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Smart Technology Trends in Industrial and Business Management

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Preface

This publication is a collection of rigorous research projects that were presented at the "*Industry of Things and Future Technologies"* international conference. The event took place in Bratislava, Slovakia, during November 22–24, 2016, and was endorsed by the European Alliance for Innovation, a leading community-based organisation devoted to the advancement of innovation in the field of ICT. The conference was organised by the Slovak University of Technology in Bratislava, Faculty of Materials Science and Technology in Trnava (MTF STU) and the Technical University of Košice, Faculty of Manufacturing Technologies with a seat in Prešov (TUKE).

The Internet of Things (IoT) offers advanced connectivity of devices, systems, and services that reach beyond machine-to-machine communications and covers a variety of domains. Therefore, the main goal of the conference was to determine the next level technologies that will drive Industry 4.0 and IoT forward and to introduce industrial innovations, smarter key technologies, and novel approaches to data analysis, rethink strategic planning, develop new opportunities, address challenges, and explore its solutions. Additionally, the focus of the conference reflected the European Union thematic priorities for research and innovation to improve the quality of life for citizens and make cities more sustainable with decreasing impact on the environment.

The conference articles were presented in the four thematic areas:

- *Technology* (responsibility in IT business, creative technologies, intelligent transport systems, advances in robotics and machine vision as a key success factor in innovative companies, the role of the human factor in the performance and sustainability of manufacturing, challenges of IoT to cybersecurity, engineering secure IoT systems, IoT impact on critical infrastructures, and others)
- *Internet* (future Internet, Internet of Things, security and safety, smart cities, creative cities)
- *Innovation* (industrial networks and intelligent systems, social networks [social marketing] and innovation in social areas, new perspectives in transport innovation, green vehicles, fast track for transport innovation, socio-economic and

behavioural research for policy-making, novel trends in production devices and systems, and others)
- *Mobility* (mobility within Danube strategy, smart mobility, mobility and its consequences on health and well-being, urban mobility, E-mobility, congestion-free, and sustainable mobility)

This publication encompasses a total of 34 research articles with worldwide contributors. Among the project findings featured in this publication are those written by the conference keynote speakers, e.g. Dr.h.c. Mult. Prof. Ing. Juraj Sinay, DrSc., the Head of the Department of Safety and Quality in Mechanical Engineering at the Technical University in Košice and the President of Automotive Industry Association of the Slovak Republic. Prof. Dr. Dragan Perakovic, the Head of Department for Information and Communication Traffic and Head of Chair of Information Communication Systems and Services Management at the University of Zagreb, and the chief editor of the International Journal of Cyber-Security and Digital Forensics (IJCSDF), contributes with his research article on Smart Wristband System in Traffic Environment. His study is included in the Smart Transportation Applications and Vehicle Data Processing System for Smart City Buses section of this release.

Next, at the conference presented highly acclaimed scholar Prof. Pedrag Nikolič who serves as a Dean of the Faculty of Digital Production at Educons University, Serbia, together with Prof. Adrian David Cheok, the director of Imagineering Institute in Malaysia. Among others, we are proud to achieve the scholarly success of this edition which resulted from our cooperation with the Comenius University in Bratislava, the Faculty of Management, and their prestigious contributors Assoc. Prof. Ján Papula, Assoc. Prof. Zuzana Papulová with the research team, Assoc. Prof. Gabriela Bartáková-Pajtinková, and Assoc. Prof. Katarína Gubíniová. We were additionally delighted to welcome Assoc. Prof. Katarína Stachová and Assoc. Prof. Zdenko Stacho from The School of Economics and Management in Public Administration in Bratislava. The Department of Management at MTF STU and The Institute of Management from Slovak Technical University were represented by Prof. Tatiana Kluvánková, Prof. Maroš Finka, and Assoc. Prof. Daniela Gažová with their teams at the conference.

Moreover, thanks to an excellent collaboration between MTF STU and the Department of Marketing and Trade at the Slovak Agricultural University in Nitra. Prof. Ľudmila Nagyová and Dr. Mária Holienčinová shared their scholarly expertise in the Smart Technology Trends Business Management section of the publication. We are also thankful for the research article contribution under the leadership of the Assoc. Prof. Marian Králik from STU Faculty of Mechanical Engineering, Dr. Peter Pištek with his colleagues from Faculty of Informatics and Information Technologies, and Prof. Michal Cehlár, the Dean of Faculty of Mining, Ecology, Process Control and Geotechnologies (BERG) at the Technical University of Košice (TUKE) with his team whose contributions are included in the Smart Transportation Applications and Vehicle Data Processing System for Smart City Buses section of the publication. Furthermore, we are grateful to Assoc. Prof. Dagmar Petríková who leads the Department of Spatial Planning and Management at the MTF STU.

Additionally, we would like to show appreciation to the PhD candidates and other academics from the MTF STU Faculty of Materials Science and Technology, particularly to Dr. Natália Horňáková, MSc. M.A. Richard Jurenka, and MSc. Augustín Stareček who mastered the exemplary teamwork and for their rigorous contributions to this publication as well as many other outstanding contributions from various institutions. Other areas of expertise covered in this edition include Industry of Things and Future Technologies and Smart Technology Trends in Industrial Management and Materials.

As chairs of the conference, we were particularly impressed by the wide range of innovative research solutions presented at the symposium. In the light of the latest knowledge and findings from scientific projects, the authors present actual R&D trends in the given field. Therefore, the Scientific Committee members and organisers would like to express their sincere thanks to all the authors who attended the conference in Bratislava, Slovakia, and particularly to the authors, who contributed to the creation of this publication. This issue not only defines the state of the art in the field, but it additionally explores related topics for future research. Moreover, we would like to thank the audience members who actively interacted in the discussion on the topics mentioned above.

Trnava, Slovakia

Dagmar Cagáňová
Dorota Horvath

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I would like to thank all the authors and reviewers, especially Prof. Juraj Sinay, Prof. Dragan Perakovič, and Assoc. Prof. Juraj Pančík who are our keynote speakers. My thanks to the Dean of Faculty of Manufacturing Technologies with a seat in Prešov of Technical University of Košice Dr. h. c. Prof. Dr. Jozef Zajac, to the Head of the Department of Industrial Engineering and Informatics, to Assoc. Prof. Dr. Michal Balog, and to my colleague Dr. Jozef Husár.

Lucia Knapčíková

Contents

Part I
Industry of Things and Future Technologies

Chapter 1
Application of AHP Method in Decision-Making Process

Richard Jurenka, Dagmar Cagáňová, and Daniela Špirková

Abstract The paper deals with the application of method – analytical hierarchy process in action of decision-making in the field of innovation management of industrial companies. Analytical hierarchy process is a tool for application of exact methods in process of decision-making. The paper contains theoretical description of analytical hierarchy process and subsequently also application of this method in the field of innovation management. Method of analytical hierarchy process brings into action of decision-making objectivity, exactness, and also the quality of the evaluation. Perhaps the biggest advantage of this method is that this method allows to evaluate comprehensively all the criteria of alternative solutions. This paper aims to highlight the widespread use of method – analytical hierarchy process in the decision-making process, including in the field of innovation management.

Introduction

In the modern business environment, organizations must respond to new challenges, constant changes, and opportunities and also must respond to the different requirements and various restrictions. Permanent transformation of the business environment is in contemporary world the necessity of continuous innovation and changes.

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Nowadays from existing organizations, some flexibility, dynamism, and constant adaptation to changing conditions are expected. The current social conditions are reflected in organizational behavior of individual companies and also in their decision-making process.

Social environment in this century is very dynamic, changeable, unstable and hardly predictable. Result of these factors is instability and unpredictable development in social environment. Different changes in such an environment and conditions are becoming a necessity and everyday reality with which organizations must deal by their flexibility and ability to adapt to new and new conditions. In dynamic environment, in which organizations want to operate and develop, constantly bringing new enhancements, innovations, ideas, and thoughts is fundamental for companies. For selection the correct option of advancement is a necessary perfect decision-making process that will consider all the factors, risks, and opportunities in outside and inside environment.

Exact Methods in Managerial Decision-Making

Decision-making is an integral part of management processes in every company and intersects across all functions of management – planning, organizing, staffing and maintaining staff, leadership people, and controlling. All managers at all levels of directing make decisions, while the ultimate effect of these decisions can have a significant impact on a range of other activities. Some decisions are strategic in their nature and significantly affect company's survival on the market; other decisions can be seemingly pointless. However, all decisions have the certain impact on business performance; therefore it is very important to give adequate attention to decision-making issue [1].

Decision-making as a complex process involves a number of different phases that must be met in order to have a final decision. Final decision is selected from several variants of solutions. Managers and competent persons, respectively, have to make decisions even under changing conditions, under pressure, in a state of uncertainty or risk, and under the influence of certain restrictions, respectively. The decision-making process is therefore a nonrandom selection of one variant of the solution according to certain criteria in order to meet predefined objectives.

Decision-Making Process

Decision-making process constitutes a comprehensive system which is characterized by the following parts:

- Decision problem – is a reflection of the significant deviation between the desirable state (planned or established standards) of specific decision object and its real state
- Decision-making situations – is given by the object of decision (selected process or operation), by state of internal or external conditions which cause deviations

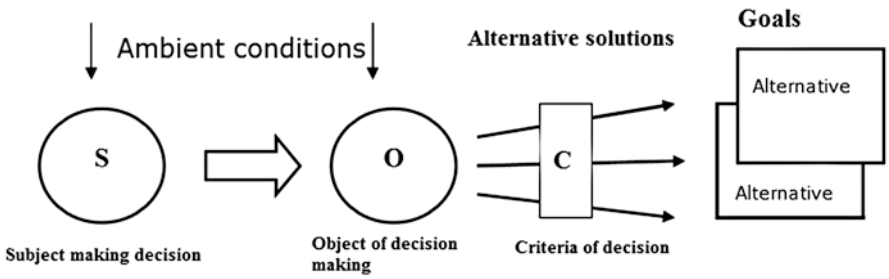

Fig. 1.1 Decision problem and decision-making situations [2]

from the desired state, by setting targets or its alternative aims, and by criteria, variants, and sometimes also consequences of possible decisions

- Decision-making process – the process of choosing between several possible solutions (search and selection of suitable alternatives solutions for the current problem)
- Variations of decisions – option of several possible and different solutions which ideally suits to specific criteria [2]

Decision-making process is affected among other things by ambient conditions, subject making decision, the object of decision-making, decision-making criteria, and setting of goals. The following picture shows how the abovementioned elements affect decision-making process (Fig. 1.1).

Necessary assumes for creating high-class decisions:

- Clear statement of the target goal which must be achieved by decision
- Adequate, verified, quality, timely, reliable information that are the basis for making any high-grade decision
- Adequate qualification and competence of decision-makers. Using appropriate methods, tools, and knowledge [3]

Decision-making process is divided by majority of authors into several main groups of steps (e.g., analytical part, project part, evaluation part). In books from many authors, it is possible to find several models of decision-making process. In context of this paper, we suggest to determine the content and steps of decision-making process in general as [2]:

1.	Discovering of the problem and acceptance of decision to resolve the existing problem
2.	Identification and analysis of the situation and analysis of the problem, causes of the problem, and possible consequences in the event of failure to resolve the whole problem
3.	Determining criteria for choosing the right solution (general requirements for possible solutions, which must be legal, ethical, economic, and feasible)
4.	Creating (generating) possible variants of solutions
5.	Assessment of possible variants of solutions according to established criteria
6.	Selecting the optimal solution
7.	Evaluation (testing) of the chosen decision – assessment of its positive and negative consequences
8.	Formulation of decision and determination of implementers, procedures, and forms

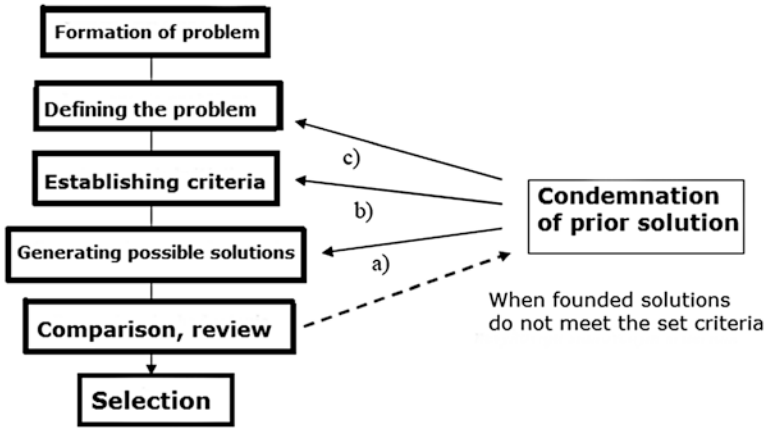

Fig. 1.2 Decision algorithm [2]

The following figure shows a decision algorithm:

In business practice the decision-making process is not always as objective, uninfluenced by each successive step, which is shown in Fig. 1.2, because a specific decision-making process can be affected by in-house arrangements, conventions, or stakeholder or under the influence of a supervisor person [4].

Exact Methods and Analytical Hierarchy Process (AHP)

Exact methods of operational analysis can be classified among the most advanced quantitative methods for decision-making. The main role of these methods is to find among the possible variants of solutions the best variant in accordance to existing problem or target goal. Among the exact methods, which are designed for resolving decision-making problems, are the relationships between the elements mainly expressed quantitatively which may include:

- Methods of mathematical statistics – theory of probability, correlation analysis, and time series analysis
- Methods of mathematical analysis and linear algebra – differential numbers, extrapolation, and matrix number
- Methods of operational analysis – economic-mathematical methods, structural analysis, network analysis, models of mass operation, etc.
- Multi-criteria decision-making methods [5]

The analytical hierarchy process is a systematic approach created in 1970 for structuring the experience, intuition, and heuristic-based decision-making into a properly defined methodology based on mathematical principles. The AHP method was created for the needs to return to quantitative assessment in decision-making process. This method provides a formalized approach for creating solutions [6].

The AHP method was created in the late 1960s by Thomas L. Saaty, an American professor who worked at the University of Pittsburgh. Saaty's analytical hierarchy process offers a methodology that allows to model complex decision situation and determine the appropriate choices.

This approach has been developed to help solve complex problems. Although this method was not originally intended for collective decision-making, nowadays thanks to its transparency and consistency is using also for group decision-making process [6].

The method of analytical hierarchy process is based on scientific analysis. This method, among other things, can be used also in the process of formulating the strategic objectives of stakeholders as well as in decision-making process in terms of crisis or risk management. The AHP method provides the framework for making effective decisions in situations, when the choosing of best decision is needed or fundamental. AHP method enables to prepare effective solutions in complex situations and simplifies the natural decision process [7].

The AHP method is one of the most exact objective methods of multi-criteria decision-making but still has several disadvantages. One of the major disadvantages of the method is burdening some steps in its application with a certain degree of subjectivity. For this reason it is necessary to objectify the allocation of specific weights for the individual criteria, which minimize subjectivity and ultimately lead to an overall objectification of the AHP method. Therefore it is necessary to create a tree structure as far as possible in an exact way that could minimize the subjective impacts of evaluators. Possible solution that partially removes such a problem is performing of an evaluation with the participation of a group of evaluators that are experts in the specific field. Objectivity could be increased by assignment of weights to individual evaluators; this process could reflect the importance of individual experts [8].

Structured hierarchy of AHP method represents a system for optimization, which consists of a primary objective, criteria, and alternatives, respectively, in other words variations. The criteria can be further spaced out to sub-criteria; this division can lead to as many levels as necessary for resolving the problem.

AHP is a method of decomposition of complex unstructured situation into simpler components. This method is first done by an expert method and then by mathematical method, which divides the main problem into smaller and more detailed elements [7].

Advantages and Disadvantages of the AHP Method

Advantages of the AHP method [7]:

- Pair comparison allows to make easier conclusion
- The method requires just one pair comparison between all criteria and between all variants of solutions
- The method is very simple and clear
- Exact weighting of individual criteria and clear results from quantitative assessments