Router-> Router_1	250	FAIL
Router_7-> Router_9	255	FAIL
Router_7-> Router_9	295	RECOVER
Main_Router-> Router_1	300	RECOVER
Main_Router-> Router_1	400	FAIL
Main_Router-> Router_1	500	RECOVER

2.1.2 RESULTS

1. **Network Convergence Duration**

The time needed for routers to have the same routing table or to be in the same state.

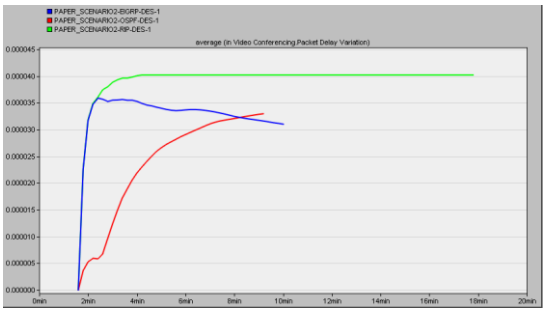
Figure 3 Network Convergence Duration



2. **Video Conferencing Packet Delay Variation**

Variance among end-to-end delay for video packets

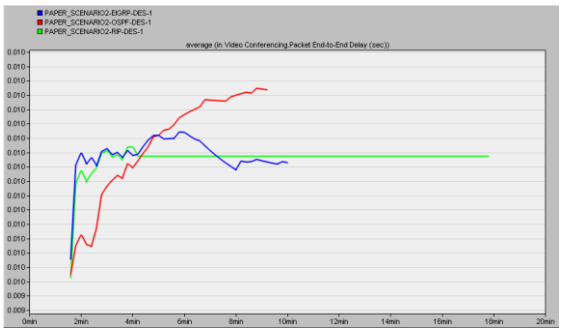
Figure 4 Video Conferencing Packet Delay Variation



3. Video Conferencing Packet end-to-end Delay

The time needed for video packet to travel from the source to the destination

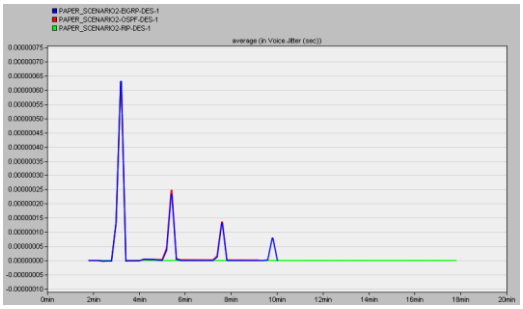
Figure 5 Video Packet end-to-end Delay



4. Jitter of VoIP

Jitter is defined as a variation in the delay of received voice packets

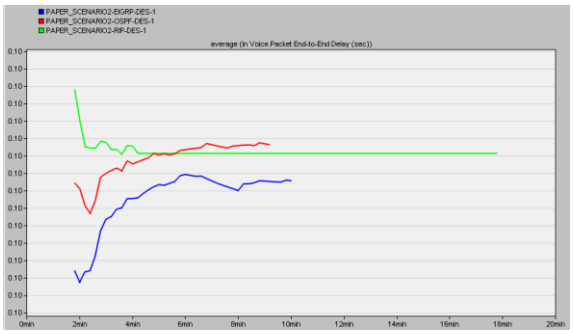
Figure 6 Jitter of VoIP



5. Voice Packet end-to-end Delay

The time needed for a voice packet to travel from the source to the destination

Figure 7 Voice Packet end-to-end Delay



3. CONCLUSION AND FUTURE WORK

The simulation case that has been carried out in this paper illustrated a comparison of evaluation performance of three Interior Getaway Protocols and the results of the simulation play a significant role in the choice of the better routing protocol for the simulated network. Firstly, EIGRP is the best protocol for fast convergence and showed the least delay for the packets of Video Conferencing and Voice to travel from the source to the destination. It performed better than the others protocols on the simulated network and presented better quality of voice. Moreover, OSPF showed the same performance with EIGRP in Jitter of Voice. Thus, it would be a suitable choice for huge networks due to its absence of limitations in hop count. On the other hand, RIP showed a good performance in convergence of the network and Jitter of Voice, so it would be a good choice for networks with small hop count. It is obvious that the routing protocols have a vital role in network communication. Nowadays, the need of use of big and different data, such as multimedia and haptic data, in networks has become a necessity. It will be significant in the future to carry out a comparative study for routing protocols with the usage of big haptic and multimedia data applications.

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Subjective well-being in Europe: a multidimensional statistical analysis of ESS data

Vasileios Ismyrlis
University of Macedonia
Greece

Odysseas Moschidis
University of Macedonia
Greece

Abstract

Subjective well-being (SWB) refers to people's own evaluations of their lives, evaluations that are both affective and cognitive where the affective part is better known as happiness and the cognitive as life satisfaction (Vitterso et al., 2005). Many studies have been conducted to discover the determinants of well-being and most of them have outlined the importance of household's income to all the dimensions of well-being. Nevertheless, the relationship of income and SWB is not so simple and many other factors can intervene. In this study, the main source of the data analyzed is ESS, a large multi-country survey that contains many questions and aspects, which have as the main scope to evaluate social characteristics of European citizens and is also considered central to the measurement of well-being. With this analysis, we attempted to discover the most important factors that influence happiness (H) and life satisfaction (LS) and whether H and LS have the same impact on other variables. For the analysis of the data a method from the multidimensional field is applied, Correspondence analysis (CA). The final results emerged from this study, seem to prove that LS and H have the similar attitude with most variables of the study. Moreover, it was deduced that income is not the most important determinant of SWB, as many other variables had demonstrated almost the same attitude.

KEYWORDS

European Social Survey, Subjective-Well Being, Correspondence Analysis, Life satisfaction, Happiness.

1. INTRODUCTION

Subjective well-being (SWB) refers to people's own evaluations of their lives, evaluations that are both affective and cognitive where the affective part is better known as happiness and the cognitive as life satisfaction. Many studies have been conducted to discover the determinants of well-being and most of them have outlined the importance of household's income to all the dimensions of well-being. Nevertheless, the relationship of income and SWB is not so simple and many other factors can intervene.

ESS is a large multi-country survey that contains many questions and aspects which have as the main scope to evaluate social characteristics of European citizens and is also considered central to the measurement of well-being. Data from this survey were analysed in order to answer the following questions:

- Which are the most important factors that influence happiness and life satisfaction?
- Is income the most important determinant of SWB?
- Life satisfaction (LS) and happiness (H) have the same impact on the other variables.
- Life satisfaction (LS) and happiness (H) have the same impact on the other variables.

For the analysis of the data a method from the multidimensional field is applied, Correspondence analysis (CA). It is a method that reduces dimensions and presents the relationships (correspondences) between variables mainly in graphical form (Moschidis, 2015). Without having a priori assumed a theoretical distribution for the data, it has the potential to present all the points to be analyzed in the same factor space (Greenacre, 2007).

The final results emerged from this study, seem to prove that LS and H have the similar attitude with most variables of the study. Moreover, it was deduced that income is not the most important determinant of SWB, as many other variables had demonstrated almost the same attitude.

2. THEORETICAL BACKGROUND

Well-being is most usefully thought of as the dynamic process that gives people a sense of how their lives are going, through the interaction between their circumstances, activities and psychological resources or 'mental capital' (Nef, 2017).

The display of quality of life and well-being in quantitative indices concerns the social sciences the whole post-war period, while such problems concerns human thought from ancient times (Veenhoven, 2010). The question of individual wellbeing, is an area which the national debate showed was important to people (Beaumont, 2011, p. 4) and which has consequently been placed at the heart of the national wellbeing framework.

The study of well-being is divided into subjective well-being and objective well-being. The objective approach of well-being (see e.g. Wolff and Zacharias 2009) evaluate the wellbeing using quantitative objective measures either one indicator like income or expenditure, or a multi-dimensional one. Whereas, the subjective approach focuses on the feeling of people on her/his life as a whole (see e.g. Diener 1984), or on some specific domains of her/his life, like health, job, leisure, financial, environmental, etc (see e.g. Cummins 1996). It must be noticed, that among economists the objective approach has been dominant for a long time, while only in the last decade the subjective approach has been enriched by interesting theoretical and empirical contributes (e.g., see Di Tella et al. 2001; Easterlin 2003; Graham and Felton 2006; Kenny 2005; Van Praag et al. 2003).

2.1 Variables that affect SWB

From many studies (the most important of which are presented below) conducted worldwide, it is evident that SWB is influenced mainly by income, health, education and work status. Of course education is related with work status, as better education provides more chances to work.

Most of the studies conducted, have outlined the importance of household's income to all the dimensions of well-being. The most controversial question (''Does having more money make you happier? and if so, how much money do you need to be just a liitle bit happier or very happy?'') in the discussion of how or if the study of happiness can help economists understand how to enhance welfare or well-being (Graham, 2011). At any point in time, rich nations are on average happier than poor nations and, in a given country, rich people are on average happier than poor people. However, over time and within a country, happiness does not increase when income increases (Easterlin, 1974), an observation that holds for developed and for several transition and developing countries (Easterlin and Angelescu, 2009; Easterlin et al., 2010). The happiness-income paradox results from the contradiction between the positive cross-sectional happiness-income relation and the nil time series relation. (Lopes et al., 2014).

There is some evidence (Diener and Biswas-Diener, 2008; Graham et al., 2004) that happier people earn more (and are healthier) than unhappy people. It was discovered that income and wealth were positively correlated with most measures of happiness (Graham, 2011). Income does pay happiness and higher income is associated with greater life satisfaction (Georgellis et al., 2009). It was also referred that the financial difficulties are the most relevant determinants of low levels of SWB (Cracolici et al. 2012).

Previous studies indicate that income is correlated with happiness and unemployment with unhappiness. Moreover, education, lowers the chances of falling into poverty (see, e.g. Ferro Luzzi et al. 2008) as it can provide more possibilities to have a job. Other results indicated that income and unemployment did not predict happiness but financial difficulties did (Gudmunsdottir, 2013).

The unemployed in nearly all countries are much less happy than those at work (see e.g. Argyle 2001; Frey and Stuzer, 2002). In a study by Huppert and Whittington (2003) which looked at positive wellbeing and psychological stress separately, unemployment was more strongly correlated with the absence of positive wellbeing than with the presence of symptoms of psychological distress.

The subjective perception for the state of health, connects in a statistical significant way with the sentiment of happiness, ''as it summarizes both the objective state and the adaptation of a person to it'' (Schimmel 2009, pp.101). We should also have in mind that connection between health and happiness is bidirectional. Individuals that feel happy and satisfied and therefore they are more confident, cope better to

health problems and live more than people who feel less happy (Schimmel 2009, pp.102; Layard 2005, pp.23; Diener and Sheligman 2004, pp.14).

3. METHODOLOGY

For the analysis of the data, a method from the multidimensional field is applied, Correspondence analysis (CA). This is a method with the use of algebric and geometric methods, reduces dimensions and presents the relationships (correspondences) between variables mainly in a graphical form. Without having a priori assumed a theoretical distribution for the data, it has the potential to present all the points to be analyzed in the same factor space and in this way makes easier the extraction of results (Moschidis, 2009). In the present analysis with the need to include more variables in the analysis, Multiple Correspondence analysis (MCA) was introduced.

3.1 ESS data

ESS is a large multi-country and academically-driven social survey that contains many questions and aspects which have as a main scope to evaluate social characteristics of European citizens and is also considered central to the measurement of well-being. It started in 2002 and the last one was realized during 2016. Published data exist until the 7th edition of 2014. Greece participated in this big survey only in the years: 2002, 2004, 2008 and 2010.

The data used in the present study is from its 7th round (ESS, 2014), where a total of twenty-one European countries are represented and the response rate of the questionnaire was 70%. 40185 persons were interviewed and the questionnaire had a total of 662 variables.

The questions concerning Life satisfaction (LS) and happiness (HP) included in ESS survey, are:

·''Taking all things together, how happy would you say you are?'' with answers on a 0 to 10 scale, where 0 corresponds to "Extremely Unhappy" and 10 to "Extremely Happy".

·''All things considered, how satisfied are you with your life as a whole nowadays?'' with answers on a 0 to 10 scale, where 0 means extremely dissatisfied and 10 means extremely satisfied.

The first is a happiness question and the second provides a more cognitive notion of well-being. The above questions were researched for their relationship with other variables (Table 1).

The main research questions(RQs) of the study are:

RQ1: Which are the most important factors that influence happiness and life satisfaction?

RQ2: Is income the most important determinant of SWB?

RQ3: Life satisfaction (LS) and happiness (H) have the same impact on the other variables.

4. RESULTS

The variables ''Satisfaction from life'' and ''Happiness'' displayed a strong interrelationship and it was decided to refer to only one of these. Satisfaction was selected randomly in order to examine its relationship with the other variables.

MCA was first applied to discover the correspondences of satisfaction and many other variables, but the most important correspondences were selected to be presented. Finally, except from satisfaction, six more variables were selected, as from the precedent analysis it was deduced that these variables affect seriously satisfaction. These variables, their coding and the specific questions asked, are presented in Table 1.

Table 1 Variables of the analysis

Variable	Code	Question

Satisfaction	Sat	How satisfied with life as a whole?
Religious	Rel	How religious are you?
Subj.health	Health	Subjective general health
Religion	Relig	Religion or denomination belonging to at present
Marital status	Marit	Legal marital status
Work	Work	Doing last 7 days: paid work
Income	Inc	Household's total net income, all sources

In order to discover the interdependence between satisfaction and the rest variables, data analysis was realized with MCA and the results are following.

Initially, it was discovered that the first axis configures a dominant tendency (Table 2) and this tendency will be presented here analytically.

Table 2 Scree plot

Axis	Inertia	%Interpr	Sum	| Scree plot
1	0,1181319	11,49	11,49	|**********
2	0,0506432	4,93	16,42	|**********
3	0,0373495	3,63	20,05	|**********

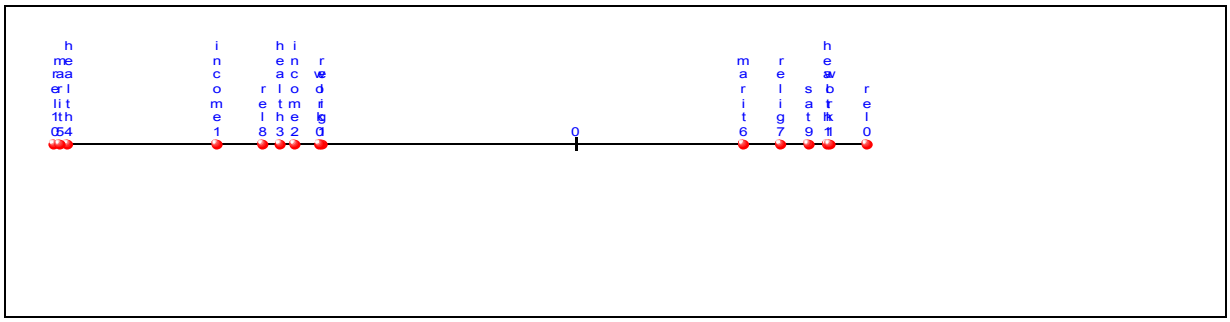
Points that distinguish with the contribution of CTR index in the 1st axis, are presented in Table 3. These points are ordered according to the coordinates (positive or negative) that they display in the axis.

Table 3 Most important points in the 1st axis

Positive coordinates			Negative coordinates		
Point	CTR	Value	Point	CTR	Value
Work1	84	Work	Marit5	117	Widow
Relig7	51	Eastern religion	Work0	85	No work
Rel0	45	Not religious	Inc1	59	1st class of income
Health1	42	Very good health	Health3	54	Fair health
Mar6	42	None	Relig1	52	Catholic
Inc9	26	9th class of income	Health4	42	Bad health
Sat9	25	Very much satisfied	Rel10	29	Very religious
			Inc2	27	2nd class of income

Figure 1 presents in a diagrammatic form, the most important points of the 1st factorial axis.

Figure 1 First factorial axis



The above results conclude that the existence of a job, the faith in eastern religions, no religiosity, very good health and the non-cohabitation or the termination of cohabitation with another person, affect seriously the satisfaction. From the other side, it was discovered that, the unemployment, the low income, the faith in the Catholic Christian dogma, bad or fair health, the widowhood and the great faith in any religion, do not affect positive the satisfaction.

This analysis provides us the potentiality to refer to correspondences between all the above variables, since MCA does not define a specific dependent variable. Therefore, it was realized that: those living alone and never separated from another person, had a very good health and they were not religious. Moreover, those who stated low income, had fair health and they were Catholics.

It is also notable that no class of the income, appear in the points with positive coordinates. This suggests that the above five variables affect more satisfaction than income does. The impact of the variable ''income'' is more evident to those with lower income, as they seemed more dissatisfied.

5. CONCLUSION

The methodology of CA provided us the opportunity to visualize in detail the examination of the relationship of the two basic variables LS and H, contrasted with other variables of the ESS survey. The final results emerged from this study, prove that LS and H have the similar attitude with most variables of the study. Moreover, it was deduced that income is not the most important determinant of SWB, as many other variables had demonstrated almost the same attitude. These variables are the marital status, the religion, the subjective health, work and the religiousness.

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Redundant constraints identification in linear programming using statistics on constraints

Eirini I. Nikolopoulou
Department of Business Administration, University of Patras
nikirene@gmail.com

Ioannis A. Nikas
Department of Business Administration, University of Patras
inikas@upatras.gr

George S. Androulakis
Department of Business Administration, University of Patras
gandroul@upatras.gr

Abstract

For very large LP problems, only a relatively small percentage of constraints are binding at the optimal solution. Many researchers have proposed algorithms for identifying the redundant constraints in LP models. Approaches like LP method, deterministic method and heuristic methods identify redundant constraints but need significant computational work and time. Some fast algorithms that were developed identify a small number of redundant constraints. In this work, the proposed method, based on some constraint statistical analysis, like the mean solution of each constraint, seems to identify a significant number of redundant constraints, in comparison with other methods in non-negative LP problems. In details, when a constraint is binding, the mean solution of the constraint is a feasible solution of the linear problem. For each constraint, a confidence interval corresponding to the mean solution is constructed and a comparative experiment between the constraints is made. A classification rule based on the lower and the upper bound of the estimated confidence interval of each constraint, as well as the cosine between the coefficients of each constraint and the coefficients of the objective function is used to determine whether the constraint is binding or redundant. Then, the constraints are ordered using probabilities from the classification rule. The proposed algorithm suggests that the constraint that has the maximum lower bound of the confidence interval among the lower bounds of the other constraints has the higher probability not to be redundant. The classification rule has a significant overall percentage of correct prediction and an almost accurate percentage of correct prediction of redundant constraints. Finally, binding constraints have greater values of the estimated confidence interval than redundant constraints. For this purpose, linear problems with coefficients that were generated independently and randomly from the uniform distribution were used and the trials were performed for different training data sizes.

KEYWORDS

Redundant constraints, optimization, classification, mean solution

1. INTRODUCTION

Linear programming (LP) is one of the most important techniques used in optimization problems in industry, commerce, and management. In this work the non-negative normal form of a LP problem is considered, as it is defined in the following:

$$\begin{aligned} &max\ \boldsymbol{c}^T\boldsymbol{x} \\ &\boldsymbol{A}\boldsymbol{x} \leq \boldsymbol{b} \\ &\boldsymbol{x} \geq \boldsymbol{0} \end{aligned} \tag{1.1}$$

where $\boldsymbol{c}^T\boldsymbol{x}$ is the objective function, $\boldsymbol{x}$ is the n-dimensional vector of decision variables, $\boldsymbol{A} = [a_{ij}]_{m\times n}$, $\boldsymbol{b} = [b_i]_m$, $\boldsymbol{c} = [c_i]_n$ are the coefficients of the LP problem, with $c_i > 0$, $a_{ij} \geq 0$ and $b_i > 0$, for $i = 1, 2, \dots, m$, and $j = 1, 2, \dots, n$.

It is well-known, that in large LP problems there is a significant number of redundant constraints and variables. For many decades the simplex method had reigned supreme as the preferred method for solving such linear programs [7-9], [15]. Briefly, the simplex method starts from a basic feasible solution, and then creates a set of basic feasible solutions that eventually converge to the best solution of the problem **(1.1)** at a finite number of iterations. Furthermore, simplex method detects areas where the problem is impossible or has a solution with a non-finite value of the objective function [7-9]. However, in large scale problems, simplex method becomes expensive, demanding too much computational time. But, since the real life LP problems, are actually large scale LP problems the development of techniques for reducing considerably the size of the problem, instead of solving the initial large one, became an inevitable need. The potential LP problem reduction, among others, will result less computational time, effort and simpler algorithms can be applied efficiently.

In this direction, many researchers [1-6], [10-12], [16-21] have proposed several algorithms to identify redundant constraints in order to reduce the dimension of the initial large scale LP problem. Brearly et al. [4] proposed a method to identify redundant constraints based on the upper and lower bounds of the variables. Telgen [20] proposed a deterministic method to identify redundant constraints using criteria as in simplex method having similar complexity with simplex. Stojković and Stanimirović method [16] identifies redundant constraints by applying the maximum and minimum principle. Paulraj et al. [18] proposed a heuristic method to identify redundant constraints. Ilya Ioslovich method [10] identifies the redundant constraints by using a constraint instead of using all the remaining constraints.

The aim of this paper is to reduce the considered LP problem's dimension by proposing a two-step procedure. In the first step of the proposed methodology some indices on the coefficients of the problems are defined and estimated, and then a statistical classification rule is applied to identify a binding constraint. In the second step of the procedure, based on the result of the first step, a heuristic methodology is developed to identify a redundant constraint.

The paper is organized as follows: In Section 2, the theoretical background is presented. The new approach is presented in Section 3 and the numerical results in Section 4. Section 5 draws with the conclusion.

2. THEORETICAL BACKGROUND

2.1 Definitions

Consider the LP problem **(1.1)**. In this problem, constraints could be binding and redundant. For the completeness of the present work, some necessary definitions are given.

Let $\boldsymbol{x}^* = (x_1^*, x_2^*, \dots, x_n^*)$ be the optimal solution of the problem **(1.1)**. Let $\overline{\boldsymbol{x}^*}$ be the mean solution of the problem **(1.1)**, where each component of $\overline{\boldsymbol{x}^*}$ is equal to $(x_1^* + x_2^* + \cdots + x_n^*)/n$. Assume equality for each constraint and let $\lambda^i = b_i / \sum_{j=1}^{n} a_{ij}$, $i = 1, 2, \dots, m$. Then the n-dimensional vector $(\lambda_1^k, \lambda_2^k, \dots, \lambda_n^k)$, constitutes a solution of the constraint k, a feasible solution and an estimated optimal solution of the considered problem **(1.1)**. The $(\lambda_1^k, \lambda_2^k, \dots, \lambda_n^k)$ is the weighted average of the solution of the constraint. However, if the ratio $a_{k(\max)}/a_{k(min)}$ approximates 1, then the $(\lambda_1^k, \lambda_2^k, \dots, \lambda_n^k)$ is approximating the mean solution of the constraint, and since the constraint holds with equality the $(\lambda_1^k, \lambda_2^k, \dots, \lambda_n^k)$ is an estimation of the mean solution of the problem **(1.1)**.

Different constraints may have different λ^is, depending on the coefficients of the problem. All the corresponding n-dimensional vectors of the constraints are feasible solutions of the considered problem **(1.1)** and are elements of the feasible area. However, these estimations may differ from the actual solution, since the vector solutions are estimations of the optimal solution of the problem **(1.1)**. The optimal solution of the LP problem, which depends on the form of the objective function, is also a solution of the binding constraints. Since λ^is have been considered as solutions of equality constraints, the question arises is how to identify

necessary constraints using λ^is, $i = 1, 2, \dots, m$. Thus, information extracted from the objective function could be used in n-dimensional vectors. As a consequence, the main idea is to compare the n-dimensional vectors $(\lambda_1^i, \lambda_2^i, \dots, \lambda_n^i)$, $i = 1, 2, \dots, m$, between all the constraints of the problem **(1.1)** and determine whether any of those λ^is are significantly different from each other. Thus, there is a comparative experiment to identify the constraints that have approximately the same λ^i.

Cosine similarity is a measure of similarity between two vectors of an inner product space that measures the cosine of the angle between them. The cosine similarity of two vectors is an arbitrary mathematical measure of how similar two vectors are on a scale of [0, 1].

Definition 1: Let $\boldsymbol{a} = (a_1, a_2, \dots, a_n)$ and $\boldsymbol{b} = (b_1, b_2, \dots, b_n)$ be two vectors, then the cosine similarity of vectors a and b is defined as:

$$\cos(a, b) = \frac{dot(a,b)}{\|a\|\|b\|},$$

where $dot(a, b) = a_1 b_1 + a_2 b_2 + \cdots + a_n b_n$ and $\|a\| = \sqrt{a_1^2 + a_2^2 + \cdots + a_n^2}$, $\|b\| = \sqrt{b_1^2 + b_2^2 + \cdots + b_n^2}$.

Definition 2: Let cos_i be the cosine similarity of $\boldsymbol{c}$ vector of the objective function and the a_{ij} coefficients of each constraint and cos_{ik} be the cosine similarity between the vectors of constraint i and constraint k, $i \neq$k, $i = 1, 2, \dots, m$, $j = 1, 2, \dots, n$.

Definition 3: Set λ^i instead of x_i in the objective function and let z_i be the corresponding computational result, for $i = 1, 2, \dots, m$.

3. THE PROPOSED STRATEGY

Consider the LP problem **(1.1)**. The proposed strategy is a two-step procedure. In the first part, the proposed approach deals with indices of binary and numeric data from the LP problem **(1.1)** to predict the status of the constraint (binding or redundant). Since the variable that should be predicted is dichotomous, logistic regression is preferred due to the low error rates [13]. This part is based on a statistical technique and therefore the identification of the redundant constraints is based on probabilities. After a binding constraint is predicted, a heuristic approach follows in the second part. Using the binding constraint and the cosine similarity of this constraint with the rest of the constraints, a ranking of calculated differences predicts a redundant constraint.

In the first stage we assume that all constraints are binding. The steps of the proposed approach are as follows:

Binding step

1. Compute λ^i, for each $i = 1, 2, \dots, m$, and the variance S^2 corresponding to λ^is.
2. Compute the cos_i for each λ^i, $i = 1, 2, \dots, m$.
3. Calculate the 95% confidence interval for each λ^i, $i = 1, 2, \dots, m$.
4. Multiply the 95% confidence interval with the corresponding z_i and the corresponding cos_i for each λ^i, $i = 1, 2, \dots, m$.
5. Find the constraint with the maximum lower bound among the lower bounds as they were calculated in Step 4. Set 1 if the constraint has the maximum lower bound or 0 otherwise.
6. Use the lower bound of the confidence interval calculated in Step 4 and the variable described in Step 5 in a classification rule to identify binding constraints.
7. Find the constraint that has the higher probability to be binding. Let the kth constraint be the one with the higher probability.

Redundant step

1. Compute the $absd_i = |cos_{ik} - cos_i|, i = 1,2,\dots,m.$
2. The constraint having the higher $absd_i$ is redundant , $i = 1,2,\dots,m.$

4.NUMERICAL RESULTS

A set of 1000 different random non negative LP small or medium scale problems in normal form was derived for the numerical experiments to identify the binding constraint using R language. The trials were performed for different training data sizes and the observations of the trial sets are independent.
The dependent variable was the status of a constraint (binding and redundant). The prediction was done to identify redundant constraints (default case). The categories of the dependent variable were mutually exclusive and exhaustive. Independent variables were the variables calculated in the Binding step of the proposed strategy.
At first, a multivariate binary logistic regression model was used to identify redundant constraints (default case). The estimated model (cut-off=0.5) fitted the data adequately and was significant at the 5% level (the Hosmer-Lemeshow goodness of fit test had a p-value=0.417). The estimated model correctly predicted the redundant constraints 94.6% of the time and the binding constraints 16.9% of the time. On the whole, the model correctly predicted the actual constraint status 75.2% of the time. The mean probability a constraint that doesn't have the maximum lower bound to be redundant was 77.393%. Also, the probability a constraint that has the maximum lower bound to be binding was up to 63.486%. Table 1 shows the p-values and the coefficients of the estimated classification model. The results corresponded to binary logistic regression with no constant in the model, since the constant was excluded from the models because it wasn't statistical significant (p-value=0.162).

Table 26 The classification model

Variables	B	S.E.	Wald	Df	Sig	Exp(B)	95% Lower C.I. for Exp(B)	95% Upper C.I. for Exp(B)
95% lower bound	0.101	0.028	12.647	1	0.000	1.107	1.047	1.17
Max lower bound	-1.353	0.042	1014.243	1	0.000	0.259	0.238	0.281

The classification rule was used in the following example.

Maximize $0.113x_1 + 0.283x_2 + 0.149x_3$

Subject to

$$0.304x_1 + 0.406x_2 + 0.89x_3 \leq 1.323$$
$$0.152x_1 + 0.589x_2 + 0.268x_3 \leq 0.569$$
$$0.417x_1 + 0.23x_2 + 0.907x_3 \leq 0.322$$
$$0.886x_1 + 0.501x_2 + 0.272x_3 \leq 0.628$$
$$0.4x_1 + 0.483x_2 + 0.492x_3 \leq 0.846$$
$$0.205x_1 + 0.501x_2 + 0.775x_3 \leq 0.969$$
$$0.857x_1 + 0.941x_2 + 0.219x_3 \leq 1.044$$
$$x_j \geq 0, \mathrm{j} = 1, 2, 3$$

From the logistic regression classification, constraint (2) has the higher probability to be binding. Table 2 deals with the calculations of the two steps of the proposed strategy. Assuming that constraint (2) is binding, then, using the Redundant step of the proposed procedure, constraint (3) is redundant. Indeed, the redundant constraints are (1), (3), (5) and (7).

Table 27 Calculations of the proposed strategy

	Constraint status	cos_i	λ^1	95% Upper bound	95% Lower bound	Max Lower bound	cos_{i2}	$absd_i$
1	Redundant	0.811	0.827	0.278	0.180	0	0.769	0.223
2	**Binding**	**0.993**	0.564	0.340	0.221	**1**	1.000	**0.007**
3	**Redundant**	0.764	0.437	0.262	0.170	0	0.692	**0.301**
4	Binding	0.790	0.378	0.271	0.176	0	0.718	0.275
5	Redundant	0.944	0.616	0.323	0.210	0	0.900	0.092
6	Binding	0.874	0.654	0.299	0.194	0	0.850	0.143
7	Redundant	0.904	0.518	0.309	0.201	0	0.866	0.127

A further statistical analysis indicated that binding constraints have greater values (mean rank=5382.68) of the 95% upper bound of the estimated confidence interval than redundant constraints (mean rank=5048.65) (U=9220425, p=0.000) and greater values (mean rank=5299.23) of the 95% lower bound of the estimated confidence interval than redundant constraints (mean rank=5076.39) (U=9434124, p=0.001).

5.CONCLUSIONS

In this paper, a two-step procedure to identify binding and redundant constraints in nonnegative LP problems in normal form was proposed. In the first step, statistical analysis reveals which constraint has higher probability to be binding and in the second step a procedure using calculations reveals which constraint is redundant. The procedure is simple and doesn't need much effort, however a complexity research needs to be done. In future, the types of the problems that fit the procedure should be investigated.

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Business Process Management Integrated with Risk Management in Construction Industry

Georgios A. Papadopoulos
National Technical University of Athens (NTUA) - School of Mechanical Engineering
gpapado@mail.ntua.gr

Sotiris P. Gayialis
National Technical University of Athens (NTUA) - School of Mechanical Engineering
sotga@mail.ntua.gr

Euripides Kechagias
National Technical University of Athens (NTUA) - School of Mechanical Engineering
mc12073@central.ntua.gr

Nadia Zamer
National Technical University of Athens (NTUA) - School of Mechanical Engineering
NZamer@ccc.net

Abstract

The main purpose of this paper is to identify and explore business process management issues in the construction industry, using business process modeling methods and tools which integrate the risk management perspective. Business Process Management is the approach of analyzing and improving business processes, in order to create a more efficient and effective organization. Business process management is achieved through business process models. These models can represent the processes from different perspectives: activities, events, decisions, resources, organizational roles, IT infrastructure. Business process management can be applied in different organizations, offering a great variety of benefits like standardization, control, analysis and improvement of business processes. In construction companies, projects commonly are exceedingly complex. Even similar construction projects may actually have vastly different risk characteristics in different regions and different processes might need to be applied. In most cases, there are inadequate amounts of information and time. Large construction projects most notably need to deal with a plethora of statutory regulations and with the presence of various interest groups. Naturally all of these factors lead to misunderstandings and create problems that can't be easily resolved. When facing such complex projects, identifying and controlling the numerous risk factors is essential. Otherwise poor performance and inconsistent results are likely to occur.

KEYWORDS

Business process management, Business process modeling, Risk management, Construction industry

1. INTRODUCTION

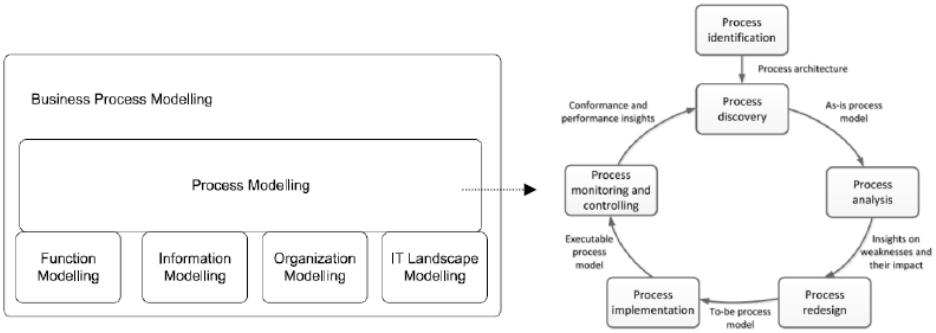
This paper presents an application of business process management in construction industry, integrating the common modeling views like function view, organizational view and information systems view with the risk management view. This perspective is essential for construction companies. The paper discusses the benefits gained for the case company while demonstrating examples of the created business process models. The work presented in this paper can clearly demonstrate the positive impact of business process management in the construction company's operations as well as the challenges faced by the industry.

The construction industry is heterogeneous and overcomplicated resulting in construction projects full of incertitude (Flanagan, Norman, & Chapman, 2006). The numerous risks that appear combined with the competitiveness surrounding the industry could potentially have disastrous consequences for the construction projects (Mills, 2001). Risks in construction projects, which can never be identical, rise from a number of the different sources (Oyegoke, 2006). Even the most experienced project managers encounter unexpected obstacles that are difficult to overcome. These risks can be identified and explored using business process modeling methods and tools – especially those integrating the risk management perspective (Sterman, 1992), (Uher & Loosemore, 2004).

Business process management an be applied in construction companies in order to formalize their operations and benefit from a more efective process control which can lead to continuous operational improvement. Process management is in no manner a fashionable new theory, nor a panacea for any company issues, nor does it invent gunpowder. It basically discovers what you do and helps you improve it, in a way that translates directly to operation. Whether you wish to adopt industry best practices for efficiency

or pursue competitive differentiation, this practice becomes a necesity (Smith & Fingar, 2003). Vertical structure of business process modelling is depicted in Figure 1, where the distinct modelling domains are presented. As shown, process modelling is at the centre of the modelling effort, because it largely integrates the modelling efforts that are conducted in the other subdomains which are all required to provide a complete picture of a process lifecycle (Pernici & Weske, 2006).

Figure 28 BPM Domains and process lifecycle
(Dumas, La Rosa, Mendling, & Reijers, 2013), (Pernici & Weske, 2006)



2. ISSUES IN CONTSTRUCTION COMPANIES

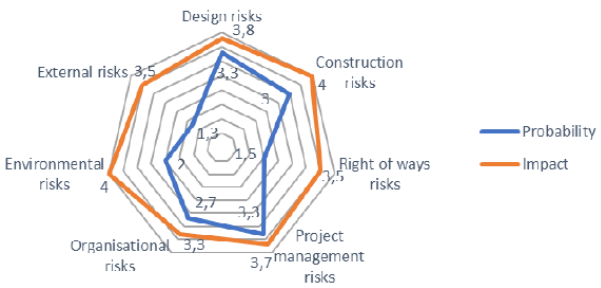
In smaller companies, the decision-making practices are person-centered and related processes are usually highly informal. In larger companies however, a small group of cross functional managers decide, and so specified procedures need to be utilized for projects under consideration. Yet, regardless of their size, all companies, have a common goal: to balance the risk associated with a project, so that they can accomplish it successfully in the foreseen time within a specific budget and requisite performance. Therefore, multiple factors including the project complexity, the client and the economic situation when making decisions (Pekuri, 2015). One of the main barriers in the construction industry is the continuous change of the project environment. This problem multiplies as the project size increases or when it involves more than one countries. Large construction projects are accompanied with planning, design and construction complexity, presence of various interest groups (owner, consultants, contractors, suppliers, etc.), resources availability (manpower, materials, equipment, and funds), environmental factors, the economic and political environment and statutory regulations, causing them to become quite unpredictable (Institution of Civil Engineers (ICE), 2014), (Cavignac, 2009).

Cost of risk is a factor most construction companies have never actually thought about despite being one of their largest expense sources. This is why business process management in construction projects needs to be integrated with risk management becoming a very important ally in the effort to achieve the project objectives within the budget and even have a satisfactory profit. Risk factors on construction projects can be split into two primary groups: Internal risks, which fall within the control of the key stakeholders (clients, consultants and contractors) and External risks, which include all of the elements that are not in the control of key stakeholders. The risks in construction projects according to their probability and impact on the objectives of the project have already been ranked based on researches **(Figure 2)**. Construction, Design and Project management risks have been recognized as the ones having the highest priority in order to be smoothed out. When clearly understanding the priority for each risk, the project team to properly understand the relative importance of each risk (Dey & Ogunlana, 2008).

Not all construction companies have identical business models. However, the logic surrounding those models tends towards internal efficiency rather than customer value creation. Consequently, business management in construction appears to concentrate on cash flow management, trying to secure a continuous stream of projects and high resource utilization. All of these factors result in construction businesses having no long-term vision or specific business purpose that would go beyond the objectives of operating and surviving (Banaitiene & Banaitis, 2011). This results in construction projects that are full of risks and uncertainties, that may face schedule delays, cost overrun and even quality errors during the execution

of the project. Poor cost performance tends to become the norm rather than the exception, and both clients and contractors suffer significant financial losses due to cost overruns (Wysocki, 2014).

Figure 2 Risks in Construction Projects
(Banaitiene & Banaitis, 2011)



3. IMPLEMENTATION AND BENEFITS OF PROCESS MANAGEMENT

The case company is one of the largest construction companies all over the world. Today the company has more than 130,000 employers, composed of more than 80 nationalities and operates in almost every country of the Middle East, Africa, Europe (including Russia), CIS countries, the Caribbean, Australia and Papua New Guinea. The construction activities of the company cover fields in: Heavy Civil Construction, Highways, roads and airports, Water and Sewage treatment plants, pumping stations and all related networks, Buildings and Civil Engineering Works, Housing and high quality buildings including hotels, hospitals, educational institutions, and airports, Roads, highways, bridges and flyovers, and airport runways, Pipelines - Slurry, Oil & Gas, and Water, Mechanical Engineering Works, Heavy and Light Industrial Plants, Marine Works, Offshore Installations Maintenance of Mechanical Installations and Underwater Structures, Pipelines for water, gas, oil and slurry, High Quality Buildings and Green Designs.

For this case study, the free BPMN tool ADONIS CE was used in order to analyze and improve the procurement processes. ADONIS was developed by BOC information Technologies Consulting GmbH in co-operation with the University of Vienna and offers essential tool support for reengineering and reorganization of projects. The key application fields of the tool are: Business Process optimization and reengineering, Quality management, Controlling (Process Costing), Personnel and Organization management, information management and risk management. ADONIS also gives us the ability to explore all major views of the company's operations such as function view, organizational view information systems view and risk management view (BOC, 2005).

The utilized tool offers to the construction company, in a comprehensive and systematic way, the ability to identify, analyze and respond to challenges not only in order to achieve the project objectives and survive in the constantly changing environment but also to expand its efficiency and increase its strengths. The benefits of the risk management are primarily identifying and analyzing risks thus improving the company and project processes and reassuring an effective use of resources. Therefore, analyzing and minimizing risks needs to be a key direction of the project management in construction projects in an attempt to deal effectively with uncertainty and unexpected events and finally achieve project success (Institution of Civil Engineers (ICE), 2014), (PMI, 2007).

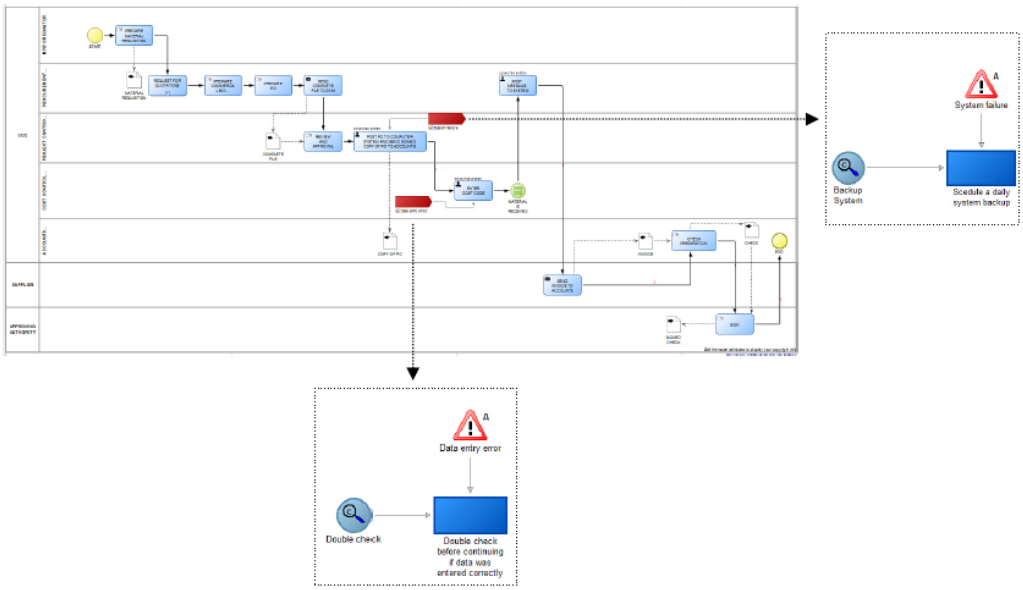
Using ADONIS, we were able to map the current business processes involved in procurement in order to analyze them and determine sources of waste. This was made possible by creating a graphical illustration of the activities, resources, IT systems, organizational structure of the company, involved stakeholders and also by splitting the more complex procedures into simpler. Subsequently we were able to specify the value of the processes and define and eliminate waste in them such as overlapping work, decision-making delays, incorrect data, and redoing work. Additionally, with the use of the risk management tools we were able to identify, categorize, evaluate and smooth many risks that where involved in the procedures. Examples of our models are presented in the Figure 3 where a business process diagram concerning site purchasing is being illustrated. Additionally, the detected risks which indicate the possible danger of the defined process objective not being achieved are being highlighted and connected with the specific process. In order to

eliminate or minimize them a general risk control method is also suggested accompanied by an applicable solution.

Business process management has multiple beneficial applications in construction companies such as the one being studied in our case. First of all, it aids the companies in order to lean towards customer value creation. The business model elements and the common formulations provide a common language among the members of an organization in order to discuss their proposals and align their efforts (Becker, Rosemann, & Uthmann, 2000). Thus, the strictly defined business models give ground for consistent management and process monitoring. Business process management can be applied in construction companies in order to formalize their operations and finally achieve the benefits of business process control and continuous improvement. Moreover, risk management aspects can be implemented in process models in order to integrate activities with risks, their controls and the mitigations actions for efficient risk management. All these factors lead to the shaping of real-world business models that manage to reveal the potential for improvement in performance and profit within the industry. After all, understanding the content and the potential of business models can lead to a revolutionary direction for the construction industry, surpassing the current industry limitations and discover new opportunities within the customer value creation idea.

Risk management in the construction project management greatly contributes in order to limit or even eliminate all the risks that may eventually become obstacles to achieve the project objectives. To achieve this goal effectively and efficiently, the responsibilities, event conditions, preferences, and risk management capabilities, all need to be clearly understood by the stakeholders that are involved in a project (Clough, Glenn, Keoki, Segner, & Rounds, 2015). Risk management helps all of the key members that participate in the project including the clients, contractors, consultants, and suppliers, to fulfil their desires and limit the cost, quality and time losses, resulting in a vast performance improvement. An effective risk management helps identifying and quantifying the risks and enables the application of controlling methods. In the end, better decision making, financial savings, greater productivity and efficiency and of course improved success rates are achieved with relative ease when a construction company manages to implement an effective risk management system (Dey, 2010).

Figure 3 Business process model including risks



4. CONCLUSIONS

This case study clearly shows that business processes and risk management are necessary for an effective and powerful construction company. Since they integrate all of the systems, data, and resources within the

construction company, they can form a protective wall against the risks to which the company is exposed. They also have a direct impact on the attractiveness and the quality of the provided services inside a really competitive market, enabling us to clarify the tasks, jobs, responsibilities and risks and shaping a strong and flexible company. Therefore, they determinate the ability of the business to adapt to the ever-changing risky circumstances, while at the same time enabling it to respond to the rapidly growing requirements. The study also makes it clear that business process management as a function doesn't just represent a simple business model, but largely integrates many factors affecting the operation of the business. In particular, aspects such as achieving the smallest possible gap between strategy and strategy implementation, the processes alignment with the business model, generally the flexibility and adoptability of the business, can be largely safeguarded through an effective business and risk management.

Although it is considered that the findings of this study are a good reflection of the issues being faced in the construction industry and the benefits of the utilizing business process modeling methods integrated with risk management tools, a more in-depth study of cases in similar or even completely different areas, is likely to provide a more comprehensive picture of how the business model tools can contribute to development and empowerment of a company.

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Proposal for an effective Decision Support System for the Pre-Selection of the Type of Concrete Highway Bridges

Nikolaos I. Tegos
Aristotle University of Thessaloniki
tegnick@yahoo.gr

Georgios N. Aretoulis
Aristotle University of Thessaloniki
garet@civil.auth.gr

Abstract

Bridges are ranked second in terms of investment volumes, but first in terms of difficulty, compared to other types of Construction projects. In the Preliminary Design Phase of a concrete highway bridge project, a question arises concerning the pre-selection of the most suitable type of bridge. The question is considered critical, since the answer is related not only to the Cost-effectiveness of the construction, but also to the satisfaction of a number of compliance criteria, such as Constructability, Safety, Serviceability, Aesthetics, Durability and Environmental harmonization. Therefore, the development of a reliable Decision Support System with respect to the selection of the type of Concrete highway bridges is an important research objective, for which only fragmentary efforts have been made worldwide so far. These efforts were concerned exclusively with the cost of bridges. In the context of this study, all contemporary construction capabilities for bridges, which correspond to the distinct types of concrete highway bridges (ranging from the simple case of one-span bridges to the 'Super Bridges) are defined. Furthermore, certain evaluation criteria governing the design of bridges are established, after thorough research. These criteria are then weighted and incorporated within the most appropriate Multicriteria analysis method. Through the application of this method, the respective optimal selection of the bridge type can be achieved, among a number of potentially suitable alternatives. Additionally, for the validation of results obtained by the method, the implementation of the proposed Decision Support System was deemed necessary in a case study of a famous bridge in Greece (e.g. Megalorema), in order to confirm or deny the correctness of the selected type of bridge, by today's standards. The study aims at covering new ground in decision making in Bridge Design.

KEYWORDS

Decision Support System, Concrete Highway Bridges, Pre-selection, Multicriteria analysis, Compliance criteria

1. INTRODUCTION

Nowadays, the classification of the bridges is better implemented through the method of their construction. The available construction methods are: 1) Cast-in-place, 2) Precast I-Girder, 3) Incremental Launching, 4) Balanced Cantilever and, 5) Advanced Shoring method. The Cable stayed and Suspension bridges are considered as special cases (super bridges); another traditional but uncommon category is Arch bridges. The selection criteria are generally related to Cost, Time and Technical Quality. The current study investigates the first 5 bridge types, which are the main ones. Their general principles, scope, particularities, advantages, disadvantages and the required material are presented at the extended "Key"-Table (Table 1).

The selection of the most suitable bridge type is influenced by the topography, traffic demands and construction methods that can be applied. In addition, the examination of seismic behavior of the structure is sometimes decisive for the structural system of the bridge in its entirety and also critical for some of its most stressed elements during an earthquake. Thus, the selection of the bridge type could not be considered a simple matter. The beginning of the design always takes place at the stage of the preliminary design, through a pre-selection. If successful, the pre-selection will also apply to the next stages of the design. Nevertheless, cases where a pre-selection of the bridge type needs to be revised at an advanced design stage are not uncommon, with severe consequences to the project, or even worse, with the retention of the wrong preliminary selection at the expense of the final result. Consequently, a successful pre-selection is crucial for the effectiveness of the final selection which is to be implemented.

The main objective of the current study is the determination of an effective Decision Support System for the Pre-selection of the Type of Concrete Highway Bridges, utilizing the tool of Multicriteria Analysis (MCA), which is a particularly widespread application of Operations Research to decision-making. The objective of this method is the systematic and mathematically standardized effort to solve decision-making problems, where many conflicting criteria are involved (such as that of bridge type selection), aiming to a rational compromise in order to make the optimal choice.

2. METHODOLOGY

The methodology followed in the study is suitable for cases of planned bridge construction projects, in which a pre-selection of the bridge type is necessary, at an early stage of design. The Alternatives provided in the context of the proposed Decision Support System consist of the five bridge types (bridge construction methods) mentioned in the Introduction. For the initial stage of the pre-selection process, the “Key”-Table (Table 1) with the features of the bridge construction methods is used, as well as the Proposed Diagram (Figure 1) with the examined Data and the Criteria, in conjunction with information about the project area. The Case study of this paper is used for a better understanding of the use of the Diagram.

The methodology is in direct relation and it exploits, in its first stage, the potential data of the project, as these are shown in the above-mentioned Diagram (on its left side). These are all those factors that characterize a bridge construction site and practically affect the manufacturing capabilities that can be applied to it. Of these data, only those which are relevant to the examined case are activated. In addition, the Diagram contains the established Compliance Criteria (on its right side), which are: Safety, Serviceability, Economy, Aesthetics, Durability and Environmental harmonization, while Constructability was considered as a super-criterion, as it is of enormous importance to the methodology. Thus, it is represented in the Diagram by the two sets of five vertical lines in its central part. With the help of the above items, a "road map" is going to emerge, indicating the potentially selectable cases of bridge types (which could be many or even only one) and simultaneously excluding the rest of them, based on Constructability.

After the definition of the potentially suitable bridge types, what comes next is the second stage of the methodology, namely the application of an appropriate Multicriteria analysis method and specifically the Analytic Hierarchy Process (AHP), which was considered to be the most compatible with the needs of the problem, as it organizes tangible and intangible factors in a systematic way. Initially, the Compliance Criteria are weighted, while the next step is the investigation of the extent to which each one of the remaining bridge types correspond to the above-mentioned criteria, and consequently the determination of relative weights (priorities) of these Alternatives. Through the application of AHP, which provides the final rank of the Alternatives, the pre-selection process of the optimal bridge type is completed, by choosing the one with the highest rating.

3. CASE STUDY

For the application of the methodology, one of the most significant bridges of the West Egnatia Motorway was selected as a Case study, and more specifically Megalorema Bridge, near the town of Metsovo in Greece. The proposed Decision Support System is applied to this real bridge project, comparing afterwards its results with the actual choice of bridge type made in the specific project.

Megalorema Bridge is a valley bridge that has a total length of approximately 500m, longitudinal inclination 5% and good foundation conditions, even in dense arrangement. It has 11 spans of 45m each, while the heights of the 10 piers vary between 11-32m. The area belongs to Seismicity Zone I and, regarding Significance, the bridge is classified as an International Highway.

According to the “Key”-Table, it appears that there are three possible construction methods that could be applied, namely Precast I-Girder, Incremental Launching and the Advanced Shoring method. Of the other two rejected methods, the case of the Cast-in-place was turned down because of the large height of the deck above the ground (more than 10m), while the Balanced Cantilever was turned down due to non-utilization of

the existing in the area possibility of developing the bridge with dense piers, thus leading to a dramatic increase in the cost of the project.

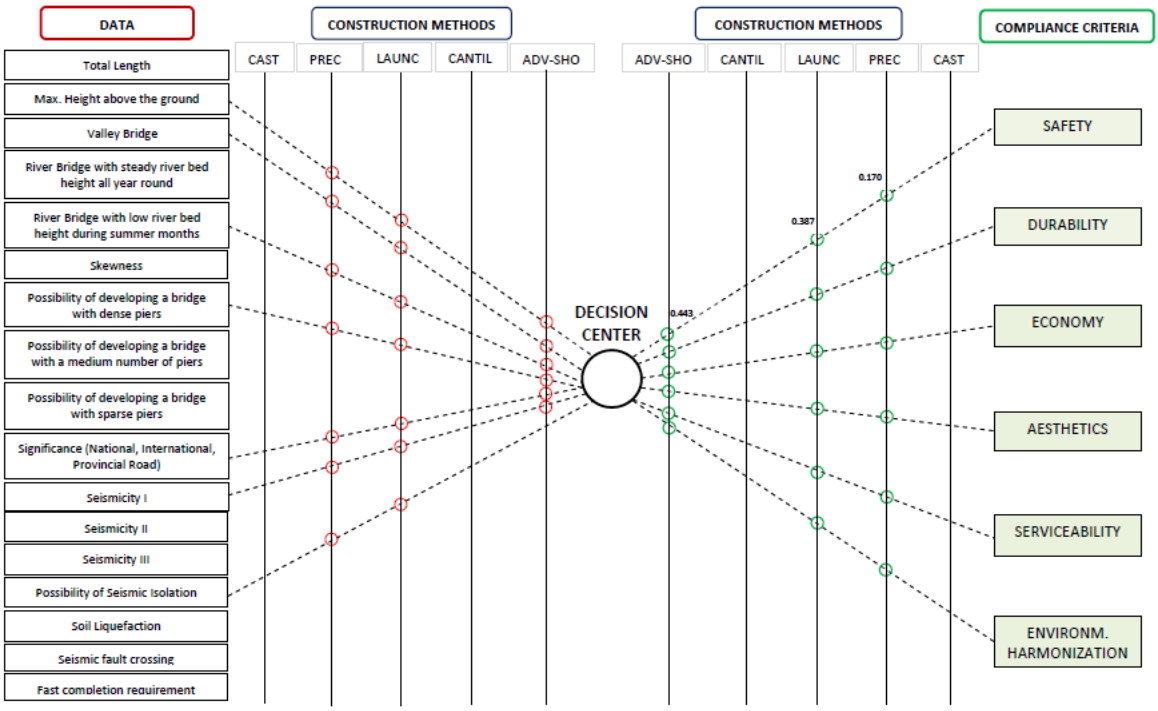
Subsequently, in the Diagram of Figure 1, six radii are drawn from the activated Data to the "Decision Center", while at the intersection points of the respective three vertical lines (Construction methods) on the Diagram's left side, small circles are marked. In addition, a seventh radius is drawn for the Seismic Isolation, which is related only to Precast I-Girder and Incremental Launching. Furthermore, the circle of the "Decision Center" is connected to the six Compliance Criteria on the Diagram's right side, and small circles are marked at the intersection points of the particular radii on the three vertical lines (Construction methods) in the right-hand section. After the application of the Multicriteria analysis method, the respective resulting priorities of the three alternative solutions are marked at each intersection point.

Table 29 "Key"-Table for the selection of construction method

CONSTRUCTION METHOD	CAST-IN-PLACE	PRECAST I-GIRDER	INCREMENTAL LAUNCHING	BALANCED CANTILEVER	ADVANCED SHORING METHOD
GENERAL PRINCIPLES	• Conventional construction method for bridges with total height less than 10m • Scaffolding is stationary on the ground	• The deck slab is cast in place on precast slabs where steel reinforcement or sheets are embedded	• The deck is constructed in segments from the one abutment to the other and is jacked forward to the final position with jacks	• Deck varying in height along the length of the bridge • Monolithic connection between deck and piers • Equipment: 2 launching bases of 5m	• Construction is achieved with span by span, pouring concrete on an erected gantry by jacking progressively a launching base
APPLICATION	• Length of spans: L = 30 - 40m • Applicable to skewed bridges	• Length of spans : L = 30 - 40m • Applicable to skewed bridges	•Cost-effective for total bridge length = 150 - 800m • Length of spans: L =40-60m • Applicable to skewed bridges	• Central span between 70 - 240m • Applicable to skewed bridges	•Length of spans: L = 30 - 60m • Similar to Incremental launching
SPECIAL FEATURES	• The deck is constructed in spans • Large variety in deck cross sections	• Alternative applications: 1. Seismic isolation 2. Seismic links and restrainers 3. Attempts to rehabilitate monolithic connection	• The required equipment is not very expensive and the method is very popular among bridge designers	• Ratio between outer and central span: 0.6-0.7 • Extensive costs for the construction of the 2 launching bases	• Monolithic connection between deck and piers is possible • Not applicable to skewed bridges
ADVANTAGES	• Monolithic connections • Increased resistance to unforeseen loads • Low-cost method •High Aesthetics	• Simple and fast construction method • The lowest cost/m² (but high maintenance cost) • Suitable for all heights	• Low construction time (4 man-hours/m³ of concrete) • Increased resistance to unforeseen loads	• Complete independence of the structure from the aerial topography • Low cost of works due to typical construction process	• Fast construction of long bridges • Construction capability of one span in 2 weeks • Suitable for large heights
DISADVANTAGES	• Applicable only for bridges with short piers • For river bridges, applicable only in summertime	• Require large number of bearings and high maintenance cost • Not allowed for bridges of high significance • Low Aesthetics	• Large steel usage • Large bearings usage • Impossible to achieve monolithic connections between piers and deck	• Large experience is required for the successful connection of the balanced pair of cantilevers	• Heavy and expensive equipment is required • The installation and demolition of the self- launching truss is time-consuming
MATERIAL USAGE	• Very low material usage comparatively to the others	• Concrete: 0.50-0.55 m³/m² • Steel: 100-110 kg/m³ • Prestress: 20-	• Concrete: 0.25 + L/110 m³/m² • Steel: 110-120 kg/m³ • Prestress: 12.5 +	• Concrete: 0.40 + 0.0035L m³/m² • Steel: 110-130 kg/m³ • Prestress: 28 +	• Concrete:0.65-0.70 m³/m² • Steel: 110-120 kg/m³ • Prestress: 35 kg/m²

		25 kg/m²	0.5 L kg/m²	0.25L kg/m²	

Figure 30 Proposed Diagram for the Decision-making



What follows is the second stage of the process, in which the AHP Multicriteria method is applied, using the three qualified construction methods as Alternatives. Firstly, the pairwise comparisons of the Criteria are taking place, by using Saaty's 1-9 numeric scale. Through the AHP algorithm, this procedure results to the determination of the relative weights (priorities) of the Criteria, as shown in Table 2. The next step is the calculation of local priorities of the three alternative bridge types with respect to each criterion (Table 3), based on pairwise comparisons among them. As far as the Economy criterion is concerned, it is worth noting that the equipment cost was not taken into account for the three examined construction methods.

Table 2 Pairwise Comparison Matrix and relative weights of Criteria

Criteria	Safety	Durability	Economy	Aesthetics	Serviceability	Environm. harmon.	Relative weights of Criteria
Safety	1	1	1	2	3	4	**0,252**
Durability	1	1	1	2	2	3	**0,226**
Economy	1	1	1	1	2	3	**0,202**
Aesthetics	1/2	½	1	1	2	3	**0,162**
Serviceability	1/3	½	½	½	1	1	**0,089**
Environm. harmon.	1/4	1/3	1/3	1/3	1	1	**0,069**

Table 3 Summary table of local priorities of the three Alternatives with respect to each criterion

Alternatives \ Criteria	Safety	Durability	Economy	Aesthetics	Serviceability	Environm. harmoniz.
Precast I-Girder	**0,170**	**0,164**	**0,490**	**0,143**	**0,4**	**0,164**
Incremental Launching	**0,387**	**0,297**	**0,312**	**0,286**	**0,4**	**0,297**
Adv. Shoring method	**0,443**	**0,539**	**0,198**	**0,571**	**0,2**	**0,539**

Eventually, the method provides the determination of the overall priorities (final ratings) of the three Alternatives, by utilizing the data in the two tables above. According to them, the final ranking is: **1) Adv. Shoring method: 42.1%, 2) Incremental Launching: 33%, 3) Precast I-Girder: 24.9%.**

As a result from the applied Decision Support System, the Advanced Shoring method was indicated as the most suitable among the three alternative bridge types. However, the bridge construction method that was applied in practice in 2003 was Incremental Launching, which however was not proved as cost-effective because of the high longitudinal inclination. It is also noted that when the issue of the selected construction method had come up, the solution of Precast I-Girder was supported by experienced bridge designers.

4. CONCLUSIONS

Concerning the innovation of the present study, this lies in the fact that the relatively few similar efforts made so far disregard, on the one hand, the part of pre-selection of the most appropriate bridge type through rational criteria, and on the other hand they are concerned with only a few of the bridge types. On the contrary, this study includes all the possible structural types within a rational Decision Support System, which combines the exclusion of some alternatives and the evaluation of the rest of them, which are potentially selectable.

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The Concept of Entropy in the Management of Construction Projects: A decision-making model of risk uncertainty

Yiannis Tarnanidis
Aristotle University of Thessaloniki
johntarnanidis@gmail.com

Efstratios Moschidis
University of Macedonia, Thessaloniki
smos@uom.edu.gr

Theodore Tarnanidis
University of Macedonia, Thessaloniki
tarnanidis@uom.edu.gr

Abstract

This article presents the calculating algorithm of entropy budgets that attempts to examine the significance of unanticipated cost and time of construction projects. A careful examination of the related literature to the specific domain, pointed to the need to analyze entropy from the distinct perspective of project management. The main problem seems to be that there is a major gap in the understanding of how entropy can be used more effectively in the construction industry, in order to foresee non deterministic situations that influence the budgeting process. More explicitly, the computational algorithm holds upon the budgetary data of the construction problem, and it gives as an output the calculation of the complementary cost and complementary working-hours. The results were estimated by the method of Monte Carlo. More explicitly, the selected methodology helped us to define and to ascertain the exact dimensions of the complementary, cost and the number of the working-hours. And as whole, it was estimated that the method of Monte Carlo cannot exceed 15%. However the probability of the computational algorithm was found to produce stable statistical inferences, i.e. 70% in the case of high-risk projects and 99% in the case of a low-risk. The innovation of this work is that we manage to develop an algorithm that successfully uses the concept of entropy in the decision-making phase, by producing a coherent analysis that improves the whole construction planning utilization.

KEYWORDS

Project management, risk assessment, entropy

1. INTRODUCTION

With the ultimate goal of deepening their scientific scope, many researchers have tried attaching their fields with other, in order to benefit from the cooperation of such processes. In this perspective, for greater profit one should associate disarray-entropy with the contemporary productive systems, operating in complex, dynamic and uncertain environments. The basic principle of thermodynamics fits in a lot of no energy regions. As a consequence, the principle of energy conversation and the principle of non maintaining entropy have been found useful tools for the analysis of various other systems that are submitted in these processes. The two above principles connected with the first and second law of thermodynamics provide the base for the quantitative and qualitative evaluation and the comparison of different systems. Some of the most distinct tasks are those that deal with the field of thermo-economics (Sciubba 2001; Rosen 2002; Rosen and Dincer 2003).

The proposed outcomes of risk analysis is the concept of entropy to be placed as base of multiple criteria decision support system. The main idea of approaching this, occurs in the utilization of synergistic result from the interaction of different significances of risk. Under the conditions, somebody can disagree with the approach of multiple criteria. There is no united objective in many programs. Generally, the goals can be achieved with a lot of different ways. The perception of risk depends immediately on the desired objective. Hence, it could be argued that it does not exist a simple estimation, even for simple activities. Various approaches are possible: production (profit, quality, schedule, etc.), application (controllability, safety etc.), possible long term results etc. However, a wide range of risk types exists: internal and exterior, controllable and uncontrollable, accentual and continuous, influenced by the profit, the quality, the duration etc.

Nevertheless, few have applied classic thermodynamics to configure productive systems. Such a parallelism proposes that the improvements in the production systems should be according to the application of the first and the second law of thermodynamics, in order to decrease the entropy of the systems (or the disarray of the systems).

As far as the production systems are concerned, it could be stated that they resemble too much with thermodynamics systems and consequently they can be described by the laws of physics. This resemblance has prompted several researchers of administrative sciences and operational researchers, to apply these laws to the analyzing or planning of such systems. Several scientists have used the data theory in order to measure the disarray in a system using the function of Shannon's (1948) entropy (Karp and Ronen, 1992; Ronen and Karp, 1994). Others have applied the classic thermodynamic approach. For example, Whewell (1997) applied the thermodynamic laws to logistics (in supply chains), while Salamon and Nitzan (1981) presented the conception of the implication from the optimization of thermodynamics in the economic system. Grubbström and Hultman (1989) presented the economic model for the exported energy and the heat storage. Using a thermodynamic approach and treating exported thermal energy as an economic commodity, its results appear to be distinctive from those obtained using traditional theoretical models. Chen (1999) presented a comprehensive qualitative study drawing the parallels between a socioeconomic system and a thermodynamic system, inventing the appropriate administrative-oriented reports of the first and second law of thermodynamics.

It should be noted that any reversal of the growth trend of entropy at a point, implies the growth of the surrounding area because whenever something happens, an amount of energy is wasted, which is useless for any future use. This "useless" energy is accumulated, increasing with incalculable consequences for society.This is the conclusion of Angrist and Hepler "any local reduction in entropy, which is derived from either human or machine, is accompanied by a greater increase in entropy of the environment, thereby maintaining the increasing tendency of total entropy". For such a complex issue with a variety of unexpected situations, for instance the cost and the time budget of a construction project, it is proposed to create a computational algorithm that will fulfill a number of conditions in order to be considered successful and applicable.

A method that is often followed is the continuous monitoring of the construction progress and the program review, based on individual variation. In addition, the need for revisions often is required due to the experience gained from monitoring work over a prolonged period of time, which makes it almost always necessary to reprise the initial estimated time for various activities. This revision implies similar interventions (changes) in the network diagram of the program. From the above it is clear that the factors affecting the cost and progress of a project are too many. In order to reduce the uncertainty the concept of entropy is used, which aims to predict the unexpected that will affect the project. Entropy is used as a unified factor in all unspecified states. So, a computational algorithm is proposed, which uses the entropy cost as an additional cost of all unforeseen situations.

2. INQUIRING OBJECTIVES

As mentioned above, the problem of the individual researcher and, by extension, of the construction company concerned, is to determine the manufacturing cost and the total number of man-hours of the project. The more accurate the budget, the greater the company's profit and the more credible the company is in the market. Taking a look at everyday life, we notice that in all major projects we always have great differences in both cost and time. The reasons for these arbitrary variations are many and often unpredictable. For example, the reason that delayed the completion of the Egnatia Road in Greece is that the initial mapping was changed due to the intervention by an ecological organization named "Arcturos", which put forward arguments to interfere with the existing ecosystem.

Small projects also show deviations from the budgeted price. To remove these discrepancies, the scholar adds an additional cost and an additional time to the already budgeted. Therefore, the aim of this paper is to reduce and to estimate this uncertainty. Beyond the factors that affect a project and can be predicted and budgeted, there are many others which can influence it significantly without being predictable. For instance, a great labor strike. To remove all these indeterminate factors, the concept of entropy is used. Utilizing entropy, as an indicator of the uncertainty of a system, an effort is made to reduce the uncertainty of the

parameters that affect the project. The ultimate goal of this effort is to be able to budget the cost and the total of the required man-hour for a project more precisely.

3. FACTORS ENTERING THE STUDY OF COST AND TIME

The result of a project has been always unique; it has a defined beginning and an end.When studying a project, the factors that affect its evolution are numerous. Some of these factors can be estimated with a reasonable process and others can be calculated. These factors can greatly influence the deviation of the budgeted cost and time from their true values. A project is a time-limited effort to create a unique product or a unique service. Different people and social groups are involved in the implementation of a project, with often different attitudes towards the project, but they are the prerequisite for the work to be accomplished. The most important factors of the project are:

• those who decide to carry out the project
• the financiers of the project
• the contractors of the project
• the manufacturer to whom the product that produces the work belongs.

In most cases, the involvement of these factors is vague. The needs, the requirements, the expectations and capabilitiues of all these factors determine to a large extent the future of the project. What these factors represent, and the ways in which they collaborate with each other, often characterizes the projects. Thus, according to Dimitriadis (2004) the main factors that mark the work, both as an attempt, and as an output is:

• the economic factor
• the time factor
• the quality factor
• the work factor
• the social factor
• the institutional and legal factor
• the globalization and multicultural factor

4. CALCULATION ALGORITHM OF COST AND TOTAL WORKLOAD OF THE PROJECT USING THE CONCEPT OF ENTROPY S.

Each project is a financial mechanism that consumes money but also produces money. The factors of the project contribute capital, labor, materials, knowledge and skills with a main goal to earn money. Therefore, taking a project, small or large, every selection, from the beginning to the end of the project, conceals within it a basic pursuit: how to spend less money and get more. Wrong choices (which are, of course, considered to be incorrect afterwards), can lead the project, either to financial loss or to financial ruin or also can create social unrest in the wider environment.

The special feature of economic regard of work is that it sometimes begins before the project starts, basically considers its course and continues, from time to time, for a long period after the completion of the project. In any case, anyone who believes that he can secure the successful outcome of the project, he is deluding himself, as the chaotic combination of unforeseen technical, legal, environmental, political, etc. conjunctions can be brought up and down, beyond any estimation and prediction. However, a systematic and methodical approach to reality, the existence of alternatives, the wide ambit within which forecasts are made, greatly limit the risk of the project. The selection and evaluation of a project to be implemented presents two perspectives:

• if it is worthwhile the contractor to undertake (or attempt to undertake) the implementation of a proposed project.
• which project is in the best interest of the contractor to implement, among the various proposed projects.

4.1 Admissions of calculating algorithm

The admissions for the computational algorithm listed below are as follows:
• The whole study is based on the quality of the produced product.
• Entropy is an approximate method and, in the mathematical sense, it is not a proper process. Consequently, the computational process is an approximate method, but it is also a good qualitative approach that allows the presentation and quantification of uncertainty as a resource that examines it in a simple intuitive way.
• Time is measured in working hours. The outputs of the algorithm are the total number of man-hours and the total cost. It does not give the completion time of the project.
• The shortest time value shown in the probability chart is the minimum number of hours of activity closure.
• The lowest cost figure shown in the probability chart is the minimum completion cost of the activity.

4.2 Calculating algorithm

The computational process described below is composed of ten steps. Each step is important and is capable of influencing the whole algorithm. So starting out we have:
1) The project divided into W_j activities, which are independent of each other. The registration of activities and the assessment of activities as independent should be done by the experts. However, it is usually not possible to separate the activities as completely autonomous (CPM). With this separation of the processes, the scholar is up to have a more complete view of the factors that affect each activity.
2) For each W_j activity, as mentioned above, there are many factors that can affect it. Depending on the activity, there are also the relevant factors that affect it. These are, generally, the available time for the estimations, the available information, the techniques that can be used, the knowledge and experience of the people involved, the overall view of the work, the technical, technological, quality, etc. specifications of the project, the underestimation of the amount of required work, the repetition of work or additional work due to planning errors, the repetition of work due to manufacturing errors, poor quality of materials etc, the loss of work due to strikes, equipment damages, delays in the delivery of materials, etc., delays due to workplace adversities, reduced work performance and equipment, assessment of the level of risk and uncertainty of the project, etc.
3) For the construction probability charts, it should be as clear as possible the set of adverse events and the estimated cost of the extra cost and time that each one brings about unforeseen or unlikely scenario.
4) For each W_j activity, the probability chart of the total number of man-hours and costs are constructed. Each chart shows the most likely value, which will be the max. Note that for the scheduling of the project the manufacturer takes as real values the ones with the greatest possibility. For the convenience of the operations normalization of probabilities takes place, so that the sum of the frequencies is equal to the unit $\Sigma f_i = 1$.
5) Then calculate the entropy S_j of the cost and the total number of man-hours for each W_j activity. Its calculation is according to the formula:

$$SD_j = -\Sigma p_i.\ln p_i$$

Where p_i is the probability given by the formula: $p_i = \frac{f_i}{\sum f_i}$

but because of the assumption $\Sigma f_i = 1$, we get $p_i = f_i$.

Then, the total entropy of the whole project is calculated as the sum of the individual entropies, which is an indication of the certainty with which the project is being studied.

$$S = \Sigma S_j$$

6) Afterwards, for each W_j activity, the additional number of man-hours and the extra cost are calculated (in parallelism with Sergey D Bushuyev and Sergey V Sochnev, where they use entropy cost as the cost ratio for entropy)

Additional Hours of Work $T_{j(+)}$ $$T_{j(+)} = \frac{\sqrt{\frac{\sum f_i (T_i - \overline{T}_i)^2}{\sum f_i}}}{S_{Tj}} \qquad \text{where } \overline{T}_i = \frac{1}{\sum f_i} \sum (f_i \times T_i)$$

$$C_{j(+)} = \frac{\sqrt{\frac{\sum f_i (C_i - \overline{C}_i)^2}{\sum f_i}}}{S_{Cj}}$$

Additional cost $C_{j(+)}$ where $\bar{C}_i = \frac{1}{\sum f_i} \sum (f_i \times C_i)$

Here it is emphasized that the numerator of the above fractior $\sigma = \sqrt{\frac{\sum f_i (C_i - \bar{C}_i)^2}{\sum f_i}}$

7) Suggested number of working hours $T_{j(suggested)} = T_{j(max)} + T_{j(+)}$ where $T_{j(max)}$ is the most likely value.
8) Suggested cost of activity $C_{j(suggested)} = C_{j(max)} + C_{j(+)}$ where $C_{j(max)}$ is the most likely value.
9) Suggested set of project working hours $T_{(suggested)}$

$$T_{(suggested)} = \Sigma\, T_{j(suggested)}$$

The proposed total working hours of the project are derived from the sum of the proposed total working hours of the individual activities. With the given total number of man-hours of the project and the independence of the individual activities, the designer indicates the critical path in order to provide the proposed completion date of the project.
10) Recommended project cost $C_{(suggested)}$

The proposed cost of the project is derived from the sum of the proposed cost elements of the individual activities.

5. CONCLUSIONS

This computational algorithm achieves an approximation of the cost and the total number of working hours of the project. It is clear that once again the subjective factor enters, since many estimates made by the scholar may have a large deviation from the estimates of some others. However, the computational algorithm, due to the importance of the concept of entropy, is able to produce satisfactory results. Its comparison with the Monte Carlo method gives deviations max 15%. The probability that the calculated computational algorithm values to be true is more than 70% for studies with high uncertainty while for those with low uncertainty, the probability reaches 99%.
The entropy, as shown by this research, is a widely used concept. Starting from its appearance in thermodynamics, it finds application in a number of scientific fields. Its effectiveness and utility is indisputable where it has been implemented.
In this work, the concept of entropy was incorporated into the programming of the projects. It entered to the cost and time budget as a measure of uncertainty. The ultimate goal, which was achieved, was to increase the certainty with which the project is being studied.
The computational algorithm is easy to understand, easy to use and practical to calculate the unpredicted cost and time that come into each budget. It is relatively simple to implement. Its computing application can be done with very simple accounting programs such as Microsoft Excel or SPSS. It is applicable to all projects. It can produce results from the simplest to the more complex, from a simple construction to the construction of a major national road axis. It can be used both as a prediction tool and a control tool as well.
This combination of thermodynamic concepts such as the entropy and the project economics gives another prospect to study objects which were previously thought to belong exclusively to one research field. The problem is examined from different angles with very significant results.
Based on the above, the computational algorithm can be considered as a useful tool for the individual scholar. By using it, it is possible to budget the cost and the total number of man-hours of a project with a great precision. It gives the advantage of calculating unpredictable factors that affect the project but cannot be budgeted. These unpredictable situations can be budgeted by using the concept of entropy. The computational algorithm gives answers to all sorts of projects, from the smallest and simplest to the larger and more complex.

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Scheduling and Risk Analysis in Large Construction Projects using Learning Curves Approach

Argyri Seira
DUTH, Greece
Vas. Sofias 12, 67100, Xanthi

Stefanos Katsavounis
DUTH, Greece
Vas. Sofias 12, 67100, Xanthi

Abstract

Methodical organize and efficient planning is inevitable for organizations that invest in more than one concurrent project, in order to become reliable and efficient. The contemporary construction industry uses special software packages for activities' harmonic correlation mapping and the effective project planning.
This paper schedules data from two large scale case studies using Primavera P6 Professional v15.2 for planning and scheduling while Monte Carlo method is used from Primavera Risk Analysis for schedule's risk and "what-if" scenarios simulation. These tools provide a variety of methods, taking into account distribution's pattern and learning curve's progress. We study the effectiveness of several distribution patterns, learning curve shapes, Skewness and kurtosis in order to monitor a project's plan baseline schedule and the ongoing progress.
Risk Analysis uses "Risk register" and "Weather modeling" based on activities' nature. Both projects that are studied include a variety of typical and non-typical activities, leading to different conclusions after the repeatedly fuzzy analysis of Monte Carlo in distribution patterns. Finally, based on the literature, we evaluate the distribution fitting in activities, using Skewness – kurtosis plane.
The results demonstrate the necessity of using sophisticated software in real-time large construction projects as well as the importance of distributions pattern, learning curves and weather modeling.

KEYWORDS

Learning Curves, Distributions, Project Management, Risk Analysis, Stochastic Modeling, Primavera

1. INTRODUCTION

Statistical methods are used in projects' duration probability estimations. In this paper, due to its innumerous value, Monte Carlo simulation is used, by investigating the effect of beta, triangle and uniform distributions. Primavera P6 is used to re-set up projects' schedule according the baseline drafts prepared by the company while Primavera Risk Analysis simulates different risk-based scenarios regarding distributions. The learning curve approach comparatively evaluates when, why and how a distribution or several distributions fit at the finish time estimation for a group of activities or a type of projects supporting also workers progress, project and risk evaluation.
According curves' skewness, kurtosis and max hits for a possible value, the distribution effect on activities and projects have been considered for their verification upon a statistical template. Two different case study projects are considered using two different risk approaches: weather modeling and risk register in which, based upon bibliography research, risks been adapted on the activities. Finally we present the appropriate type of distributions for each project and activities group, demonstrating why risk mitigation and learning methods are important to project's time minimization.

2. DISTRIBUTION PATTERNS, LEARNING CURVES

A project's schedule is built by regarding data of previous and similar projects or by statistical approach. In this paper the statistical approach is used for time estimation, including important factors being able to produce an accurate risk analysis. The widely used PERT method is inaccurate for wide range large projects. Monte Carlo simulation, being used in Primavera Risk Analysis and for the purpose of this study produces fuzzy rates depending on distribution patterns and the max hits of simulation iterations. Rather than PERT, has the advantage of putting risk percentage into activities according risk criticalness and run analysis under these circumstances.
Learning curves are not only able to shown workers' performance but according to distribution pattern, iteration hits, skewness and kurtosis can reveal differences between varieties. Also, through S curves can help a planner to choose the appropriate pattern and risk mitigation for an activity or group of activities, to produce safely and in a desirable short time, a project completion.

2.1 Learning Curve Theory

Workers' performance through activities' iterations, IT or mechanic support in conjunction with manual labor, activity's critical rate and difficulty as well as worker's experience can be estimated with mathematical approaches and formulas. Such a mathematical analysis tries to verify these factors and meet the survey's aim. Regarding the latter we not only obtained results through Primavera Risk Analysis but through learning curve's formula

$$y = ax^{b} \tag{2.1}$$

where y the total completion time of an activity, a the time referring to the first time that the activity completed, x number of iterations that the activity will or has completed and b the parameter that shows curve's slope regarding worker's performance rate of an activity, in range $[-1,1]$ (same group activities have same b) or S-curve's skewness. Another formula which represents worker's time rate for an activity that happens for the first time or has been forgotten is

$$y_n = K\prod_{i=1}^{x} c_i n_i^{b_i} \tag{2.2}$$

where n the iterations number, x total number of activity's iterations, K worker's performance on activity's first time completion, and c the coefficient of the independent variable i. The latter formula is quite interesting for activities that are repeated once in a while or their degree of difficulty is high, providing a planner with realistic results about worker's performance, and a regular project's control. We both consider what happen if mitigate difficult activities with training factor through Risk Analysis and on the other hand using these formulas. The results will be shown in the following.

2.2 Template $\Theta_1 - \Theta_2$ and Distribution Patterns

Primavera Risk Analysis simulation produced the results at distribution analyzer, while S curves shown the cumulative results of each simulation. Different distribution patterns provided different skewness and kurtosis rates. The template $\Theta_1 - \Theta_2$ (AbouRizk and Halpin, 1992) estimates and evaluates the pattern that provides the desirable fit for each activity/project.

$$\Theta_1 = \frac{\beta_1}{\beta_1 + 1}, \ \Theta_2 = \frac{1}{\beta_2} \tag{2.3}$$

where $\Theta_1, \Theta_2 \in [0,1]$, β_1 is the Skewness and β_2 curve's kurtosis.

Monte Carlo simulates the project completion time by including risk to activities and according to distribution patterns that are enabled upon activities/whole project to run risk analysis. Beta, triangle and normal distribution have been considered, for their diversity and to consider different results depending on activities or project nature.

Beta distribution, as Gamma's offspring has the advantage to give varieties between $[0,1]$ while allows displaying values on both skewing sides (pessimistic or optimistic area) or even symmetrical. Parameters a,b of Beta distribution have great impact on skewness and kurtosis. Giving different a,b values in Monte Carlo simulation, distribution skewness and kurtosis take different shapes. Depending on skewness value, the curve has a great skew for the values between $[-1,+1]$, middle skew $[-1,-1/2]$ or $[+1,+1/2]$ and the curve may be symmetric when the values are between $[-1/2,+1/2]$. Regarding the latter, a critical statistic principle, allowed us to scrutinize differences among the same activity, depending on the risk and simulation's distribution. The following section presents survey's case studies as well as simulation results based on these characteristics.

3. CASE STUDIES

Two different large scale projects in the Northern Halkidiki are tested, the tailings deposition area construction, and the enrichment's plant remanufacturing of new and present industrial equipment in a mining industry company. Table 1 shows the variety of each project depending on the activities:

Table 1 Project Categorization

	Project 1	Project 2
Considering activities	77	137 (16%)
Activities in total	77	841
Categories (total)	5	8
Completion Time (original)	73 weeks	94 weeks
Completion Time (actual)	47 weeks	62 weeks
Baseline finish	15/2/2016	10/3/2017
End of Baseline schedule (updated)	13/5/2017	23/4/2017

At first, projects have been inserted in Primavera P6 Professional R15.2 (Oracle®) with updated baselines, following the principles of activities' correlation given from the company. Primavera Risk Analysis took the latest update to simulate "what-if" scenarios, depending on the risks that have been registered in the activities. Costs and resources haven't been considered due to their non-critical role in the survey's purpose.

Outdoor projects in conjunction with indoor ones are prone to weather conditions. Risk analysis weather simulation by the "Weather Modeling" tool, including former precipitation data from the last three years in a statistical/ percentage way inserted into Primavera Risk Analysis, changed the completion of project 1 in a critical way.

While "Risk Register" tool is used for risk installation through the activities, "Templated Quick Risk" tool is used to insert different distribution patterns in simulation. The graph in Figure 1 shows the different S-curve

patterns produced by Monte Carlo simulation while risks has been considered into the projects and different distributions run each time the simulation.

Each colour represents different distribution pattern for the two projects. For both projects grey curve represents, beta distribution, blue curve the uniform distribution and pink one the simulation under the template of triangle distribution. Vertical bars represent the different values developed through simulation.

Figure 31 Distribution Analyzer patterns of case projects after Risk Analysis simulation using three different distributions

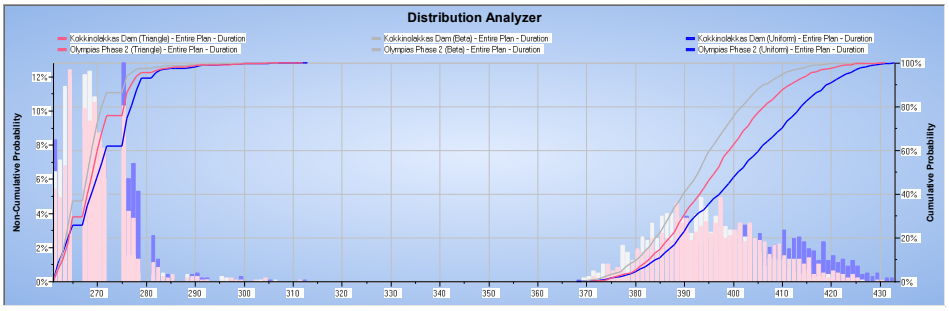


Table 2 Values outline of Risk Analysis for both projects regarding Figure 1

	Determ. Value	Determ. Prob.	Min	Max	Mean	Selected: 50%	Skewness	Kurtosis	Max Hits
Project 1 Triangle	305	<1%	371	430	396	396	0,241	2,625	49
Project 2 Triangle	262	10%	261	311	269	269	1,636	8,642	124
Project 1 Beta	305	<1%	369	426	393	393	0,205	2,730	49
Project 2 Beta	262	14%	261	306	268	268	1,921	10,64	123
Project 1 Uniform	305	<1%	368	432	401	401	0,045	2,215	38
Project 2 Uniform	262	13%	261	312	271	270	0,957	5,450	128

Project 2 (factory's reconstruction) has an intricate curve pattern, sharp acceleration progress and bigger skewness, as its non-typical and repeated activities have different risk patterns that affect the result. Although values in project 2 are affected, time values in project 1 are affected in a wider range. Another observed critical issue, is the fact that project 1 is characterized from less complexity and diversity amongst its group activities, as earthmoving and technical activities follow Gamma distribution, exports a smoother cumulative result.

In a micro perspective, we evaluate different activities using three distributions for each simulation time, based on their completion time (critical, maximum and minimum duration activities) in Project 2. The graph below shows that skewness and kurtosis values are quite different in each simulation while time values are different too.

Figure 2 Project 2 critical activities' patterns simulating using 3 different distribution patterns

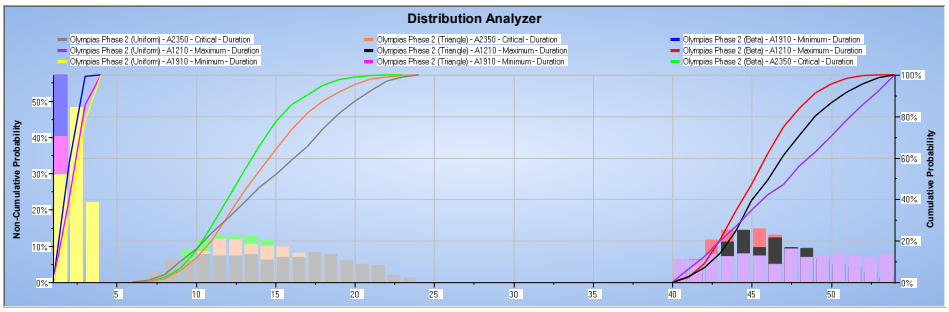


Table 1 Values outlining Figure 2

	Determ. Value	Determ. Prob.	Min	Max	Mean	Selected: 50%	Skewness	Kurtosis	Max Hits
Uniform - A2350 Critical	9	16%	6	23	14	15	0,051	1,980	82
Uniform - A1210 Max	44	35%	40	53	47	47	-0,032	1,803	91
Uniform - A1910 Min	1	30%	1	3	2	2	0,114	1,959	483
Triangle - A2350 Critical	9	12%	6	23	13	14	0,335	2,599	118
Triangle - A1210 Max	44	40%	40	53	46	46	0,283	2,400	144
Triangle - A1910 Min	1	40%	1	3	2	2	0,390	2,104	454
Beta - A1910 Min	1	57%	1	3	1	2	0,437	1,619	572
Beta - A1210 Max	44	47%	40	53	45	45	0,332	2,587	147
Beta - A2350 Critical	9	16%	6	22	12	13	0,372	2,811	131

We placed yellow (triangle), green (uniform) and red (beta) dots upon the prototype temple, according to AbouRizk and Halpin (1994), using the values of the entire projects:

Figure 3 Adapting Projects' values to template $\Theta_1 - \Theta_2$

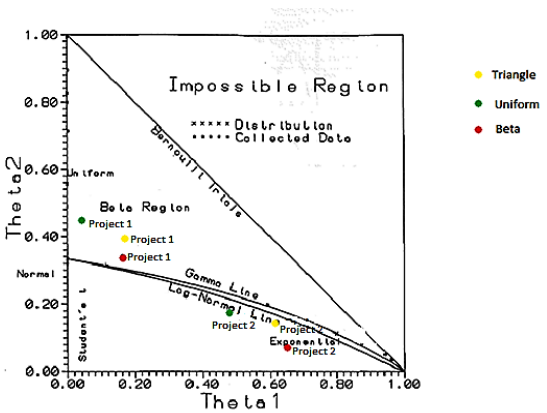
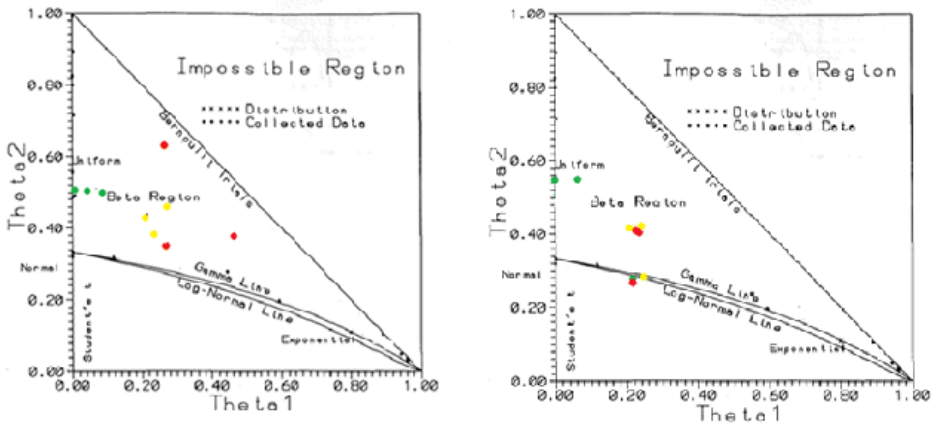


Table 3. $\Theta_1 - \Theta_2$ values from Project 1&2 regarding simulation's distribution

	Θ_1	Θ_2
Project 1 Uniform	0,043	0,451
Project 2 Uniform	0,489	0,183
Project 1 Beta	0,170	0,366
Project 2 Beta	0,657	0,093
Project 1 Triangle	0,194	0,380
Project 2 Triangle	0,620	0,115

Different kinds of projects need different distribution patterns planning completion time. $\Theta_1 - \Theta_2$ values in project 2 are under log-normal line, denoting that there are not enough data to simulate an accurate plan. Under the log-normal line region estimations are non-stable and inaccurate. In contrast projects in total, distributions are accurate enough when the evaluation and detailed planning occur in activities. Activities from both projects with critical, maximum and minimum durations appear different values for each pattern.

Figure 4 Activities' adaption for Project 2 and Project 1 respectively regarding simulation's distribution



Distributions affect activities, making accurate and stable estimations, as the whole values are including in the beta region and in the limit of gamma or log – normal line.

Table 4 Activities' values for templates adapting regarding distribution and Θ

Project 2	Θ_1			Θ_2		
	Uniform	Beta	Triangle	Uniform	Beta	Triangle
A2350	0,048	0,271	0,250	0,505	0,355	0,384
A1210	0,031	0,249	0,220	0,554	0,386	0,416
A1910	0,102	0,304	0,280	0,510	0,617	0,475

Project 1	Θ_1			Θ_2		
	Uniform	Beta	Triangle	Uniform	Beta	Triangle
A1600	0,226	0,226	0,260	0,328	0,328	0,328
A1260	0,069	0,256	0,260	0,554	0,406	0,412
A1410	0,000	0,225	0,223	0,554	0,412	0,422

3.1 Learning Curve Approach

Project 1 activities demonstrated a difficulty in their completion due to their quite rare nature, having such a great range of stretch and scope of use. We chose the three most difficult, according to project manager suggestion, to investigate the phenomenon of learning curve approach in accordance with risk mitigation tool of Primavera Risk Analysis.

Figure 5 Cumulative distribution analyzer of Project 1 activities pre and post mitigation simulation

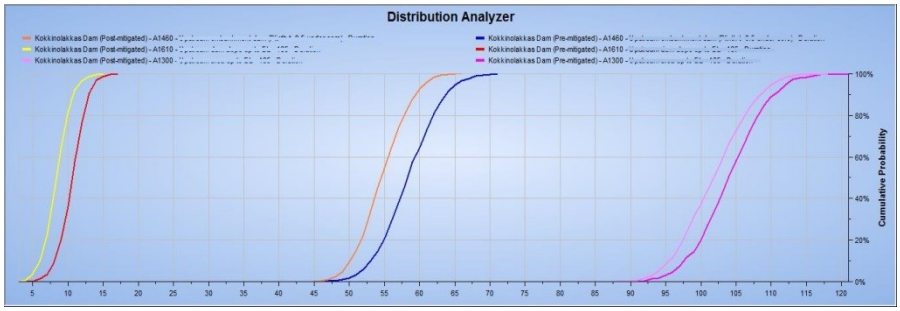


Table 5 Activities' values outlining Figure 5 curves

	Det. Value	Det. Prob.	Min	Max	Mean	Sel. 50%	Skewness	Kurtosis	Max Hits
Post A1460	73	100%	45	65	54	55	0,112	2,635	118
Post A1610	15	100%	3	14	8	8	0,139	3,133	226
Post A1300	143	100%	88	117	101	102	0,097	2,587	76
Pre A1460	73	100%	45	70	58	58	0,059	2,857	103
Pre A1610	15	100%	4	16	10	11	-0,077	3,141	216
Pre A1300	143	100%	90	120	104	104	0,095	2,945	80

The diagram above shows activities' S - curves patterns before and after risk mitigation. For simulation purposes we insert 72% for activity critical difficulty (count as risk) which descended to 20% after mitigation regarding the educational factor. The final completion time was reduced by 4 days. Adapting the outcome values to formula (2.1), with $a = 10$, $x = 10$ (for 10 days of repeat), $b = -0.077$ (A1610).

$$y = 10 * 10^{-0.077} = 8.375 \qquad 3.1$$

Simulation result: $y = 8$ days

In conclusion, the same activity for a next time will be planned from 8.375 days considering that the workers have an experience of 10 days from former projects. Furthermore, activities' skewness will be a straight line as well as kurtosis too.

Based on literature, this type of activities has a learning percentage of 85%, in a day $0.85 * 8 = 6.8$, means that a worker will spent 6.8 hours for activity's completion the second time (ideal). Since there are 3 shifts per day there are a total of $6.8 * 3 = 20.4$ hours for an activity's completion.

Activities urge for risk planning as alongside with a 10 days experience, an educational preparation from either supervisors or managers a worker may reduce the completion time of an activity and the planner, saving 4 work days.

4. CONCLUSIONS

Distribution patterns and learning curves have the ability to affect and determine significant parameters of project management process. Skewness, kurtosis and workers' experience, along with an efficient risk analysis, play a substantial role in project completion time and in addition, under template adaption, evaluate the decisions that lead to accurate and stable estimations.

In this paper, we studied this effect in two large scale construction projects using special purpose software, investigating how these parameters affect and change the final outlines.

The results demonstrate that distributions' shape parameters, risk analysis and learning curve theory can help a project manager during the planning phase and in the verification of risk mitigation, considering worker's progress and time consuming.

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A Combined Use of GIS, PROMETHEE and Monte Carlo Simulation Methods for Major Transportation Infrastructure Impacts Evaluation

Vavatsikos[1], A.P. Smaragdas[2], A.V. Giannopoulou[3], M.
[1]Lecturer, e-mail: avavatsi@pme.duth.gr
[2]Production and Management Engineer, e-mail: thsmaragdas@hotmail.com
Democritus University of Thrace, Production and Management Engineering Dpt.
[3]Associate Professor, mgian@civil.duth.gr
Democritus University of Thrace, Civil Engineering Dpt.

Abstract

Renowned for their ability to deal with spatial problems, commercial GIS software packages can play crucial role in spatial decision making processes, given that they are provided with sophisticated tools that allow both private and public organizations to manage and analyze spatial referenced data. However, especially during the last two decades, there is a strong consensus regarding their limited capacity as Decision Support System since they do not facilitate procedures that allow the consideration of Decision Makers' (DMs) preferences in either structured or semi-structured decision problems for selecting and/or ranking alternative scenarios with respect to the satisfaction of conflicting objectives.

In order to expand GIS abilities to the consideration of decision criteria, OR/MS researchers strongly pronounce in favor of developing synergies between GIS and multicriteria decision making tools. The rationale of this integration is the GIS ability to store and manage and visualize geographically referenced data and the efficiency of Operational Research tools for modeling decision problems. As a result MultiCriteria Spatial Decision Support Systems (MC-SDSS) provide a consistent framework that allows alternatives ranking combining both spatial data and DMs preferences according to a selected decision rule

Regarding to their applicability in situations that involve classification multiattribute decision models are considered as a very attractive procedures in urban and regional planning regarding the appraisal of transportation infrastructures realization. Egnatia motorway consists one of the most significant innervations that have been realized in Greece during the early pre-Olympic Games period and up to the year 2007. With a length of 67km crosses 12 regions that lays between the Igoumenitsa port at the northern west and the Kipoi customs at the northern east respectively part of Greece. As a motorway it has been designed as a dual carriageway with two traffic lanes per direction resulting to an overall construction cost of about 6b€. Aiming to enrich Northern Greece potential in transport industry and tourism European Union has heavily invested in its construction.

In the present an integration among GIS functionalities and multi-attribute decision making models such as PROMETHEE method is discussed in detail. The framework proposed aims to estimate the impacts provoked by the realization of Egnatia motorway in regional level. For that the 12 regions are evaluated with the use of socioeconomic, environmental and transportation indices. Moreover, the analysis facilitates sensitivity analysis performance through Monte Carlo simulation implementation. The proposed framework consists a valuable tool that allows public investments evaluation in regional level and in the same time inter-regional inequalities estimations. Finally, the characteristics of a toolkit under development are presented.

KEYWORDS

Regional Planning, Multicriteria Evaluation, GIS, PROMETHEE, Monte Carlo Simulation

1. INTRODUCTION

Despite the indisputable contribution of GIS to decision making, their application as SDSS has several limitations. In short, the supported procedures are incapable of a) building DM preferences into the analysis; b) evaluating alternatives given the fact that each one satisfying the analysis constraints is considered an acceptable solution; c) including evaluation criteria with respect to the analysis goal; and d) providing frameworks that satisfy the spatial distribution of the decision analysis (Laaribi et al., 1996; Chakhar & Martel,

2003). Recent advances in computer science have allowed for the development of combinations of GIS technology and multiple criteria decision analysis (MCDA) methods to reduce previous disadvantages. To enhance the capability of GIS as a decision-aiding tool, Multi-Criteria Spatial Decision Support Systems (MC-SDSS) are tools that allow for ranking alternatives by combining spatial data and DM preferences according to a selected decision rule (Malczewski, 1999). Based on McHarg's (1992) seminal work and land use planning models proposed by Voogd (1983), spatial multi-criteria decision analysis provides the framework for alternative site evaluation according to DM preferences (Laaribi et al., 1996). The development of MC-SDSS aims to rank the alternatives according to DM preferences in conjunction with study area characteristics. The synergy of MCDA models with GIS is a powerful tool for handling structured or semi-structured site selection decision problems that allows for suitability index estimation of alternatives. This usefulness is mainly due to their ability to identify and rank potential sites considering several decision criteria, maximizing the analysis efficiency. MC-SDSS facilitate estimation of suitability indexes for every candidate location and increase the accuracy of the result, thereby simplifying the siting procedure.

2. PROMETHEE II

PROMETHEE methods (Brans & Vincke, 1985) are well-established procedures capable of treating MCDA problems that are formulated through a decision matrix. Along with ELECTRE, they are considered the major representatives of the family of outranking relations methods. They provide the framework to combine information between the criteria using criterion weights and information within each criterion using the amplitude of the deviations between every pair of alternatives for the analysis criteria considered (Eq. 1) (Brans & Mareschal, 2005). The methods' preference structure is based on pairwise comparisons. To handle the scaling effect that arises from the nature of MCDA problems, PROMETHEE methods utilize the performance of six types of generalized criteria P_j, aiming to estimate the preference P_j of one alternative over the other under the consideration of criterion j (Eq. 2).

$$d_j(x_i,x_k) = g_j(x_i) - g_j(x_k) \tag{1}$$

$$P_j = F_j\left(d_j(x_i,x_k)\right) \tag{2}$$

$$\pi(x_i,x_k) = \sum_{j=1}^{n} w_j P_j(x_i,x_k) \tag{3}$$

$$\Phi^+(x_i) = \frac{1}{m-1}\sum_{k=1}^{m} \pi(x_i,x_k) \tag{4}$$

$$\Phi^-(x_i) = \frac{1}{m-1}\sum_{k=1}^{m} \pi(x_k,x_i) \tag{5}$$

$$\Phi^{net}(x_i) = \Phi^+(x_i) - \Phi^-(x_i) \tag{6}$$

$$aPb \;\; if \;\; \Phi^{net}(a) > \Phi^{net}(b) \tag{7}$$

$$aIb \;\; if \;\; \Phi^{net}(a) = \Phi^{net}(b) \tag{8}$$

Generalized criteria functions are customized to meet decision makers' needs through the definition of thresholds q, p and s. The indifference threshold q consists of the larger deviation that is considered negligible by the decision maker. The strict preference threshold p is the smallest deviation that generates a full preference of one alternative over the other. The threshold s consists of an intermediate status between q and p (Brans & Mareschal, 2005). The degree of preference of the ith over the kth alternative for the analysis criteria n is obtained from the estimation of a preference index $\pi(x_i, x_k)$ using Equation 3, where w_j is the relative weight of the jth criterion. PROMETHEE II provides a complete ranking of alternatives based on positive and negative outranking flows (Eqs. 4 and 5) through the estimation of the net outranking flow (Eq.

6) (Brans et al., 1986). Accordingly, the preference structure among two alternatives is established using Equations 7 and 8.

Figure 32 Alternative scores for each criterion – attribute table fields

Table

Decision_Matrix

FID	Shape *	NOMOS	SET01	SET02	SET04	SET05	SET07	SET09	SET12	SET13	SET16	SET18	SET20	SET21	ENV03	ENV06	ENV07	ENV09	T
0	Polygon	THESPROTIAS	0,822492	3,41	1,8	0,020611	9,1	0,26	38,57	6,54	0,2961	618	64,3	2,08	4,9	8,18	0,079626	1	0
1	Polygon	TRIKALON	0,164071	3,44	3,3	0,022623	88,8	0,33	12,83	6,9	0	0	47,2	2,1	1,1	5,32	0	9	
2	Polygon	GREVENON	0,813592	2,74	4,1	0,013835	0	0	13,78	6,67	0,4491	179	52,3	2,03	0	18,03	0,401722	14	
3	Polygon	IOANNINON	0,785185	4,29	2,5	0,009451	18	2,27	54,45	6,61	0	0	50,4	2,39	4,7	10,04	0	48	1
4	Polygon	KOZANIS	0,795865	3,78	3	0,029609	4,8	0,59	42,78	6,34	0,22735	103,5	50,4	2,18	12,9	2,52	0,332176	17	0
5	Polygon	HMATHIAS	0,725129	0,25	2,6	0,017108	34,4	0,72	84,87	5,96	0,4842	326	44,6	0,95	9,1	5,25	0,180458	6	
6	Polygon	THESSALONIKIS	0,223485	3,32	2,1	0,000394	3,8	1,34	96,48	3,36	0,241525	74,25	48,8	0	30,4	4,41	0,099356	35	
7	Polygon	KAVALAS	1	3,38	2,2	0,006577	3,3	0,42	71,89	5,97	0,1608	279	16,6	2,07	8,8	9,08	0,096553	15	
8	Polygon	RODOPIS	0,851537	2,34	2	0,01108	7	0,57	53,63	6,03	0,2425	240	22,8	2,05	12,7	6,13	0,220522	11	
9	Polygon	SERRON	0,051974	1,44	2,6	0,011945	71,4	0,06	22,22	5,69	0	0	54,1	1,25	1,4	0,55	0	6	
10	Polygon	XANTHIS	0,859189	2,84	1,5	0,000079	4,4	1,1	81,72	4,71	0,3968	445,5	0	1,93	20,1	5	0,465096	55	
11	Polygon	EVROY	0,49312	1,56	2,4	0,005209	1,3	0,54	59,78	5,73	0,3698	392	17,6	2,02	3,7	2,83	0,261529	8	

1 (0 out of 12 Selected)

Decision_Matrix

3. SOFTWARE DEVELOPMENT

The paper at hand presents the basic features of a software package developed using Python programming language to assist PROMETHEE method implementation in GIS environment. Python 2.7.2 is installed along with ArcGIS 10.1 installation. Two modules have been developed up to now aiming to read spatial data from both ArcGIS created shapefiles and MS Excel data sheets that facilitate decision matrix data (i.e alternative locations performances to the analysis criteria). The first module supports alternatives rankings via PROMETHEE II Net flow estimation while the second supports multiple rounds solutions estimations to assist sensitivity analysis. The alternative locations performances are represented as values in fields inside the attribute table as shown in Fig. 1. For the time being a MS Excel file has been formed to facilitate Decision Makers preferences needed to perform PROMETHEE II algorithm. These are criterion number (used as a defining name for each criterion) criterion weights, criteria types (ascent/descent), preference function type (Usual, U-shape, V-shape, Level, Linear, Gaussian), and indifference (q), strict preference (p) and Gaussian (s) preference thresholds (Jose Figueira, Salvatore Greco, Matthias Ehrgott, 2005) (Fig.2)

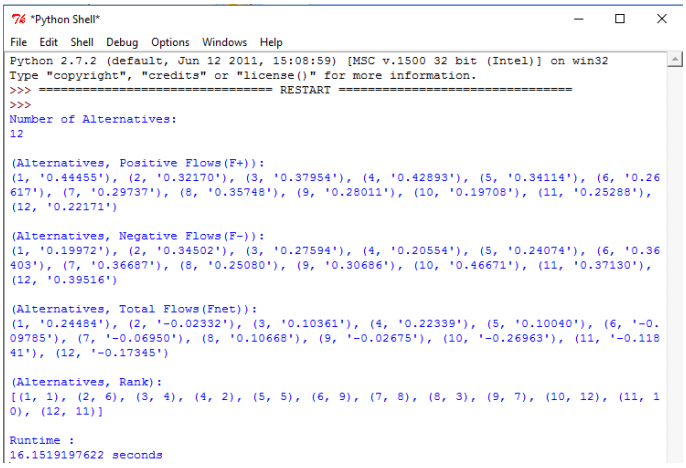
Figure 2 Excel file

	A	B	C	D	E	F	G	H	I	J	K
1	Criterion Number	1	2	3	4	5	6	7	8	9	10
2	Weights	0,0837	0,0691	0,0554	0,0461	0,0491	0,033	0,033	0,023	0,0341	0,0216
3	Criterion Type	Ascent	Ascent	Ascent	Ascent	Descent	Ascent	Ascent	Ascent	Ascent	Ascent
4	Function Type	Type I	Type II	Type II	Type IV	Type VI	Type I	Type II	Type VI	Type III	Type IV
5	Indifference Threshold: q	0	0,5	0,3	0,001	0	0	30	0	0	100
6	Strict Preference Threshold: p	0	0	0	0,002	0	0	0	0	0,08	200
7	Gaussian Preference Threshhold: s	0	0	0	0	22,4	0	0	6,41	0	0

Both modules have been developed based on mathematical operations between lists. Lists are the main data structure used in Python and are very similar to matrices of C and C++ programming languages. After the import of the two files, a timing begins so that the runtime of the code will be printed in the end. The code reads the two imported files and saves their data into two basic lists, the one that contains alternative scores and the second one that contains the rest of information needed for PROMETHEE II. As soon as the basic information is stored the module starts to create the matrices needed step by step, beginning from Divergence Matrices and going on to Preference Indicators' Matrices, Weighted Preference Indicators'

Matrices, Summed Weighted Preference Indicators' Matrices, Positive, Negative and Total Flows matrices. Technically this is achieved with the use of “for-loops” and “while-loops” along with “if else” statements. The module has many nested loops and in some points it can be considered complicated but without needing too much memory or runtime. In each step the matrices are saved in lists. The subLists are being used to temporarily save data having the same name so no extra memory space is captured. In some points the code uses functions so that it can save time and do operations that will be performed faster and will create more distinct results. Libraries like math, xlrd, tkFileDialog and Arcpy along with others are necessary for mathematical operations, managing excel files and creating graphical user interfaces which in the paper is determined as a file browser.

Figure 3 Code Printing



```
*Python Shell*
File  Edit  Shell  Debug  Options  Windows  Help
Python 2.7.2 (default, Jun 12 2011, 15:08:59) [MSC v.1500 32 bit (Intel)] on win32
Type "copyright", "credits" or "license()" for more information.
>>> ================================ RESTART ================================
>>>
Number of Alternatives:
12

(Alternatives, Positive Flows(F+)):
(1, '0.44455'), (2, '0.32170'), (3, '0.37954'), (4, '0.42893'), (5, '0.34114'), (6, '0.26
617'), (7, '0.29737'), (8, '0.35748'), (9, '0.28011'), (10, '0.19708'), (11, '0.25288'),
(12, '0.22171')

(Alternatives, Negative Flows(F-)):
(1, '0.19972'), (2, '0.34502'), (3, '0.27594'), (4, '0.20554'), (5, '0.24074'), (6, '0.36
403'), (7, '0.36687'), (8, '0.25080'), (9, '0.30686'), (10, '0.46671'), (11, '0.37130'),
(12, '0.39516')

(Alternatives, Total Flows(Fnet)):
(1, '0.24484'), (2, '-0.02332'), (3, '0.10361'), (4, '0.22339'), (5, '0.10040'), (6, '-0.
09785'), (7, '-0.06950'), (8, '0.10668'), (9, '-0.02675'), (10, '-0.26963'), (11, '-0.118
41'), (12, '-0.17345')

(Alternatives, Rank):
[(1, 1), (2, 6), (3, 4), (4, 2), (5, 5), (6, 9), (7, 8), (8, 3), (9, 7), (10, 12), (11, 1
0), (12, 11)]

Runtime :
16.1519197622 seconds
```

“Arcpy” is the library that connects ArcGIS and Python 2.7.2 environment. The use of map and sum functions are an example of functions that are being used to perform operations without the need of creating new ones. In some point arrays are being created too so “numpy as np” library is imported in the beginning of the code. The code finally prints out the Positive, Negative, Total Flows and the final ranking of the alternatives along with the runtime described in seconds as shown in Fig. 3. Additionally it allows the user to close the tk window created and adds the fields that are printed inside the attribute table as shown in Fig. 4. Finally when alternatives obtain the same total flow are ranked together and they are printed out so that the user will define them and there are not any misunderstandings in their rankings.

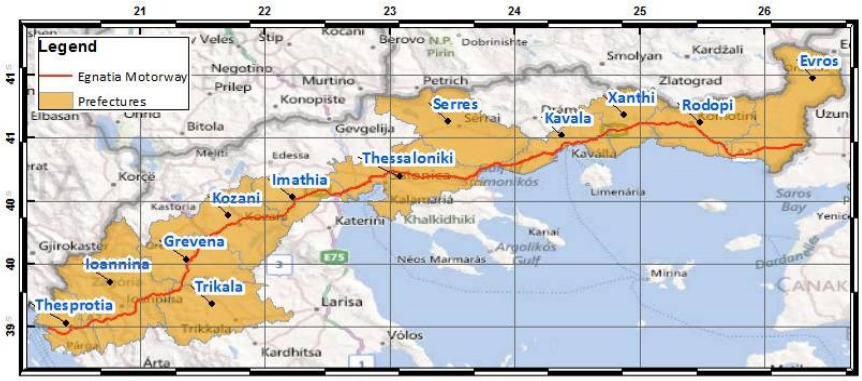
Figure 4 Fields added to the shapefile

TRA01	TRA05	TRA10	TRA14	F_plus	F_minus	Total_Flow	RANK
0,5025	200	14,93	148,9	0,444554	0,199717	0,244837	1
2,14	0	0,36	0	0,321698	0,345019	-0,023321	6
1,235	101	6,98	151,6	0,379541	0,275935	0,103605	4
1,2425	147	6	124,5	0,428927	0,205536	0,223391	2
0,2425	86	14,58	143,5	0,341144	0,240742	0,100402	5
0,17	80	8,22	56,1	0,266172	0,364027	-0,097855	9
0,195	78	10,84	85	0,297373	0,366874	-0,069501	8
0,08	81	23,61	167	0,357484	0,250802	0,106682	3
0,06	102	20,19	106,5	0,280112	0,306863	-0,026751	7
0,33	73	1,5	205,1	0,197081	0,466707	-0,269626	12
0,07	86	11,96	142,6	0,252884	0,371297	-0,118414	10
0,02	125	15,11	243,4	0,22171	0,395159	-0,173449	11

The second component has been developed so that it can read alternative weights series produced for instance by standard multiattribute-based Monte Carlo procedures. As soon as the number of iterations and their weights are specified the component is capable of performing numerous different rounds for the data provided in the first component. The component performs calculations of PROMETHEE II Flows estimations with the exception that Weighted Preference Indicators' Matrices calculation and on is performed for every different round of weights provided before. As soon as alternatives’ rankings have been established the module calculates how many times the alternatives were ranked 1st and creates a new field in attribute

table, along with the ranking, where the times are converted to proportion. Both modules can be used for any GIS-based decision making problem.

Figure 5 Egnatia Motorway horizontal axis (Vavatsikos, Giannopoulou, 2014)



4. CASE STUDY IMPLEMENTATION

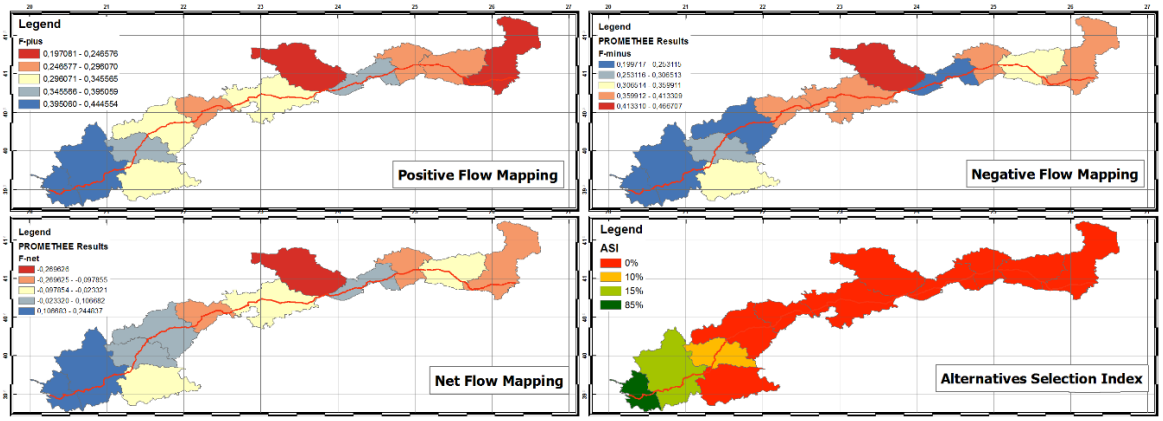
For the present paper, 12 prefectures crossed by the Egnatia motorway, are evaluated with the use of socioeconomic, environmental and transportation indicators according to Vavatsikos & Giannopoulou (2014). In their model alternatives' evaluation to the analysis criteria is performed using indices estimated and published by the Egnatia Motorway Observatory (http://observatory.egnatia.gr) The horizontal axis of the Egnatia Motorway is shown in Fig. 5. These indicators form a total of twenty analysis riteria and will be imported to the attribute table of a shapefile containing the map of Egnatia Motorway and the intersected prefectures. Each column will represent one criterion as shown in Fig. 1.This shapefile will constitute the first import for the module. There is an exclusion, so that the code won't calculate columns like FID, Shape* and NOMOS. Rows in attribute table represent the 12 alternatives which are the different prefectures. Then a file in MS Excel format has been formed to fit the analysis standards. All types of preference functions were used in order to examine all the possible situations. Additionally, in a second sheet, criterion weights sets for performing sensitivity analysis using Monte Carlo simulation has been generated using the triangular distribution. The module executed two runs with sixteen and two thousand iterations. The derived results mapping from both modules are illustrated in Figure 6.

5. CONCLUSIONS

The continuously developments with respect to modern GIS software packages and the contribution of programming languages leads to the creation of scientific automatization tools that can deal with a huge amount of information fast, efficiently and accurately. In that context Land-Use Suitability mapping and analysis can are expanded to the consideration of decision criteria to evaluate spatially related decision problems. On the other hand PROMETHEE methods enrich the analysis with their ability to a/ simultaneously deal with qualitative and quantitative criteria and b/ manage uncertain and fuzzy information provided by the decision makers. The presented developed modules can be considered fast while in the same time they capable to manage big amount of data and information. They provide analysts with the ability to convert spatial data into information used for decision making model and vice versa. Moreover, the results are quickly printed and can be easily understandable by the users. With respect to the case study the results derived in both situations in approximately 11 seconds for the case of sixteen iterations and it took 23 seconds for the two thousand iterations. The first module that estimated PROMETHEE II preference flows with stable criteria weights lasted approximately 7 seconds As for the results, Prefecture of Thesprotias with Igoumentitsa as the capital city was ranked first at 85,1% of the 2000 rounds and 81,25% of the 16 rounds. Prefecture of Ioannina with the homonymous city as its capital was also ranked first but only 18,75% of the times in 16 rounds and

14,8% for 2000 rounds. In the case of 2000 rounds There is a third prefecture with Grevena as its capital that was ranked first at 0,1% of the times.. The code was tested on a personal computer with medium hardware package. Future research will be focused to develop appropriate GUI assist decision makers.

Figure 6 Prefectures Positive, Negative, Net Flow and First Ranking Index mapping



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A multi-criteria fuzzy AHP approach for assessing forest management sustainability: A Greek case study

Vassiliki Kazana *
*Eastern Macedonia & Thrace Institute of Technology, Department of Forestry & Natural Environment Management *
*1st km Drama-Mikrohori, 66100 Drama, Greece**

Angelos Kazaklis*
*Olympos- Centre for Integrated Environmental Management *
*39 Androutsou Str., 55132 Kalamaria, Thessaloniki, Greece **

Dimitrios Raptis *
*Eastern Macedonia & Thrace Institute of Technology, Department of Forestry & Natural Environment Management *
*1st km Drama-Mikrohori, 66100 Drama, Greece **

Christos Stamatiou*
Eastern Macedonia & Thrace Institute of Technology, Department of Forestry & Natural Environment Management *
1st km Drama-Mikrohori, 66100 Drama, Greece *

Abstract

Sustainable forest management implementation and monitoring constitutes a legal requirement for all public forests of the EU countries including Greece. However, the forest management sustainability assessment process is a complex task, mainly because it involves integration of multiple environmental, socio-economic and institutional impacts at different spatial scales of the alternative forest management policies, which are considered for implementation at any forest location. Much of the on-going research, therefore, is focusing on development of tools that can facilitate the forest management sustainability assessments. This paper presents a multi-criteria fuzzy AHP approach, which was used to assess the forest management sustainability performance of eight alternative forest management policies for the forests of Eastern Macedonia and Thrace Region in Greece. The sustainability assessment process was implemented through the operation of the National Forest Governance Council and it included a 10 year planning horizon. The "business as usual" policy alternative was used as the baseline condition. Impact assessments were performed by using relevant spatially referenced environmental, socio-economic and institutional impact indicators from the INFORM knowledge base. An Overall Forest Sustainability Performance Index (OFSPI) was calculated for each of the eight alternative forest policies. Based on the OFSPI values, continuation of the business as usual alternative will reduce the Region's forest sustainability over the planning horizon under consideration. On the other hand the alternative policy that can contribute the most to the Region's forest sustainability concerns the improvement of wood stock for technical, firewood and pulpwood production.

KEYWORDS

Fuzzy AHP, governance, forest sustainability performance

1. INTRODUCTION

Sustainable forest management (SFM) planning, implementation and monitoring constitute a legal requirement for all public forests of the EU countries including Greece under the frame of FOREST EUROPE. However, the forest management sustainability assessment process is a complex task, mainly because it involves integration of multiple environmental, socio-economic and institutional impacts at different spatial scales of the alternative forest management policies, which are considered for implementation at any forest location. An additional challenge emanates from the need to appropriately incorporate the preferences that reflect the interests of the various stakeholders related to the forest resources towards the different types of impacts. Therefore, much of the on-going research is focusing on development of tools that can facilitate the forest management sustainability assessments (Kangas and Kangas 2005, Dursun and Kaya 2010, Sharma et al. 2012, Kazana et al. 2014a, 2014b, Nilsson et al. 2016).

This article presents the application of a combined multi-criteria methodological approach, which was used to assess forest management sustainability in the forests of Eastern Macedonia & Thrace Region of Greece. The application was performed through the National Forest Governance Council (NFGC) function. The NFGC is an

innovative forest governance structure, which has been set up and put into operation through INFORM, an EU LIFE project (www.inform-life.gr) to help establishing a national forest policy framework for sustainable management of the country's forests. The NFGC consists of a moderating team (the authors are members of this team), Forest Service top-level staff from Forest District Offices all over the country, scientists of different expertise related to the management of forests and representatives of opinion influencing stakeholders in fields of concern to sustainable forest management (NGOs, Hunting Association, Forest Cooperatives, and Forest Owners' Association).

2. THE MULTI-CRITERIA DECISION PROCESS FOR FOREST MANAGEMENT SUSTAINABILITY ASSESSMENT

The multi-criteria decision process for SFM assessment involved: i) the definition of planning assumptions and prerequisites in relation to specific for the forest areas of Eastern Macedonia & Thrace Region SFM alternative policies, ii) assessment of the environmental, socioeconomic and institutional impacts of these SFM policy options by using spatially referenced relevant indicators, iii) estimation of the overall forest management sustainability performance indicator for each SFM policy option in the Region.

2.1 SFM policy options, planning assumptions and prerequisites

The NFGC moderators elaborated the planning assumptions and prerequisites of the SFM alternative policies related to the forest area of the Region and the SFM evaluation work was carried out through a 2-day NFGC workshop. Specifically, they organized the required spatial information in the form of spatial forest entities at the landscape system level and selected the combination of the appropriate at this spatial scale indicator models for environmental, socio-economic and institutional impact assessments. The environmental impact assessment indicator models concerned mainly the assessment of the SFM alternative policy impacts on the forest ecosystems, the rangelands, the water and soil resources, the recreational resources and the wildlife of the Region (Kazaklis et al. 2014, Kazana et al. 2014a). Seven SFM alternative policies were considered in the multi-criteria SFM evaluation process in addition to the 'business as usual" alternative. These included: 1) Improvement of the available wood stock for wood production (firewood, technical wood and pulpwood), 2) Development of forest recreation/ ecotourism, 3) Enhancement of the production of non-wood products, 4) Conservation of the Region's forest biodiversity, 5) Improvement of the hunting opportunities in the Region's forests, 6) Protection of the Region's forests from abiotic factors (mainly wildfires) and 7) Protection of the Region's forests from biotic factors (particularly illegal logging, illegal hunting, forest land encroachment and land use change).
The moderators set as planning horizon for evaluation of the anticipated environmental, socio-economic and institutional impacts a 10 year period starting from 2012 to 2022. They also prepared impact evaluation templates along with relevant guidelines for the NFGC members, who performed the evaluation.

2.2 SFM policy impact evaluation

The procedure and the tools for impact assessment were presented to the members by the moderators during the workshop and all the relevant material prepared in stage 1, such as the forest spatial entity maps, spatially reference impact indicator models and the impact evaluation templates were provided to them. Estimations were made on the basis of the "business as usual" alternative and directions of change were clearly marked. The NFGC expert members were asked to select the most appropriate for the areas under evaluation environmental, socioeconomic and institutional indicators from the INFORM knowledge base provided by the moderators and adapt the baseline indicator model values, where needed. A total of 38 environmental, 10 socio-economic and 8 institutional impact indicators relevant at the landscape system level

spatial scale were used by the NFGC members in order to assess the different types of impacts of the SFM policy options on the forest areas of the Eastern Macedonia & Thrace Region.
The underlying question for filling in the relevant evaluation tables of the environmental and the socio-economic impact indicators was to what degree in terms of the selected indicator the area under concern would be impacted by each SFM policy option. For the environmental impact assessments the indicator scale used was from 1 to 20, with 1 meaning that the specific SFM policy had a very low impact on the indicator under examination and 20 indicating a very high impact.

Table 1. Fuzzy numbers for qualitative cross-impact assessment

Fuzzy number	Membership function
$\bar{1}$	(1, 1, 3)
$\bar{x}$	(x-2, x, x+2) for x=3, 5, 7
$\bar{9}$	(7, 9, 11)

1: equal impact, 3: small impact, 5: moderate impact, 7: high impact, 9: very high impact

Table 2 Overall Environmental, Socioeconomic and Institutional Performance Indices of the SFM policy options in the Region of Eastern Macedonia & Thrace

SFM policy options in the Region of Eastern Macedonia & Thrace	**Normalized Crisp Values**		
	Overall Environmental Performance Index	Overall Socioeconomic Performance Index	Overall Institutional Performance Index
"Business as usual"	0.04	0.15	0.06
Wood stock improvement for wood production (firewood, technical wood, pulpwood)	0.51	0.66	0.64
Forest Recreation/Ecotourism	0.47	0.32	0.33
Production of non wood products	0.33	0.30	0.45
Conservation of biodiversity	0.39	0.38	0.39
Hunting	0.35	0.26	0.27
Protection from abiotic factors	0.29	0.15	0.15
Protection from biotic factors	0.21	0.34	0.18

Table 3 Ranking of SFM policy options in the Region of Eastern Macedonia & Thrace based on the Overall Forest Sustainability Performance Index

Ranking	**SFM policy options**	**Overall Forest Sustainability Performance Index**
1	Wood stock improvement for wood production (firewood, technical wood, pulpwood)	0.57
2	Protection from abiotic factors	0.42
3	Protection from biotic factors	0.41
4	Hunting	0.39
5	Production of non wood products	0.37
6	Forest Recreation/ Ecotourism	0.36
7	Conservation of biodiversity	0.34
8	"Business as usual"	0.15

For the socio-economic and institutional impact assessments, the indicator scale used was from 1 to 5 corresponding to the following degrees of impact: very low potential impacts (1), low potential impacts (2), moderate potential impacts (3), high potential impacts (4) and very high potential impacts (5). In addition, the NFGC members were asked to provide an assessment of the impact importance on the Saaty scale, that is, 1,

3, 5, 7 and 9. All partial indicators were aggregated then to form higher level indicators on two directions, that is, gain and loss with regard to specific resources.

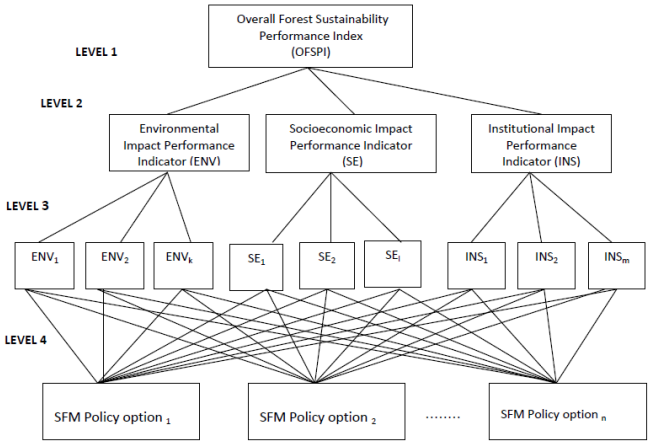
2.3 SFM integrated policy impact evaluation

The integrated forest management sustainability assessments was based on a combination of three different approaches, the Analytic Hierarchy Process (AHP), fuzzy analysis and the ideal solution concepts (Saaty 1980, Zeleny 1981, Hwang and Yoon 1981, Chen and Hwang 1992, Zadeh 1996, Deng 1999, Buckley et al. 2001, Beynon 2005). The calculations to estimate the SFM impact performance indicators involved the following:

1) A decision matrix for the SFM policy options based on assessments representing impact ratings of each SFM policy with respect to each indicator
2) Indicator weights representing the relative importance of the evaluation indicators
3) A fuzzy reciprocal judgment matrix for each SFM policy option importance with respect to a specific indicator by using the fuzzy numbers of the Table 1.
4) A fuzzy impact performance matrix by multiplying the decision matrix with the indicator weights
5) An interval impact performance matrix by using an *alpha* (α) value ($0 \leq \alpha \leq 1$) to represent the NFGC members' confidence on their fuzzy assessments regarding SFM policy options ratings and indicator weights. The larger the *alpha* value the more confidence the NFGC members were assumed to have on their assessment values.
6) A crisp performance matrix by incorporating the NFGC members' attitude towards risk represented by an optimism indicator λ. With λ = 1, the NFGC experts were assumed to have an optimistic view, with λ =0.5 a moderate view and with λ=0 a pessimistic view.
7) The normalized impact performance matrix
8) The positive and negative ideal solutions by selecting the maximum and the minimum values across all SFM policy alternatives with respect to each indicator.
9) The degree of similarity between each SFM policy alternative and the positive ideal solution and the negative ideal solution
10) The Overall Forest Sustainability Performance Indicator (OFSPI) at each relevant level of detail

The generalized hierarchical structure of the SFM policy options integrated evaluation process in the AHP frame is depicted in Figure 1.

Figure 33 The hierarchical structure of the SFM policy options integrated evaluation process



The Overall Environmental, Socioeconomic and Institutional Performance Indices for each of the 8 SFM alternatives evaluated in the Region of Eastern Macedonia & Thrace are presented in Table 2, while the OFSPI indices are shown in Table 3. The SFM policy options that were evaluated for the forests of the Region of Eastern Macedonia & Thrace were assumed mutually exclusive. The confidence of the Region's NFGC experts on their fuzzy assessments regarding the policy options ratings and the indicator weights was considered

moderate, since the α indicator value was equal to 0.6. The experts' attitude to risk was slightly optimistic according to the λ indicator value that was equal to 0.65.

3. CONCLUSIONS

The multi-criteria decision process for SFM assessment that was presented in this article made it possible to incorporate the experts' confidence in their fuzzy assessments and their attitude towards risk. It also made it possible to obtain answers to the following questions: i) to what extent the current management policies implemented in the forests of Eastern Macedonia & Thrace Region lead to forest sustainability, ii) which forest management policies could perform better compared to the current management policies towards forest sustainability and iii) how should the different management policy options be ranked towards achieving forest sustainability. The "business as usual" OFSPI value showed that continuation of the present management policy of the Region's forest areas will diminish the Region's forest sustainability performance in the following 10 years. The SFM policy option concerning the improvement of the Region's wood stock for technical wood, firewood and pulpwood production will contribute the most to the Region's forest sustainability and therefore it should constitute a first priority management objective for the Region's forests should the forest authorities decide to improve the Region's forest sustainability. For the remaining SFM options, protection of forest areas from abiotic and biotic factors would also contribute significantly to the Region's forest sustainability, while hunting, production of non wood products, promotion of forest recreation/ecotourism and conservation of biodiversity although they could improve the present management policy of the Region's forest areas towards sustainability, their OFSPI values were low. The work presented in the current article can be used to improve the current FOREST EUROPE working program at the European level by providing a suitable approach to perform integrated forest management sustainability assessments, so as to better monitor the sustainable management of Europe's forests.

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Optimization Model for Irrigation Water Management under Deficit Irrigation

Pantazis E. Georgiou
Department of Hydraulics, Soil Science and Agricultural Engineering, School of Agriculture
54124 Thessaloniki, GREECE
e-mail: pantaz@agro.auth.gr

Dimitris K. Karpouzos
Department of Hydraulics, Soil Science and Agricultural Engineering, School of Agriculture
54124 Thessaloniki, GREECE
e-mail: dimkarp@agro.auth.gr

Abstract

In this paper an optimization model is developed to determine the optimal allocation of irrigation water to multiple crops in irrigated agriculture under deficit irrigation. The deficit irrigation is the distribution of limited irrigation water resources in order to satisfy essential water needs of plants. The model takes into account the water availability for irrigation. The impact on crop yield due to water deficit and the effect of soil water dynamics on crop water requirements taken into account by an integrated soil water balance model. The soil water balance model calculates the consumptive green and blue water used from irrigated crops. The objective function of the model is based on crop-water production functions and economic values. The model constraints include the available water resources, irrigation water requirements, crop yield etc. The optimization problem is non-linear without analytical solution and with multiple local optima. For this reason, global optimization techniques are used to identify the global or near global optimal solution. Namely, the results concern the optimal water allocation to meet irrigation requirements of a cropping pattern under deficit irrigation for a given irrigated area. The model can be used as a decision support tool for irrigation scheduling.

KEYWORDS

Reservoir operation, Deficit irrigation, Soil water balance, Simulated annealing

1. INTRODUCTION

Agriculture is the main user of the world's water resources. The contribution of irrigated agriculture to food production is important. Therefore, sustainability of irrigated agriculture would demand the efficient management of the available finite water resources under the existing constraints. Traditionally, agricultural research is focused primarily on maximizing the yield per unit area by allocating water to different crops according to their water requirements. In the recent years, the research focuses to increase water productivity within the constraints of available limited water resources. Deficit irrigation has been suggested as a way to increase system benefits, at the cost of individual benefits, by decreasing the crop water allocation and increasing the total irrigated land. The reduction in the yield may be small as compared to the benefits gained through diverting the saved water to cover more cropped area under irrigation (Garg and Dadhich, 2014). Also, for a given irrigation area with limited available water resources, deficit irrigation can be applied successfully by means of the optimization of the crop water allocation; the reduction of the profit compared to full irrigation condition is minimized.

Decision making for reservoir releases for irrigation involves many subtle considerations such as the nature and timing of the crop being irrigated, its stage of growth, the competition among different crops for the available water and the effect of a deficit water supply on the crop yield. Water release from the reservoir is utilized by the crops in the form of evapotranspiration. To determine the amount of release from a reservoir, it is necessary to consider the crop water requirement in relation to the crop growth and its yield (Ghahraman and Sepaskhah, 2002; Georgiou and Papamichail, 2008). A large body of the literature related to crop-water production functions deals with the question of the impact of water scarcity at different times of growing season on the crop yield. The most usable relationships are Jensen's (Jensen, 1968) and Doorenbos's and Kassam's (Doorenbos and Kassam, 1979).

The purpose of this paper is to develop and solve a nonlinear reservoir optimization model for the entire irrigation season, which determine the optimal allocation of irrigation water to multiple crops in irrigated agriculture under deficit irrigation. All subsequent inflow during the irrigation season is regulated and used for the irrigation. In determining the release policy for irrigation, the crop irrigation season has often been used as the decision interval. In this paper the irrigation interval is used, because the irrigation release decisions have to be made in a much shorter time interval. The objective function maximizes the total net farm income and the decision variables are the water releases from the reservoir to meet irrigation requirements of specific cropping pattern of a given irrigated area under deficit irrigation.

The optimization is performed in two stages. During the first stage, the simulated annealing (SA) as a global optimization stochastic search algorithm (Azencott, 1992; Georgiou et al., 2006) is used. In the second stage the solution reached by the first stage is refined by a stochastic gradient descent algorithm, which also does not make use of analytically or numerically computed gradient information. The model can be used as a decision support tool for irrigation scheduling.

2. MATERIALS AND METHODS

2.1 Model formulation

The optimization model is developed for optimal operation of an irrigation reservoir for determining the optimal water allocation to meet irrigation requirements of specific cropping pattern of an irrigated area under deficit irrigation. The problem may be considered to be one of maximizing the utilization of the available water supply when conflicts between supply and demand occur during the growing season. The reservoir storage constitutes the system's state variable, whereas the system inputs – commonly referred to as decision variables - are the water release by the reservoir for each crop in each time interval to satisfy irrigation requirements. The reservoir inflow and the effective rainfall at each time interval are treated as uncontrolled system disturbances, and the crop water requirements and limited reservoir capacity lead to state dependent constraints for the system input.

Objective Function

On the basis of the production function given by Jensen (Jensen, 1968), the following objective function is considered for the optimal operation of a reservoir to irrigate n crops at any time interval j:

$$Z^* = \max_{A_i, R_{i,j}} \sum_{i=1}^{n} \left[P_i \cdot (Y_m)_i \cdot \prod_{j=1}^{k} \left(\left(ET_a \right)_{i,j} / (ET_m)_{i,j} \right)^{\lambda_{i,j}} - \left(B_i + C_i \right) \right] A_i \tag{1}$$

where: Z^*= total net farm income (€), P= product price (€/kg), Y_m= maximum crop yield under given management conditions that can be obtained when water is no limiting (kg/ha), ET_a= actual evapotranspiration (mm), R= reservoir release to irrigate area i in time interval j, ET_m= maximum evapotranspiration (mm), λ= sensitivity index, B= fixed cost (€/ha), C= variable cost (€/ha), A= cultivation area (ha), n= number of crops, k=number of time intervals, i= cultivation crop and j= time interval.

The fixed cost term (B) includes the land cost and the variable cost term (C) is the summation of all other costs such as seed, fertilizer, pesticides, machinery, harvesting, marketing, drying, unexpected costs, etc. The time interval was selected to be ten days, which is less or equal to the irrigation interval. The sensitivity index λ reflects the sensitivity of the crop yield to a water deficit and can be determined from the yield response factors k_y (Kipkorir and Raes, 2002) by transformation to a time interval sensitivity index, using a graphical method (Tsakiris, 1982). The maximum evapotranspiration ET_m coincides with crop evapotranspiration, which is the product of a crop factor k_c and the reference evapotranspiration which is computed from the FAO Penman-Monteith equation (Allen et al., 1998).

Constraints

State equation of the reservoir

By removing the overflow variable from the reservoir storage continuity equation, and rewriting it as a state equation, the reservoir storage becomes:

$$S_{j+1} = \min\left(S_{max}, S_j + Q_j - \sum_{i=1}^{n} A_i R_{i,j} - 0.001 g_j f\left(S_j\right) \right) \tag{2}$$

where: S= reservoir storage, Q= reservoir inflow, R= reservoir release, g= reservoir surface area evaporation, f(S)= function of reservoir storage versus reservoir surface area, i= cultivation crop and j= time interval. The rainfall on reservoir area is negligible and for this reason in this study it has not been included in the model. The reservoir storage at any time interval is bounded between an upper limit (active and dead storage-S_{max}) and a lower limit (dead storage-S_{min}). The state equation of the reservoir (eq. 2) is nonlinear and time-varying, because of limited capacity and water evaporation from the reservoir, respectively.

Soil water balance

To express the water content as root zone depletion is useful. The soil water balance, express in terms of depletion for any given crop i and time interval j is given as follows (Allen et al. 1998):

$$\left(D_r\right)_{i,j+1} = \left(D_r\right)_{i,j} - ERAIN_{i,j} - IR_{i,j} + \left(ET_a\right)_{i,j} + (TAW_{i,j+1} - TAW_{i,j}) \quad (3)$$

where: $(D_r)_{i,j+1}$= root zone depletion of crop i at the end of time interval j+1 (mm), ERAIN= effective rainfall (mm), IR= net irrigation depth that infiltrates the soil (mm), ET_a= actual evapotranspiration (mm) and TAW= total available soil water in the root zone (mm). The terms of runoff from the soil surface (RO) and capillary rise from the groundwater table (CR) are negligible and for this reason in this study they have not been included in the model. The water loss out of the root zone by deep percolation taking place if the soil water and effective rainfall overcome the total available soil water.

The irrigation requirements $IR_{i,j}$ of a crop i in a given time interval j, depend on the initial soil water level, the effective rainfall, the maximum evapotranspiration and the remaining soil water. The irrigation requirements specify the maximum releases of the reservoir, which are given by:

$$\left(R_{max}\right)_{i,j} = IR_{i,j} \Big/ CE = \left[\left(1-p_{i,j}\right)TAW_{i,j} + \left(ET_m\right)_{i,j} - \left(SW_{in}\right)_{i,j} - ERAIN_{i,j}\right] \Big/ CE \quad (4)$$

where: R_{max}= maximum release from reservoir to meet irrigation requirements (mm), p_m= maximum allowable deficit level (fraction of TAW) within which no water stress condition exists, SW= available soil water (mm) and CE= conveyance efficiency.

Actual evapotranspiration ET_a

The actual evapotranspiration ET_a is determined by the (Allen et al., 1998):

$$ET_a = k_s \cdot ET_m \quad (5)$$

where: k_s is soil water stress coefficient and can be written:

$$k_s = \frac{TAW - D_r}{TAW - RAW} = \frac{TAW - D_r}{\left(1-p_m\right)TAW} \quad (6)$$

where: RAW= readily available soil water in the root zone (mm). D_r will be greater than RAW at the water stress condition (deficit irrigation) and can be written as:

$$D_r = p_s \cdot TAW \quad (7)$$

where: p_s= allowable deficit level (fraction) of TAW at water stress condition (deficit irrigation).

Bounds

In the foregoing the decision variables are the irrigation releases and the state variable is storage. The lower and upper limits for these variables are the following:

$$S_{min} \le S_j \le S_{max}, \quad 0 \le R_{i,j} \le R_{i,j}^{max} \quad (8)$$

2.2 Solution technique

Optimization techniques for such problems include dynamic programming based on the state equation, and nonlinear programming based on the conversion of the problem to static optimization, by introduction of slack variables (overflow). In this paper the optimization is performed in two stages. During the first stage a *simulated annealing* (SA) algorithm (Georgiou et al., 2006) is used. The SA algorithm is a metaheuristic search method based on mathematical simulation of systematic heating and cooling of materials and formation of crystals having minimum energy. During the cooling process temporary higher-energy states may be visited, according to the Boltzman probability distribution. SA exploits this feature to escape any local optimal solutions. Simulated annealing has been often used to solve difficult multidimensional problems in the water resources scientific field (e.g. Karpouzos and katsifarakis, 2013)

In the context of dynamic system optimization, the basic idea is at first to generate a feasible sequence of random normally distributed reservoir releases. The random releases effectively produce a random-walk for the system state trajectory, which satisfies equation (2). In the context of SA, the sequence of reservoir

releases corresponds to an aggregated state q. The total net farm income (eq. 1) can be expressed as a function Z=-E(q), and corresponds to an energy, which can be minimised by simulated annealing.

Since the number of iterations during the optimization is finite, the SA procedure will typically compute near-optimal solutions. For this reason, in a second stage, we refine the solution reached by the SA, using a stochastic gradient descent algorithm. This algorithm assumes that no analytical expression exists for the constrained gradient of the cost function. Furthermore, it does not try to estimate numerically the gradient information, because this can be time consuming for problems of high dimensionality. Instead, it iteratively computes random perturbations of the first-stage solution, accepting only new solutions with lower energy.

3. RESULTS AND DISCUSSION

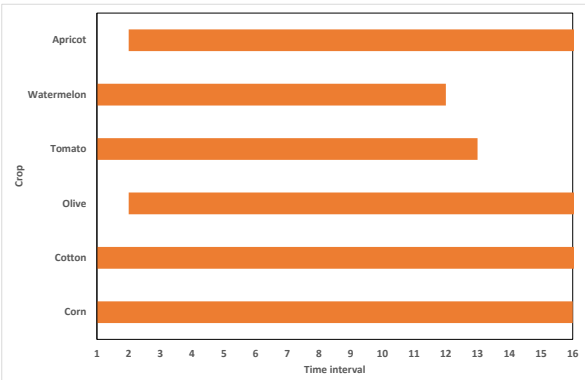
The Chalkidiki region in Northern Greece was used as an application example for the optimization model. The main source of irrigation water in the region is from a planned reservoir on the Havrias river. The useful reservoir capacity is planned to be 26 hm^3 and the dead capacity 4.3 hm^3. Determination of optimal releases from reservoir to meet irrigation requirements for the region requires a good knowledge of the availability of the water in the reservoir during the irrigation season, meteorological conditions for the region and crops characteristics. The presented optimization model was used to compute irrigation scheduling under deficit irrigation for the cropping pattern of six crops (Table 1) and with data of 1980.

Table 34 Allocation of cropped area

Crop	Area (ha)	Crop	Area (ha)
Corn	50	Tomato	1135
Cotton	50	Watermelon	590
Olive	1100	Apricot	50

The irrigation season starts in April and ends to September. The time interval used was ten days, which is less or equal to the irrigation interval for crops (1st time interval corresponds to 3rd ten-day period of April). The peak irrigation demand is expected in the months of July and August where the crop evapotranspiration is the maximum and the rainfall is close to zero. Figure 1 shows the duration of irrigation period for each crop. The peak irrigation demand is expected in the months of July and August (time interval 8-12) where the crop evapotranspiration is the maximum, the rainfall is close to zero and irrigated all crops.

Figure 1 Duration of irrigation period for each crop



The reference crop evapotranspiration was derived from daily climatic data of the region by the FAO Penman-Monteith equation (Allen et al., 1998). Effective rainfall was computed from the procedure which is described by USDA. The mean conveyance efficiency is 0.85. Monthly inflow was computed from a simple rainfall – runoff model which is described from Steenhuis and VanDerMolen (1986). The ten day inflows derived by dividing the monthly inflows by three. In the cost calculations, it was assumed that farmers own the land, thus fixed cost (B) is equaled zero. The variable cost (C) for each crop was computed from data supplied by the Region of Central Macedonia, Greece (Georgiou and Papamichail, 2008).

Both optimization stages (simulated annealing and stochastic gradient descent) have been implemented in Matlab language. Because the optimization algorithm is stochastic, the computed optimal solution would

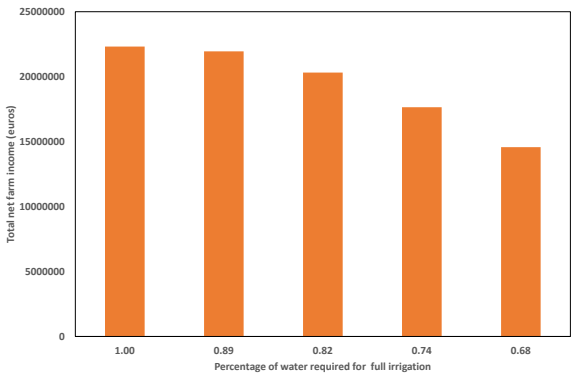
differ slightly from execution to execution. The globally optimal solution was achieved after mutiple executions of the optimization procedure for the same initial conditions and parameters. The term "globally optimal" refers to the best solution discovered among all executions.

For the full irrigation of six crops the reservoir storage in the beginning of irrigation period is 11.0 hm^3. The optimization model was applied for four different initial reservoir storage values which correspond to deficit irrigation. The total net farm income for different reservoir storage in the beginning of irrigation period are given in Table 2 and show in Figure 2.

Table 2 Total net farm income for different reservoir storage in the beginning of irrigation period

Reservoir storage (hm^3)	Total net farm income (€)	Reservoir storage (hm^3)	Total net farm income (€)
6.85	14,571,744	9.6	21,945,741
7.68	17,647,903	11.0	22,316,704
8.64	20,311,949		

Figure 2 Total net farm income for five different scenarios of water availability



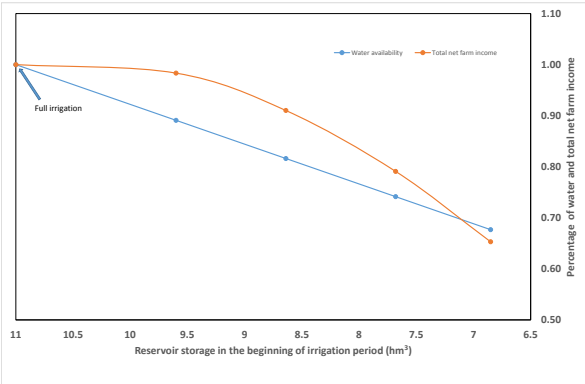
The relative yield of six crops for different reservoir storage in the beginning of irrigation period are given in Table 3.

Table 3 Relative yield of six crops for different reservoir storage in the beginning of irrigation period

Crop	Reservoir storage in the beginning of irrigation period (hm^3)				
	6.85	7.68	8.64	9.6	11.0
Corn	0.70	0.70	0.70	0.70	1.00
Cotton	0.72	0.70	0.70	0.70	1.00
Olive	0.70	0.76	0.95	0.99	1.00
Tomato	0.90	0.98	0.99	1.00	1.00
Watermelon	0.70	0.78	0.84	0.98	1.00
Apricot	0.71	0.71	0.73	0.94	1.00

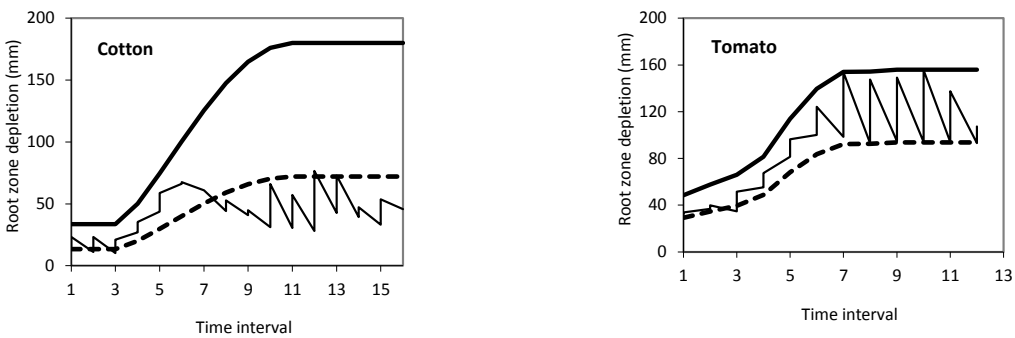
As it can be seen in Table 3, the crops of tomato followed by olive and watermelon have the highest relative yields in all cases of reservoir initial storage values. This could be linked with the fact that these crops are the most profitable. In figure 3, the variation of the total net farm income with regard to different initial reservoir storage values is presented. It can be pointed out that with regard to full irrigation, the deficit irrigation produces smaller relative decrease values of total net income compared to the relative decrease of water used for irrigation in almost all cases under study. For example, for a relative decrease of about 13% of water availability the corresponding relative decrease in total net farm income is less than 2%. This difference, as it can be easily seen in figure 3, fades out as the relative decrease of water availability becomes too high (small values of initial reservoir storage).

Figure 3 Evolution of total net farm income and water for different reservoir storage in the beginning of irrigation period



Given the irrigation water allocated and the irrigation time interval, the irrigation scheduling can subsequently be derived by plotting the root zone depletion along the time axis for crops with the help of the soil water balance model (Figure 4). To avoid crop water stress, the root zone depletion should not exceed the threshold value for no stress (lower limit). If so, the depletion will be larger than Readily Available Soil Water (p_m*ASM) and the crop will experience water stress. The resulting yield decrease depends on the severity of the stress and the sensitivity of the crop at the particular time interval. Figure 4 shows that in the crop of Tomato with relative yield 1.00 the soil moisture depletion in the root zone at the end of each time interval is always above the threshold for no water stress. On the other hand, to avoid water losses, the soil water content in the root zone after an irrigation event should not exceed available soil moisture (upper limit).

Figure 4 Soil water depletion in the root zone at the end of each time interval for the crops of cotton and tomato under study. Thick continuous line represents total available soil water in the root zone (TAW), dashed line represents threshold for no water stress and continuous line represents soil water content



4. CONCLUSIONS

A multi-crop irrigation model for a single reservoir operating under water scarcity constraints has been optimized using a two-step stochastic optimization algorithm. The optimization computes the optimal water allocation to meet irrigation requirements of specific cropping pattern of an irrigated area under deficit irrigation. The model can be used as a decision support tool for irrigation scheduling while it can indicate cases where a deficit irrigation can lead to notable water savings with limited decrease of economic profit.

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Analyzing quality characteristics: The case of an e – health application

Stavros Stefanakakis
School of Information Sciences
Department of Applied Informatics
University of Macedonia
GR54006 Thessaloniki, Greece

Stylianos Trevlakis
CERTH
Thermi, GR57001
Thessaloniki

Fotis Kitsios
School of Information Sciences
Department of Applied Informatics
University of Macedonia
P.O. Box 1591, GR54006
Thessaloniki, Greece

Abstract

The study of the user satisfaction is one of the most significant issues of modern management. Modern companies, including hospitals, have recognized the importance of measuring satisfaction and have developed measuring procedures targeting at the immediate finding and improvement of their weaknesses. Furthermore, the modern competitive environment makes more intense the need of studying the clients' behavior, in our case the patients' behavior. It is of great importance, that by measuring satisfaction, companies and organizations have a clear view of their performance compared to the competition. The Six Sigma approach has been well recognized as an important tool for continuous improvement and business excellence. The MUSA method is a multicriteria method used to calculate partial and global customer satisfaction of a product or service based on criteria. For this paper, the selected criteria are the quality dimensions of an e – health appointment system.

KEYWORDS

Kano model, Six Sigma, Musa, e-health, customer satisfaction

1. INTRODUCTION

According to ITU, Greece's rank in the ICT development index (IDI) is 39, mobile telephony subscriptions are 120,04% of population and Internet users 56%. The term e-appointment refers to "an internet-mediated agreement between two or more parties as social subjects (person or institution) to interact at a certain time and place for a certain purpose (e.g. business meeting, medical treatment)" (Klischewski, 2003). The importance of information technologies in health care is growing, as in all industries. The main target of implementing such technologies is the increase of service quality and minimization of costs (Çam, 2016). Previous research has been done on user satisfaction of e – appointment systems (Stefanakakis et al, 2016). This paper is an expansion of this research. The purpose of this paper is to categorize the characteristics of an appointment system of a Greek hospital in Thessaloniki based on Kano's satisfaction model, and provide data for future improvement of the system based on the users' needs.
There are three main parts in this paper. In the literature review the three methodologies that are used are presented, then the used methodology is described and finally, there are the findings, the conclusions and the suggestions of the research.

2. LITERATURE REVIEW

2.1 The Six Sigma Approach

The Six sigma approach was introduced by engineers Bill Smith & Mikel J Harry while working at Motorola in 1986. Using Six Sigma Motorola became known as a quality leader and a profit leader. Six Sigma is a rigorous, focused and highly effective implementation of proven quality principles and techniques. A company's performance is measured by the sigma level of their business processes (Pyzdek, 2003).
Six Sigma is the application of the scientific method to the design and operation of management systems and business processes which enable employees to deliver the greatest value to customers and owners. The scientific method works as follows:

1. Observe some important aspect of the marketplace or your business.
2. Develop a tentative explanation, or hypothesis, consistent with your observations.
3. . Based on your hypothesis, make predictions.
4. Test your predictions by conducting experiments or making further careful observations. Record your observations. Modify your hypothesis based on the new facts. If variation exists, use statistical tools to help you separate signal from noise.
5. Repeat steps 3 and 4 until there are no discrepancies between the hypothesis and the results from experiments or observations.

This approach has been used by researchers in several fields of research including public administration e – services (Alhyari et al, 2012) and services (Chakrabarty et al, 2007), (Antony et al, 2007), (Antony, 2006) and (Kim et al, 2010).

2.2 The Kano Model

Kano's model, proposed by the Japanese professor Noriaki Kano and his colleagues, is a tool used to understand customer needs and their impact on customer satisfaction. It is used to classify quality characteristics of a product or service. This model describes three types of requirements that contribute to customer satisfaction (Kano et al., 1984).

a) **Expected / must-be requirements**: These are the basic characteristics of a product or a service. The absence of any of these results to customer dissatisfaction, but their presence does not improve customer satisfaction. Fulfilling the must-be requirements will only lead to a state of "not dissatisfied".
b) **One dimensional requirements:** There is a linear relationship between customer satisfaction and the level of fulfillment of these requirements. The higher the level of fulfillment, the higher the customer satisfaction and vice versa.
c) **Attractive requirements:** These are the criteria that influence customer satisfaction the most. They are not expected by the customer and if they are not met, there is no feeling of dissatisfaction.

(Yang, 2005) introduces the weights of each characteristic to the refined Kano's model, a characteristic is important if its weight is greater than the mean weight of all the characteristics.
This model has been used during the design procedure of products (Chen et al, 2008), software (ArunKumar et al, 2016), mobile applications (Li et al, 2016), cars (Xu et al, 2009). Several hybrid models have been proposed. It has been combined with AHP (Jung et al, 2016) ,(Kim et al, 2016) and SERVQUAL (Tan et al, 2001).

2.3 MUSA Method

The MUSA method is a multicriteria method for measuring and analyzing customer satisfaction (Grigoroudis and Siskos, 2010). The method assesses global and partial satisfaction functions. The method produces many results. One of the most important is the criteria weights which represent the relative importance of the satisfaction criteria. The method also produces a set of indices, which includes the satisfaction indices that show the level of satisfaction in the range 0-1, the demanding indices which can be considered as an indicator for the company's improvement efforts and the improvement indices which represent the improvement

margin on each criterion. Moreover, a series of diagrams can be developed: the action diagrams, a combination of criteria weights and satisfaction indices and the improvement diagrams combining improvement and demanding indices.

2.4 Previous Research

The proposed methodology has been used by (Politis et al, 2016) for the analysis of the quality characteristics of the Greek mobile communications companies. The researchers used eight quality characteristics of the services provided by the companies and concluded that the service has all types of characteristics. Also e-health applications have been studied

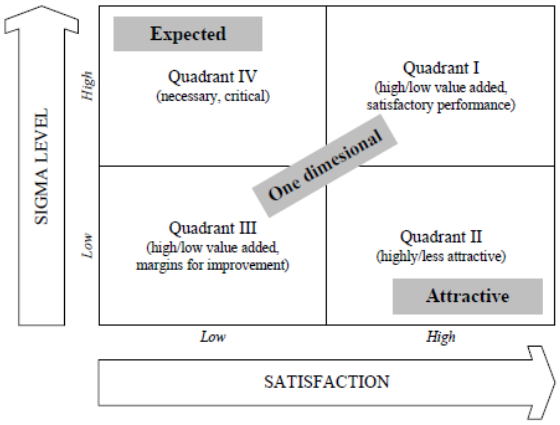
3.METHODOLOGY

The methodology used in this paper is proposed by (Politis et al, 2016). Since sigma is a function of the customer's satisfaction level, there is a direct relationship between satisfaction rating and sigma levels. In customer satisfaction surveys, dissatisfied customers can be regarded as an indicator of defects rate.

Combining satisfaction indices and sigma levels, diagrams can be developed.

1. Characteristics with high sigma level but low satisfaction level can be considered as expected characteristics (Quadrant IV). Despite the high performance (high sigma level) customer satisfaction is not increased. A company must retain sigma level at least at the same level as the competition in order to be able to maintain its customers.
2. Characteristics with low sigma level but high satisfaction level are considered attractive, as they increase customer satisfaction even if their performance is low. Increased performance gives high competitive advantage to the company (Quadrant II).
3. The remaining characteristics (Quadrants I & III) can be considered as one dimensional as there seems to be a linear relationship between performance and satisfaction. Higher sigma level leads to higher customer satisfaction.

Figure 2 Customer satisfaction – sigma level
Source: Politis et al, 2016



3.1 Satisfaction Criteria

The scope of this research is to evaluate the satisfaction level of the users of the e-appointment system of Papageorgiou General Hospital of Thessaloniki, Greece. In order to develop the questionnaire of the survey, relevant literature has been reviewed. Four papers came up, presenting researches about e-appointment systems evaluation and (Chang et al, 2015) was selected. The authors used 6 dimensions of the e-servqual scale and the TAM model for analyzing data. Four of these dimensions and added items from (Loiacono et al, 2002) were used.

3.2 Data Collection

The collection of the data has been done using electronic forms over a period of two weeks in May 2016. The questionnaire was available only to registered users, on the home page of the system. The questionnaire contained 41 questions. The questionnaire contained demographic questions, questions about how experienced the users of the system on using a computers are and questions that asked the users to evaluate their satisfaction level on a scale 1-5. 187 questionnaires were collected but only 142 of these were analyzed as the others contained blank answers.

4. CASE STUDY

4.1 Findings

The proposed methodology is used to analyze the results of the MUSA method applied on data collected about user satisfaction of an appointment system.

Table 1 shows the average satisfaction indices, the percentage of dissatisfied users, which is the percentage of users who have answered as “totally dissatisfied” and “dissatisfied”, the two lowest levels of the 5 – level Likert scale used at the questionnaire , the DPMO (Defects Per Million Opportunities) and the sigma level.

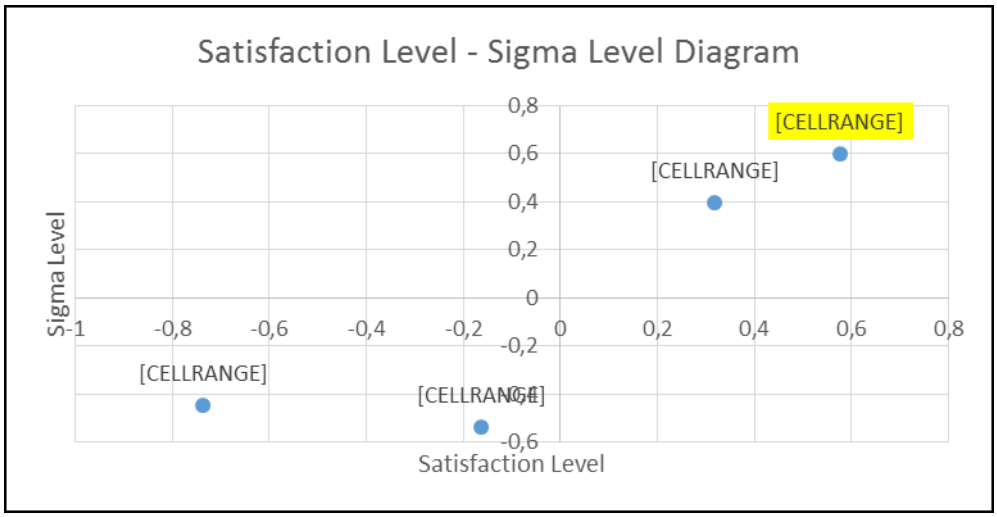
Table 35 Satisfaction and performance data

Criteria	Weights	Average Satisfaction Indices %	Dissatisfied Customers %	DPMO	Sigma Level
Website Quality	11,163	85,785	6,7	67.000	3
Perceived Ease of Use	49,448	96,906	2,3	23.000	3.5
Perceived Usefulness	18,738	93,013	2,8	28.000	3,41
Service Quality	20,652	77,137	6,2	62.000	3,04

Combining the average satisfaction indices and the sigma level of each quality dimension and normalizing the values in the interval [-1, 1], we can create Figure 2. At the X – axis we have satisfaction level and at the Y – axis the sigma level. The cut – off level for both axes is (0,0).

Examining Figure 2, it is clear that all characteristics are in the first and third quadrant. Taking into consideration Figure 1, can be concluded that all four quality characteristics of the system are one dimensional. Furthermore, it is obvious that as performance, indicated by sigma level, increases, customer satisfaction also increases. Indeed, looking at table 1, we can see that the two characteristics with the lowest sigma level, website quality and service quality, also have the lowest average satisfaction indices.

Figure 2 Satisfaction level - sigma level diagram



All characteristics of the system have a sigma level under 3.5 which means that there is much room for improvement so as the defects are minimized. As the research has been done on a single hospital we are not able to determine if the performance is competitive in comparison with other providers.

According to the refined Kano's model only the characteristic of perceived ease of use is considered important and can be characterized as highly value – added. All others are low value – added.

4.2 Conclusion

The quality characteristics of the system have been analyzed using the results from the MUSA method and the performance level. All characteristics fall below 3.5 sigma level, which means that there is much room for improvement. All characteristics are one dimensional and there are no attractive or expected characteristics. Only one of the characteristics can be characterized as high value added. The providers of the service should improve the performance of some of the characteristics so as user satisfaction is increased more. The findings and conclusions of this study can be used for further development and improvement of the system and also for the development of new e – health applications of such type.

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Evaluating occupational stress and job satisfaction in health sector during the austerity: the case of Greek NHS dentists

Aristomenis I. Syngelakis[1,2]
1Department of Preventive and Community Dentistry, Faculty of Dentistry, School of Health Sciences, National and Kapodistrian University of Athens 2Unit of Health & Social Welfare Management, Department of Business Administration, Faculty of Management & Economy, Technological Educational Institut of Athens (T.E.I. of Athens).
aristomenis.syngelakis@gmail.com

Fotis C. Kitsios[3]
3School of Information Sciences, Department of Applied Informatics, University of Macedonia, P.O. Box 1591, GR54006 Thessaloniki, Greece.
kitsios@uom.gr

Abstract

The Greek National Health System (Greek NHS) has been strongly affected by austerity policies since 2010: substantial cuts on government health spending as well as a broad restructuring of the public health sector have been imposed in a short period. Therefore, the Greek NHS professionals, including non-hospital dentists, have to overcome wage cuts, health personnel reduction, job and social instability as well as an increased demand of public healthcare services. The aim of this study was to evaluate the occupational stress of non-hospital Greek NHS dentists, during the current economic crisis and public sector reform, by using Effort – Reward Imbalance (ERI) questionnaire, a contemporary research instrument strongly linked to labour market conditions. Methodology: All 192 non hospital NHS dentists were invited to participate; 135 (70.3%) agreed. Of them, 68 (50.4%) were men (55.3 ± 6.6 years) and 67 (49.6%) were women (54.3 ± 4.5 years). The Greek version of the ERI, a semi-quantitative 23-item questionnaire using a simplified, uniform 4-point Likert response scale, was delivered between July and October 2012, with permission of the Greek Ministry of Health. Results: Dentists indicated a moderate degree of job satisfaction; ER ratio >1 was found in 58.1% of dentists while specific determinants of occupational stress and job satisfaction were defined. Conclusions: A relative imbalance between efforts given and rewards received was found in non-hospital (primary care) Greek NHS dentists at the time of research. Therefore, well designed interventions should be implemented to address occupational stress, which is expected to increase during the ongoing crisis. Additionally, targeted policies by the Greek government aiming to improve the Public Dental care System in the Greek NHS would also be necessary.

KEYWORDS

Dental care, Effort – Reward Imbalance (ERI), occupational stress, job satisfaction, Greek National Health System (Greek NHS), Health Policy.

1. INTRODUCTION

The Greek National Health System (Greek NHS) has been strongly affected by austerity policies since 2010, when the first Memorandum between Greece from the one side and European Union, European Central Bank and I.M.F. was signed (Government of Greece, 2010). Memorandum allowed necessary financial support for Greece but also imposed harsh conditions on the Greek side, creating asphyxiation in Greek economy and society (Economou, 2012). As a result, enormous cuts on government health spending (about 33% in real terms between 2009 and 2013) (OECD, 2015) as well as a broad restructuring of the public health sector have been imposed in a short period (Economou et al, 2014).

Therefore, the Greek NHS professionals have to overcome wage cuts, health personnel reduction, job and social instability as well as an increased demand of public healthcare services. Under these tenuous circumstances in the context of globalization and economic crisis it is expected that work-related stress and insecurity will be increased among the Greek NHS professionals including non-hospital dentists (Siegrist et al,

2009). Consequently it is important to evaluate the occupational stress of non-hospital Greek NHS dentists, during the current economic crisis and public sector reform.
Aim of this study was to investigate chronic occupational stress of Greek NHS non-hospital dentists by using the ERI questionnaire.

2. LITERATURE REVIEW

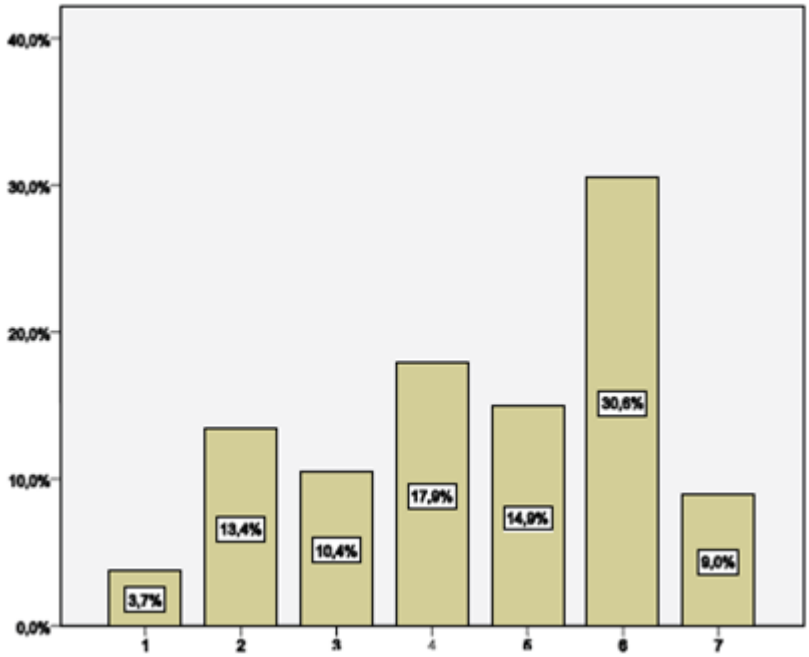
Among the main instruments for the assessment of the chronic occupational stress, *Job demand-control-support model*, and *Effort-Reward Imbalance (ERI)* model are included. The first is a traditional procedure which postulates that employees with high job demands, low decision latitude and low social support have increased risk of adverse health events (Siegrist et al, 2004); the latter is a contemporary instrument (Siegrist et al, 2009; Siegrist et al, 2004). Both models address chronic work-related stress and its consequences on health of employees and provide a framework for understanding the problem and seeking appropriate interventions to improve the working environment (de Jonge et al, 2000).
According to Siegrist et al (2009), "*The Effort-Reward Imbalance model claims that lack of reciprocity between efforts spent and rewards received ('high cost/low gain') occurs frequently under specific conditions and that failed reciprocity elicits strong negative emotions and sustained stress reactions that in the long run adversely affect physical and mental health*.". ERI model advantages include the following (Siegrist et al, 2004; Siegrist et al, 2009; Msaouel et al, 2012): a. it integrates structural and personal components, b. it is strongly linked to macro-economic labour market conditions and addresses issues of distributive justice and fairness. Therefore the ERI model would be particularly useful in evaluating and addressing professional stress and its adverse health effects among Greek dentists.
The structure of the ERI questionnaire has 3 dimensions (Msaouel et al, 2012):

- Effort: 6 items (1-6)
- Reward: 11 items (7-17)
- Esteem (Items 7-10, 15)
    - job promotion (Items 11,14,16,17)
    - Job security (Items 12,13)
    - Overcommitment: 6 items (18-23).

3. POPULATION & METHODOLOGY

All 192 non hospital NHS dentists were invited to participate; 135 (70.3%) agreed. Of them, 68 (50.4%) were men (55.3 ± 6.6 years) and 67 (49.6%) were women (54.3 ± 4.5 years). The distribution of study participants (dentists) per health region is as presented in figure 1:

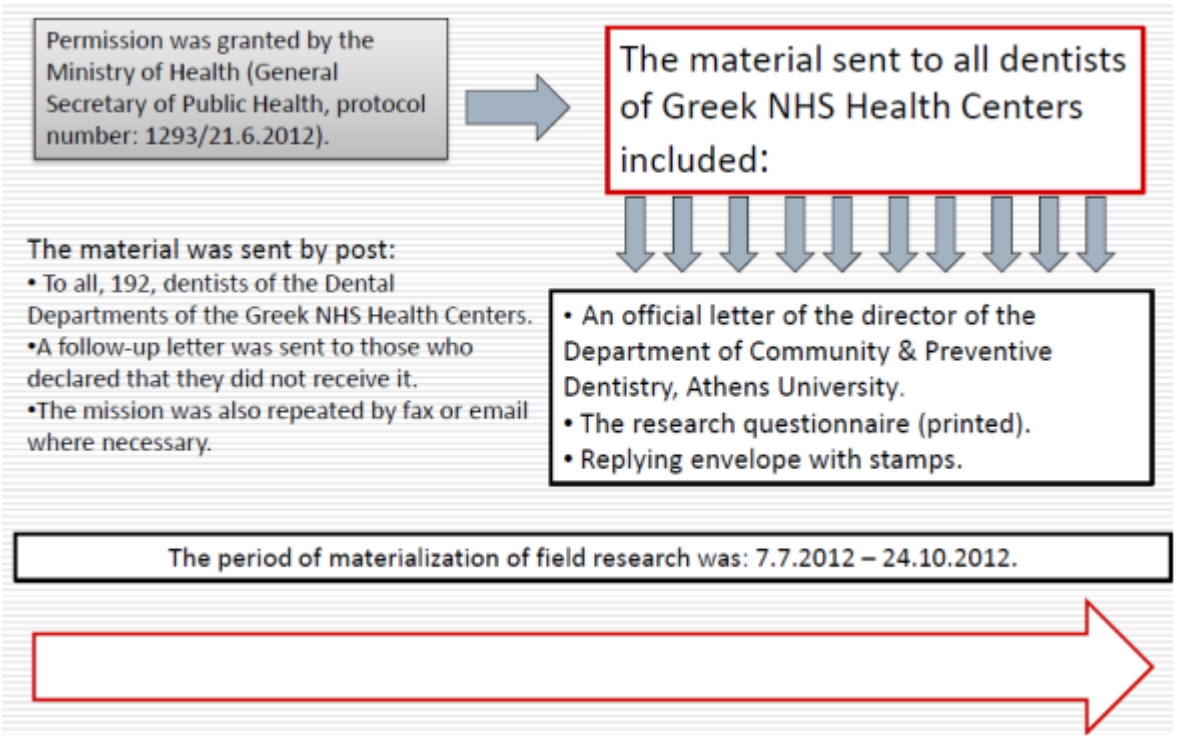
Figure 36 The distribution of study participants (dentists) per health region



ERI questionnaire was translated, validated and culturally adapted in Greek (Msaouel et al. 2012). The Greek version of the ERI, a semi-quantitative 23-item questionnaire using a simplified, uniform 4-point Likert response scale was delivered between July and October 2012, with permission of the Greek Ministry of Health, as the 2nd part of a broader study.

The materialization of research field is presented in figure 2:

Figure 2 Materialization of the research field



Other variables that were also queried were demographics, organizational components of the Dental Departments, oral health promotion activity, and educational activities. This research instrument (ERI) was used for the first time among Greek dentists, while it has been used in other health workers.

4. RESULTS

Greek NHS non hospital dentists indicated a moderate degree of job satisfaction; ER ratio >1 was found in 58.1% of dentists. This demonstrates a relative imbalance between high efforts and low rewards at work in the majority of the participants. On the other hand, this figure is lower comparing to the results of a study in Greek healthcare workers (physicians, nurses, physiotherapists and laboratory staff: 80.7% of them had an ER ratio > 1) (Msaouel et al, 2012).

Dentists indicated a moderate degree of professional satisfaction and support (table 1). No statistically significant differences were observed in the whole scale between the Health Regions (p> 0.05).

Table 1 Evaluation of occupational stress and job satisfaction by using the Greek version of ERI questionnaire

ERI questionnaire (Range 1 to 4).		Mean	SD
1.	I have constant time pressure due to a heavy work load.	2.58	.74
2.	I have many interruptions and disturbances while performing my job.	2.54	.79
3.	I have a lot of responsibility in my job.	2.92	.75
4.	I'm often pressured to work overtime.	2.08	.79
5.	My job is physically demanding.	3.16	.65
6.	Over the past few years, my job has become more and more demanding.	2.98	.77
7.	I receive the respect I deserve from my superiors.	2.82	.84
8.	I receive the respect I deserve from my colleagues.	3.08	.75
9.	I experience adequate support in difficult situations.	2.54	.79
10.	I'm treated unfairly at work.	2.81	.93
11.	My job promotion prospects are poor.	2.09	.75
12.	I have experienced or I expect to experience an undesirable change in my work situation.	2.17	.86
13.	My employment security is poor.	2.63	.76
14.	My current occupational position adequately reflects my education and training.	2.62	.83
15.	Considering all my efforts and achievements, I receive the respect and prestige I deserve at work.	2.91	.69
16.	Considering all my efforts and achievements, my job promotion prospects are adequate.	2.45	.78
17.	Considering all my efforts and achievements, my salary/income is adequate.	2.11	.77
18.	I get easily overwhelmed by time pressures in work.	2.21	.72
19.	As soon as I get up in the morning I start thinking about work problems.	2.20	.78
20.	When I get home, I can easily relax and 'switch off' work.	2.39	.69
21.	People close to me say that I sacrifice too much for my job.	2.40	.77
22.	Work rarely lets me go, it is still on my mind when I go to bed.	2.18	.72
23.	If I postpone something that I was supposed to do today I'll have trouble sleeping at night.	2.31	.77

5. CONCLUSIONS

A relative imbalance between efforts given and rewards received was found in non-hospital Greek NHS dentists at the time of research. Therefore, well designed interventions should be implemented to address occupational stress, which is expected to increase during the ongoing crisis. The suggested interventions include the motivation of NHS dental personnel using financial, educational and moral incentives (f.e. establishing justice, objectivity and transparency in dental personnel's evaluation process) as well as guarantying professional security (meaning that blind layoffs are not permitted). Additionally, targeted policies by the Greek government aiming to improve the Public Dental care System in the Greek NHS as well as to guarantee the sustainability and safe-keeping of the social character of NHS Dental Care would also be necessary.

The limitations of the research include the lack of ERI data before the crisis to compare (the instrument was only recently validated in Greek).

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Applying the multi-criteria method Promethee II for the startup ranking during a business ideas competition

C. Nikoloudis *
Sector of Industrial Management and Operational Research
School of Mechanical Engineering, National Technical University of Athens
Athens, Greece

E. Strantzali
Sector of Industrial Management and Operational Research
School of Mechanical Engineering, National Technical University of Athens
Athens, Greece

K. Aravossis
Sector of Industrial Management and Operational Research
School of Mechanical Engineering, National Technical University of Athens
Athens, Greece

Abstract

The "startup explosion" has raised the interest of both academics and businesses, as according to the literature it has multiple economic, employment and social benefits. The interest of academics and startup's ecosystem (universities, business and technology centers, business incubator or accelerator, angel investors and venture capitalists) focuses on the best selection of startups (through various criteria and indicators) that will be financially feasible and scalable. The present paper makes an attempt to list and describe what investors do, and other stakeholders see when evaluating a startup in the early stage (pre-seed and development) during a business ideas competition. A multi-criteria decision-making model has been developed, based on previous research analyzing the criteria used by investors (venture capitalists and angel investors) to evaluate startup funding. The multi-criteria method, Promethee II, used in the evaluation process to consider both quantitative and qualitative data. The weighting of criteria is carried out according to three different perspectives, each one focusing on financial, management team and market/product benefits. In the decision support model proposed, each stakeholder can evaluate every proposal in a personal way according to its scoring on a consistent family of the evaluation criteria. After the development of the evaluation model, it was applied to register business plans of a business ideas competition, in order to test it. The obtained empirical results comparing all the registered business ideas of startups, showed that the proposed multi-criteria model could be used for evaluating the pre-seed (business idea) stage of startups, and that offers promising new perspectives in this field of research.

KEYWORDS

Model Evaluation; Startup Validation and Selection; Analysis of Collective Decision-Making; Promethee method; Investment Decisions

1. INTRODUCTION

According to the literature, several authors have conducted within variant studies linking economic growth, job creation and well-being with new ventures and startups dynamism. Though few in number high-growth businesses (startup is associated with a business that is typically technology oriented and has high-growth potential) have a big impact on the economy (Kauffman Center, 2017). Research has indicated that startups differentiate themselves from other companies by expanding not just in size but also in number of new locations—creating new opportunities in diverse geographic areas (Acs et al, 2008) and encourage subsequent employment growth in their related industries (Bos et al. 2013).

Stenberg et al (2005), concerning the macroeconomics effects, mentioned that "entrepreneurship in the sense of the creation of new businesses is particularly related to innovation, competition and restructuring. A small but significant proportion of business startups introduce new knowledge to the economy, embedded in new products or new ways of producing an existing good or service". On the other hand, there are many consequences at the personal level of the startups founders, like earning a higher income and achieving quality objectives such as autonomy and independence, the opportunities for learning, by surmounting obstacles, through high levels of responsibility and by maintaining relationships with customers, business partners and advisors. General conclusion regarding the contributions of startups is that they play an important role in the economy serving as agents of change by their entrepreneurial activity, being the source of considerable innovative activity, stimulating industry evolution and creating an important share of the newly generated jobs.

In the light of the above, it is the view of authors that the research on startups characteristics is of high importance. While a significant amount of research activity has sought to measure new ventures, it generally has not distinguished among startups based on their initial growth potential or "entrepreneurial quality. This paper is a first step towards a more informed critique of the startup phenomenon and its evaluation, as part of a broader effort among both investors and entrepreneurs (startupers) to understand how to better support the growth of innovative startups. In particular, this paper makes an attempt to list and describe what investors do, and other stakeholders see when evaluating a startup in the early stage (pre-seed and development) during a business ideas competition.

Although, several studies of startup evaluation have been conducted previously, there are very few to examine the startups at the stage of the idea with the multi-criteria decision making method. The model, proposed in this paper, is based on three previous researchers who analyzed the criteria used by investors (venture capitalists and angel investors) to evaluate startup funding. Because of the complexity and multidimensional nature of the startup evaluation, the criteria were both qualitative and quantitative.

In a first phase, the selected criteria were divided into six general categories such as Financial, Market, Product-Strategic, Management team, Management competence and Business plan. Subsequently, the criteria weights, are estimated using a selection of a reference set and the inference of the weights through special linear programming techniques. In a second phase, a questionnaire was created, based on the selected criteria, in order to collect data from the submitted proposals (business plans) in the Mindspace Business Idea Challenge. Finally, the model using the multi-criteria method Promethee II, was applied to 15 different submitted proposals and a complete ranking based on a score called the net preference flow was built. As a result, all the submitted proposals would be ranked from the best to the worst one

2. PREVIOUS RESEARCH AND THE SELECTED CRITERIA

According to the literature, investment criteria have been studied extensively over the years using different methods, including personal interviews, unstructured interviews, conjoint analysis, verbal protocol analysis and observation (Zacharakis et al, 2000). Furthermore, the majority of authors give emphasis in the fact that investment criteria usually fall into six categories: the personality of the entrepreneur, the experience and qualifications of the entrepreneur and management team, the product/ service, the market and financial considerations. Although each of the studies that have been carried out, lead on specific criteria and specific weights, in the present paper the multi-criteria problem based on three surveys.

The first survey reports a formal study of the criteria used by venture capitalists when they evaluate venture proposals (MacMillan et all, 1985). Twenty-seven investment criteria were identified, collated, and assembled. The criteria were classed into six major groups related to: 1) the entrepreneur's personality; 2) the entrepreneur's experience; 3) the characteristics of product/service; 4) the characteristics of the market; 5) the financial considerations and 6) the composition of the venture team. According to the authors, the most important finding from the study is the direct confirmation of the frequently iterated position taken by the venture capital community that above all, it is the quality of the entrepreneur that ultimately determines the funding decision.

The second survey conducted by Muzyka et al. (1996) who emphasize that venture capitalists have to make trade-offs between various criteria in their screening of investments. In particular, they used a conjoint analysis (trade- offs) to analyze 35 criteria, which are grouped in seven general categories: 1) financial criteria, 2) Product-Market criteria, 3) Strategic-Competitive criteria, 4) Fund criteria, 5) Management team criteria, 6) Management competence criteria and 7) Deal criteria. Muzyka, Birley and Leleux (1996), found that venture capitalists would prefer to select an opportunity which offers a good management team and reasonable financial and product market characteristics, even if the opportunity does not meet the overall fund and deal requirements.

The third and last survey refers to an advance understanding of the decision-making criteria currently used by Canadian equity investors to evaluate early stage technology based companies. Bachher and Guild (1996), with the article "Financing early stage technology based companies: investment criteria used by investors", concluded in a total of 95 criteria which they received a assignment to one of five categories: 1) characteristics of the entrepreneur(s), 2) characteristics of the market, 3) characteristics of the venture offering, 4) investor(s) requirements and 5) characteristics of the investment proposal.

3. THE SELECTED CRITERIA AND THE EVALUATION MODEL

To achieve an overall assessment for evaluating the urban development proposals, a consistent family of criteria was built according to the classical multicriteria modeling methodology of Roy (Roy, 1985). According to this methodology a multicriteria evaluation system should be composed from criteria that respect the monotonicity, exhaustiveness, and non-redundancy properties. According to the combination of the above three surveys, the authors were concluded in 31 final evaluation criteria which separated in six general categories in Table 1.

Table 37 The selected criteria

C_1: Financial criteria	**C_2: Market criteria**	**C_3: Product-Strategic criteria**
$C_{1.1}$: Net Present Value (NPV)	$C_{2.1}$: Degree of market already established	$C_{3.1}$: Technology Readiness Levels - degree of maturity
$C_{1.2}$: Time to breakeven	$C_{2.2}$: Existing size of market is attractive	$C_{3.2}$: The product is proprietary or can otherwise be protected / copyright - patent
$C_{1.3}$: Internal Rate of Return (IRR)	$C_{2.3}$: The target market enjoys a significant growth rate	$C_{3.3}$: Ease of market entry
$C_{1.4}$: Return of Investment (ROI)	$C_{2.4}$: Sensitivity to economic cycles	$C_{3.4}$: Not easily imitated nor substituted
$C_{1.5}$: Validation and Stability of Financial values	$C_{2.5}$: There is a strong dominant competitor with a large market share	$C_{3.5}$: Specific legal arrangements – Licensing
C_4: Management team criteria	**C_5: Management competence criteria**	**C_6: Business Plan**
$C_{4.1}$: Corporate synthesis (number of partners)	$C_{5.1}$: Process/Production capability of team	$C_{6.1}$: The amount of initial investment
$C_{4.2}$: Track record of lead entrepreneur	$C_{5.2}$: Organizational/Administrative capability of team	$C_{6.2}$: Timetable for the development and implementation of the overall project
$C_{4.3}$: Management commitment	$C_{5.3}$: Financial/Accounting capability of team	$C_{6.3}$: Holding period of the investment
$C_{4.4}$: Recognized industry expertise in management team	$C_{5.4}$: Management team's research and development background	$C_{6.4}$: Distinction in competitions for innovation and entrepreneurship
$C_{4.5}$: Job experience of management team	$C_{5.5}$: Marketing/Sales skills of management team	$C_{6.5}$: Participation in business incubator
	$C_{5.6}$: Level of education	

3.1 The Promethee II method

The Promethee II ranking method was first developed by Professor Jean-Pierre Brans in 1982 and is among the most widely used multicriteria decision aid methods. Many organizations (private companies, public administrations, research centers, universities, individuals,) worldwide have been using Promethee II for their decision-making or evaluation problems in various fields such as: banking, human resources management, water resources, investment, environmental problems, planning etc.

The Promethee II ranking is a complete ranking method. This means that all the actions are compared and that the ranking includes no incomparabilities even when comparison is difficult. The resulting ranking can thus be more disputable, especially in the presence of strongly conflicting criteria.

The ranking is based on the net preference flow. It combines the two-other preference flows in a single summary score. So, action a is preferred to action b in the Promethee II ranking if and only if it is preferred to b according to the net preference flow. That is:

$aP^{II}b$ *if and only if* $f(a) > f(b)$

where P^{II} stands for "is preferred to in the Promethee II ranking".

3.2 Weighting of criteria

Although there are several methods which give an appropriate value to the weights of criteria, in this paper the Simos method have been used. According to Simos (1990 a, b) a set of cards is used, allowing someone to determine indirectly numerical values for weights. The main advantages of the technique are: it is less arbitrary than direct assignment of weights, it is much simpler than most indirect techniques, it can be easily understood by decision makers and leaves them enough freedom to accurately articulate their preferences (Stranzali et al, 2017).

Table 38 Criteria weighting

Ranking	*Criteria*	*Number of criteria (N)*	*Weight W*	*Average Weight =ΣW/N*	*W*	*Relative Weight (%) w = (W /ΣW)×100*
1	$C_{2.1}$, $C_{2.4}$	2	1,2	3		2,20%
2	$C_{1.4}$, $C_{3.3}$	2	3,4	3,5		2,56%
3	$C_{1.3}$, $C_{2.5}$, $C_{3.1}$, $C_{3.5}$	4	5,6,7,8	6,5		4,76%
4	$C_{6.1}$, $C_{1.2}$, $C_{2.2}$, $C_{3.2}$	4	9,10,11,12	10,5		7,69%
5	$C_{6.2}$, $C_{6.4}$, $C_{6.5}$, $C_{3.4}$	4	13,14,15,16	14,5		10,62%
6	$C_{1.1}$, $C_{4.1}$, $C_{4.2}$ $C_{5.3}$	4	17,18,19,20	18,5		13,55%
7	$C_{2.3}$, $C_{5.4}$, $C_{5.6}$, $C_{6.3}$ $C_{1.5}$	5	21,22,23,24,25	23		16,85%
8	$C_{5.1}$, $C_{5.2}$, $C_{5.5}$	3	26,27,28	27		19,78%
9	$C_{4.3}$, $C_{4.4}$, $C_{4.5}$	3	29,30,31	30		21,98%
Total		**31**	**820**	136,5		**100%**

Table 2 gives an explanatory example of the way weights of importance are calculated from the defined rank order. Criteria with the same rank are placed in the same row. As can be observed the criteria $C_{4.3}$, $C_{4.4}$, $C_{4.5}$ are ranked with the highest weight, whereas the criteria $C_{2.1}$, $C_{2.4}$ with the lowest.

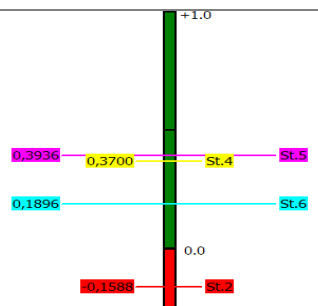
4. RESULTS

The final stage of the evaluation process was the implementation of the already constructed model in cooperation with the Mindspace (a Greek student organization for entrepreneurship and innovation). The constructed model was applied in semifinals of the Mindspace Challenge (Entrepreneurship and Innovation Business Idea Competition) in Ioannina, Greece with the selection of 6 startups (St.1, St.2, St.2, St.4, St.5 and St.6).

In the final stage, it is the presentation of the results obtained by applying the PROMETHEE II method. As mentioned in the previous section classification determined by the value of the net flow ϕ, calculated from the difference of the positive to the negative flow classification.

Table 39 PROMETHEE rankings and flow table

Φ Preference Flows			**Promethee II Complete Ranking**
Phi+	Phi-	Phi	



St.1	0,1084	0,4848	-0,3764
St.2	0,2381	0,3968	-0,1588
St.3	0,0926	0,5106	-0,4181
St.4	0,5638	0,1938	0,3700
St.5	0,5453	0,1517	0,3936
St.6	0,4207	0,2311	0,1896

As it can be seen from the results obtained from Promethee, the final ranking of the alternative business plans-ideas (startups) the alternative proposal St.5 dominates and, also, the proposals St.5, St.6 and St.4 are the only ones that have a positive net flow ϕ.

5. CONCLUSIONS

This study provides an evaluation framework to assess and rank the optimal new ventures in a business idea competition. In order to evaluate a startup, a new valuation model was proposed using the multi-criteria valuation method – Promethee II. A coherent set of 31 criteria was selected, grouped in six main categories: Financial, Market, Product-Strategic, Management team, Management competence and Business Plan. The model has been validated under real conditions. It has been compared and classified 6 startups proposals, that are submitted in Mindspace Business Idea Challenge. The results obtained from the proposed methodology were the same as the results of the challenge. This approach demonstrates that the proposed evaluation model, and multicriteria analysis in general, could be used in the assessment of innovative startups in their initial growth.

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