Research Journal of Recent Sciences _____ ISSN 2277-2502
Vol. **4(6),** 116-131, June **(2015)** *Res.J.Recent Sci.*

Evaluating the Business Intelligence in Organizational Decisions using an integrated ANP, DEMATEL and TOPSIS Approach

Zahra Khodadadi Dehkordi[1], Mohammadreza Motadel[2] and Tahmores Sohrabi[2]
[1]Department of Information Technology Management, Electronic Branch, Islamic Azad University, Tehran, IRAN
[2]Department of Industrial Management, Central Tehran Branch, Islamic Azad University, Tehran, IRAN

Available online at: www.isca.in, www.isca.me
Received 5th February 2014, revised 10th April 2014, accepted 16th June 2014

Abstract

Decision making is critical in any business and always all businesses are involved in decision making. Such decisions influence cost, productivity, quality and performance. Thus, the success key in every organization is selection proper choice and appropriate decision making. Business intelligence is a novel approach in the organizational business and architecture which makes managers prepared for decision making and provides relatively comprehensive and realistic analysis of the institution's condition through rapid data access and analysis. Hence, current research work aims at identifying effective factors of business intelligence in organizational decisions and determining significance degree of the factors and specifying the main factor. It is an applied research work in terms of purpose of study and it is qualitative study in terms of data. Nature of the research method is descriptive survey. Statistical population includes 100 senior, middle and operational managers in Islamic Revolution Mostazafan Foundation (Foundation of the Oppressed and Disabled or "MFJ"). Statistical sample was selected non-randomly. This work provides an integrated model taken from Analytic Network Process (ANP), Dematel, and TOPSIS and proposes solution of supporting analytical and intelligent decision making as the best solution for evaluating business intelligence in organizational decisions and makes some recommendations for the future works.

Keywords: Organizational decisions, business intelligence, analytic network process (ANP), decision-making, trialand evaluation laboratory (Dematel), technique for order preference by similarity to ideal solution (TOPSIS).

Introduction

Socioeconomic reality of contemporary organizations necessitates them to search for tools for facilitating effective process of data acquisition, analysis and processing from different and scattered sources so that a new foundation is established for new knowledge exploration. Over the years, management information systems supported organizations in performing their tasks/ however, available management information systems so far could not meet expectations of organizational decision makers. Thus, business intelligence was introduced as a way for dealing with inefficiencies of management information systems[1]. Business intelligence systems include a wide set of programs and techniques for data collection, storage, analysis and access which help organizational management in making better tactical and strategic decisions[2]. Business intelligence systems provide practical information in appropriate time when decisions are to be made[3]. Large organizations mainly use business intelligence systems for management, supervision over business activities, reporting, planning, supporting decision making and improving their relationship with the customers[1]. Business intelligence provides capability of data access and analysis[4], so that scattered data from different sources of large organizations are grouped in a coherent and integrated manner and thus an overall or 360-degreeperspective of the business is provided[5]. Business intelligence can be defined as a wide collection of software platforms, practical programs and technologies which effectively and efficiently help decision makers. At top management levels, business intelligence systems provide input for strategic and tactical decisions[2]. In lower managerial (operational) levels, business intelligence systems help people in performing their daily activities[3]. At strategic level, business intelligence systems provide such information, based on which it is possible to produce future results according to the past results. At tactical level, they provide a basis for decision making for operations so as to optimizing overall company's performance. At operational level, business intelligence systems offer appropriate and timely analysis of the performance of a department or part of the organization (intelligence). One of the important components for success of modern companies is ability of the companies for using the whole available information capacity through online analytical processing (OLAP)[6]. It refers to some techniques which perform complex analysis on the data stored in database and turns them into decision making data[7]. Main aim of the current work is providing a model for business intelligence evaluation on organizational decisions with Analytic Network Process (ANP) approach, Decision Making Trial And Evaluation (Dematel), and Technique for Order Preference by Similarity to Ideal Solution (TOPSIS). The study was carried out as a case study in central staff of Islamic Revolution Mostazafan Foundation. Its minor aim is rating and prioritizing identified factors and suggesting the best solution. According to the model in figure-1

and considering review of related literature, following hypotheses are proposed:

The most effective index in business intelligence evaluation at strategic decisions level is index of focus on financial characteristics. The most effective index in business intelligence evaluation at tactical decisions level is consolidated and combined reporting (MRS / Excel). The most effective index in business intelligence evaluation at operational decisions level data collection and storage in private databases. Options of business intelligence evaluation in organizational decisions (organizational level and strategic, tactical and operational management levels) in Islamic Revolution Mostazafan Foundation include respectively: i. Options of supporting intelligent analytical decision making, ii. options providing relevant experience and integration with environmental data, iii. Options of optimizationand model suggestion, iv. Options of reasoning capability, v. Options of advanced decision making tools, vi. Options of shareholders satisfaction. Options of supporting intelligent analytical decision making are the most effective options of business intelligence evaluation at decisions level (strategic, tactical, operational). Integrated model proposed with ANP, Dematel and TOPSIS approaches is a reliable model for business intelligence evaluation at managerial decisions levels (strategic, tactical, operational).

Although business intelligence systems are widely used in business, there are rare research works on them[3]. Understanding value of business intelligence systems for business is crucial since such systems support decision making at all management levels including strategic, tactical, and operational through data analysis and delivery[1]. Aim of the current work is evaluating business intelligence at three management levels. In the proposed model, criteria are strategic, tactical and operation criteria at management levels and indexes are effect of business intelligence which is investigated in these levels. Options include tools which are used for implementing intelligence business at organizational decisions levels. In fact, aim of the current research study is proposing the best solution for facilitating and supporting managers' decision making process at three managerial decisions levels, and investigating effects of business intelligence on management decisions at management decisions levels. Following analysis of business intelligence advantages based on Analytic Network Process (ANP), Decision Making Trial And Evaluation (Dematel) and Technique for Order Preference by Similarity to Ideal Solution (TOPSIS), current research study attempts to answer this question: how it can propose an appropriate model for business intelligence evaluation and its effect on organizational decisions with ANP, Dematel, and TOPSIS approach at management decisions levels.

Review of Literature

Value of business intelligence systems in the business mainly denote the fact that such systems provide information which may be used as basis for essential changes in a particular company. Business intelligence systems are different from traditional management information system in various ways. Frist, they cover a wide range of topics. Second, they provide multivariate analysis and structured data from various sources and offer multidimensional data. In addition, it is assumed business intelligence systems, regardless of level of their creators, support decision making at all management levels[1]. business intelligence systems refers to a managerial philosophy and tool which helps organizations in management and refining business data in order to take effective decisions[8]. Business intelligence aims at helping to control business data resources and flow within and around the organization. Business intelligence in the information century helps considerably to organization's management knowledge and intelligence by identifying and processing abundant and different data. Business intelligence provides business information in due time in appropriate way and offers ability of reasoning and understanding implicit meanings in information[9]. According to reviewed literature, the main application of business intelligence is helping decision making in organization. Thus using structured and non-structured data of organizational systems is the basis for business intelligence in the organization[10]. Business intelligence systems can be used for directing and improving decision making in all strategic and tactical and operational levels[11]. At operational level, decisions are related to current operations of the organization. These decisions are generally related to daily financial information, dealing information and cooperation with suppliers and customers[1]. At this level, business intelligence takes scattered data in the organization's current operations and transform them to information form and provides them to decision makers of the organization[12]. Business intelligence systems provides information at operational level which leads to[1]: Identifying problems and bottlenecks. Providing the best and worst analysis. Product analysis, 4.Providing staff analysis. Presentation of local analysis (using measurable criteria such as sales, expenses or measurable results). Interim analysis platform and answering questions related to current and daily operations of finance and sales departments. Operational level decisions are those decisions which allow the organization to perform its daily activities[13]. Thus, a summary of data and information provided by business intelligence systems are analyzed at operational level and combined with external information so that strategic planning direction and path is provided for the organization[14]. At tactical level, decisions are related to planning and rely upon timely data and prediction for directing future measures of marketing, sale, financial affairs and capital management. Tactical level decisions are often made for supporting strategic decisions[1]. Details of the activities related to tactical decisions which are supported by business intelligence systems include: Analysis of the deviation from the realization of special programs of organizational units, individuals or indexes. Decisions related to direct marketing, sales, finance and asset management. Forecasting demand for a certain product or service. Information provided from these activities allows

optimization of the actions which are going to be performed in the future and organizational dimensions of the company's performance are improved[14]. At strategic level, decisions are related to a set of goals which it should be ensured they are well realized. Business intelligence systems at strategic level provide information which supports strategic decisions related to extending future results based the past results, profitability, and effectiveness of the distribution channels[1]. Negash[3] maintains that based on previous data and information, strategic decisions make some predictions using business information systems and integrate them with current performance of the company and then it is used for estimating future conditions of the organization[3]. According to the reviewed literature, data provided by business intelligence systems for decisions taken at strategic level are used for[3]: Setting the entry into new markets. Changing from a product- focused to customer-focused orientation. Launching a new product[15]. Determining objectives and their realization[1]. Business intelligence system term is used in this work as a general term covering most concepts such as information systems architecture and it is taken from information and business. Such systems are used for transforming data to information, information to decisions, and decisions to successful measures.

Lloyd[14] provided a research work entitled *Identifying key elements in business intelligence systems and their role in management decision making* and business intelligence systems are defined. Then their role is investigated in enabling business through knowledge creation. This study identifies four elements of the most common business intelligence tools including ETL tools, database, OLAP techniques and data mining. Finally it investigates use of business intelligence tools in facilitating management decisions at three levels of the organization (strategic, tactical, and operational). His work is used in the current study in order to examine use of business intelligence and its effect at management decisions level and extract indexes. It has been also widely used in literature on business intelligence[14]. Ghazanfari et al.[16] provided a research paper entitled *A tool for business intelligence evaluation in organizational systems*. It argues that most organizations yet experience lack of business intelligence (BI) in their decision making processes at organizational systems. Thus, models and techniques of intelligent evaluation and investigation at organizational systems level can be effective in improving supporting decision making. This research paper proposes a specialized tool for investigation competency of business intelligence in the systems using a combination of statistical methods and factor analysis. Factor analysis identifies six factors for evaluation model, which include: Analytical and Intelligent decision support. Providing related experiment and integration with environment. Optimization and recommending models. Reasoning. Enhanced decision tools. Shareholder's Satisfaction. Intelligence of business systems can be measured using extracted indexes and show them in six dashboards. Organizations can have better support for decisions at their organizational environments with this evaluation approach, which enables them to use it for achieving higher competitive advantage. In fact ns or solutions of business intelligence in the current research study. In the current study, the starting point is identifying all key elements which are usually present in all business intelligence systems. Solutions of business intelligence used in the organization under study (Islamic Revolution Mostazafan Foundation) are classified into 6 classes considering reviewed literature and findings of similar works. Of course, each class also includes some tools which are ranked at the end of study[16]. All research variables are shown in a conceptual model in figure-1.

Methodology

Considering the main aim of this work is proposing an integrated model for business intelligence evaluation on organizational decisions with ANP, Dematel, and TOPSIS approach, it can said it is an applied study. Considering library and field study methods were used, it is a descriptive survey in terms of nature and methodology. Statistical population includes 100 managers at 8 departments of Islamic Revolution Mostazafan Foundation including 8 strategic managers, 40 tactical managers, and 52 operational managers and supervisors. Following methods were utilized in this work: Delphi method to determine the validity of questionnaire. Cronbach's alpha to determine reliability of the questionnaire. Friedman Test for nonparametric inferential statistical analysis of the data and testing research hypotheses and. Model recommendation using mixed approaches of ANP, Dematel and TOPSIS. Analytic Network Process (ANP) technique is developed form of AHP which is able to model correlations and feedbacks between effective elements in one decision, and it is able to consider and enter all internal effects of effective elements in decision in the calculations. Thus, it is a distinct and the most perfect technique of multivariate-decision making methods. Dematel technique transforms causal relationships between elements in complex decisions to a tangible structural model[17]. It is comprehensive method for preparing and analyzing a structural model which includes cause and effect relations between complex factors[18]. This method acts based on directed graph theory. Result of Dematel method is division of present factors in two groups of causes and effects. Dematel is also used for structuring a set of assumed information, so that it examines strength of relationships as scoring form, it explores feedbacks along with their significance and accepts inalienable relations. In order to easy application, weighting method used by Gabus and Fontela[19] can be summarized in four steps: Developing direct relations matrix. Normalization of direct relations matrix. Formation of general relations. Developing causal diagram. TOPSIS technique is one of the best MADM models and it is widely used. In this method, ideal solution (also known as positive ideal) is solution which maximizes benefit of criteria / attributes and minimizes the cost of criteria / attributes, while negative ideal solution (which is also known as non-ideal solution) is the solution which maximizes cost of criteria / attributes and minimizes the benefit of criteria / attributes. The

best alternative is one which is closest to ideal solution and farthest one to negative ideal solution. TOPSIS method investigates both distance of alternative to positive ideal solution and negative ideal solution simultaneously by obtaining relative closeness to the ideal solution. This technique includes 6 steps: Normalization of decision matrix, weighting normalized decision matrix, determining the ideal and negative solution, calculating distance, calculation of closeness (Ai) toward the positive ideal, 6 - ranking of options. All indexes and options were provided using Delphi method as well as taking opinion of managers and experts and eliminating components. Mean of which was less than total mean. Cronbach's alpha was reported for indexes of strategic, tactical and operational level as 806, 833, and 850, respectively. Questionnaires related to indexes of these levels were verified and their reliability was confirmed. Cronbach's alpha for options (solutions) of business intelligence at management levels for each class of solutions was reported as follows: 0.893, 0.742, 0.783, 0.817, 0.739 and 0.762, respectively, and reliability of the respective questionnaire was confirmed.

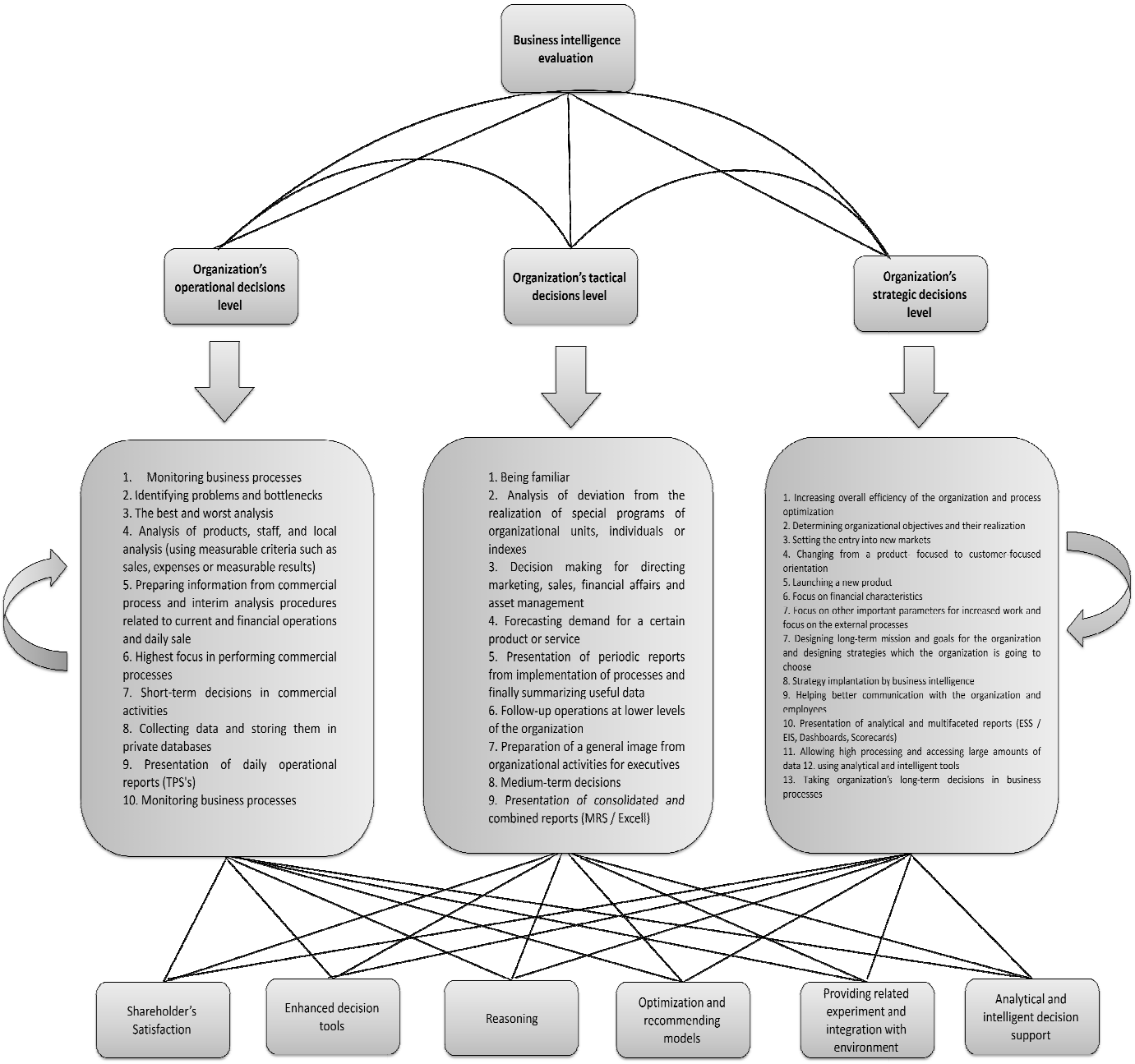

Figure-1
Research Conceptual Model

Table-1
Friedman Test results for prioritizing indexes of strategic, tactical, and operational levels by SPSS

Friedman Rank	**indexes of strategic level**	**Mean rank**
1	Focus on financial characteristics	7.7
2	Timely access to cost information	6.65
3	Allowing high processing and accessing large amounts of data using analytical and intelligent tools	6.05
4	Presentation of analytical and multifaceted reports (ESS / EIS, Dashboards, Scorecards)	5.85
5	Increasing overall efficiency of the organization and process optimization	5.55
6	Taking organization's long-term decisions in business processes	5.25
7	Determining entry into new markets	5.2
8	Helping better communication with the organization and employees	4.9
9	Launching a new product	4.4
10	Focus on other important parameters for increased work and focus on the external processes	3.45
Friedman rank	**indexes of Tactical level**	**Mean rank**
1	Presentation of consolidated and combined reports (MRS / Excell)	5.1
2	Presentation of periodic reports from implementation of processes and finally summarizing useful data	4.95
3	Being familiar	4.9
4	Preparation of a general image from organizational activities for executives	4.48
5	Analysis of deviation from the realization of special programs of organizational units, individuals or indexes	4.48
6	Medium-term decisions	4.15
7	Follow-up operations at lower levels of the organization	3.95
8	Forecasting demand for a product or service	3.35
Friedman rank	**indexes of operational level**	**Mean rank**
1	Collecting data and storing them in private databases	3.35
2	Identifying problems and bottlenecks	3.1
3	Monitoring business processes	2.9
4	The best and worst analysis	2.85
5	Short-term decisions in commercial activities	2.8

Results obtained from testing H1, H2, and H3 shown in Table 1 indicates that focus on financial characteristics is the most effective index of business intelligence at strategic decisions level, presentation of consolidated and combined reports (MRS / Excel) is considered as the most effective index at tactical decisions level, and collecting data and storing them in private databases is regarded as the most effective index at operational decisions level. Thus, H1, H2, and H3 are supported given results of Friedman Test.

Priority of Effective Indexes in Business Intelligence at Decisions Level (Strategic, Tactical, Operational): In proposed model, the purpose is evaluating business intelligence in organizational decisions and criteria include three levels of decisions (strategic, tactical, and operational). Considering results of calculations in the previous step, 3 classes of main indexes (overall 23 indexes) were determined as business intelligence indexes at the organization's management decisions levels. They include 10 indexes at strategic level, 8 indexes at tactical level, and 5 indexes at operational level. Then pairwise comparison questionnaire with 9-point scale was designed for pair wise comparison of business intelligence indexes. Using its data, pairwise comparison and weight of business intelligence indexes were calculated by Eigenvector technique. Matrix consistency rate was investigated and calculated in the next step. Then internal weight between indexes was estimated using

Dematel method and normal value of Matrix T was calculated. At last, priority of indexes or their weights was calculated using Super Decisions Software and considering results obtained from Dematel method, results of which are given as follows. It should be noted as it is observed in software image (figure-2), it is assumed there is interrelation between main criteria, i.e. there management decisions levels. In addition, interrelation was also considered between indexes in each index classes.

Results of Pairwise Comparison and Calculating Weight of Business Intelligence Indexes at Decisions Levels Using Eigenvector Technique: Table gives weights obtained from geometric mean method for the main criteria of the research. Following obtaining weight of the main criteria, their internal effects weight should be calculated. Table 3 gives related weights of the criteria. It should be noted pairwise comparison tables with two components, indexes or options do not need calculation of inconsistency rate.

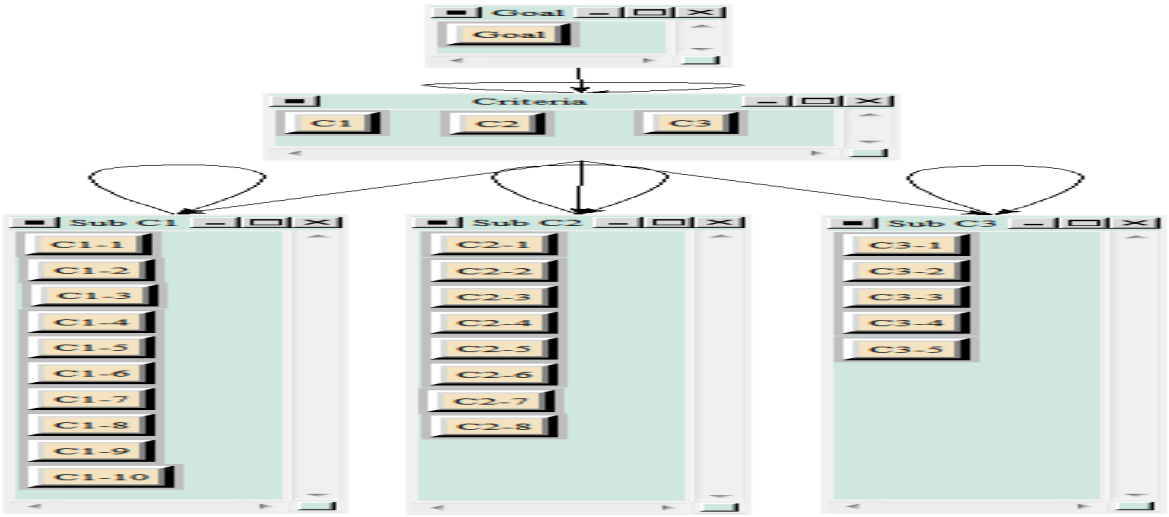

Figure-2
Model in Super Decision Software

Table-2
Weight of three main criteria

	Strategic decisions level	Tactical decisions level	Operational decisions level	Geometric mean	Weight
Strategic decisions level	1.00	2.55	4.82	2.31	0.63
Tactical decisions level	0.39	1.00	1.89	0.90	0.25
Operational decisions level	0.21	0.53	1.00	0.48	0.13

Table-3
Weigh of criteria resulting from criterion of strategic, tactical and operational decisions level

	Tactical decisions level	Operational decisions level	Weight
Tactical decisions level	1.00	6.79	0.8706
Operational decisions level	0.15	1.00	0.1294
	Strategic decisions level	Operational decisions level	Weight
Strategic decisions level	1.00	5.89	0.8548
Operational decisions level	0.17	1.00	0.1452
	Strategic decisions level	Tactical decisions level	Weight
Strategic decisions level	1.00	6.62	0.8692
Tactical decisions level	0.15	1.00	0.1308

Also weight of indexes toward each main criterion should be calculated. Tables 4, 5, and 6 show these weights for indexes of strategic decisions level, tactical decisions level, and operational decisions level.

Unweighted Super Matrix Formation and Performing Calculations Using Super Decision Software: As it was mentioned, Dematel is a method which is used for summarizing causal relationship between elements and components and indexes in a problem. However, its other application is estimating weights of interrelations between elements of the ANP model. This application is considered in the current work. Followings are needed for completion of super matrix: weight of the main criteria toward the target, weight of interrelations between main criteria, weight of indexes toward each criterion and weight of interrelations between indexes. All cases have been calculated up to now except weight of interrelations between indexes. In order to obtain results of weight blocks needed for estimating weights of interrelations between indexes of three main criteria, Dematel method was used. Results of this method are given in tables-7, 8, and 9.

Table-4
Weighted indexes of tactical decisions level

Pairwise comparison of indexes of at strategic decisions level											**Weight**
	Increasing overall efficiency of the organization and process optimization	Determining entry into new markets	Launching a new product	Focus on financial characteristics	Focus on other important parameters for increased work and focus on the external processes	Timely access to cost information	Helping better communication with the organization and employees	Presentation of analytical and multifaceted reports (ESS / EIS, Dashboards, Scorecards)	Allowing high processing and accessing large amounts of data using analytical and intelligent tools	Taking organization's long-term decisions in business processes	
Increasing overall efficiency of the organization and process optimization	1.00	7.89	7.77	4.89	6.89	4.89	6.89	1.07	1.07	1.07	0.2674
Determining entry into new markets	0.13	1.00	2.08	0.27	0.48	0.32	0.32	0.17	0.20	0.24	0.0267
Launching a new product	0.13	0.48	1.00	0.15	0.48	0.50	0.35	0.16	0.20	0.25	0.0234
Focus on financial characteristics	0.20	3.73	6.77	1.00	1.00	1.00	7.00	1.07	3.00	1.07	0.1243
Focus on other important parameters for increased work and focus on the external processes	0.15	2.08	2.08	1.00	1.00	1.00	7.00	3.09	1.00	1.07	0.1107
Timely access to cost information	0.20	3.09	2.00	1.00	1.00	1.00	5.00	1.07	1.00	1.07	0.0885
Helping better communication with the organization and employees	0.15	3.09	2.88	0.14	0.14	0.20	1.00	0.20	0.20	0.20	0.0298
Presentation of analytical and multifaceted reports (ESS / EIS, Dashboards, Scorecards)	0.93	6.00	6.18	0.93	0.32	0.93	5.09	1.00	1.07	1.07	0.1135
Allowing high processing and accessing large amounts of data using analytical and intelligent tools	0.93	5.09	5.09	0.33	1.00	1.00	5.00	0.93	1.00	1.07	0.1081
Taking organization's long-term decisions in business processes	0.93	4.09	4.00	0.93	0.93	0.93	5.00	0.93	0.93	1.00	0.1076

*Largest eigenvalue: 11.2945, and IR is equal to 0.0965,

Table-5
Weighted indexes of tactical decisions level

Pairwise comparison of indexes of at tactical decisions level									Weight
	Being familiar	Analysis of deviation from the realization of special programs of organizational units, individuals or indexes	Forecasting demand for a product or service	Presentation of periodic reports from implementation of processes and finally summarizing useful data	Follow-up operations at lower levels of the organization	Preparation of a general image from organizational activities for executives	Medium-term decisions	Presentation of consolidated and combined reports (MRS / Excell)	
Being familiar	1.00	4.09	2.08	2.88	0.32	0.45	5.89	2.08	0.1453
Analysis of deviation from the realization of special programs of organizational units, individuals or indexes	0.24	1.00	0.48	1.07	0.15	0.16	1.07	0.48	0.0395
Forecasting demand for a product or service	0.48	2.08	1.00	1.07	0.20	0.24	2.08	0.48	0.06
Presentation of periodic reports from implementation of processes and finally summarizing useful data	0.35	0.93	0.93	1.00	0.14	0.16	2.08	0.48	0.0472
Follow-up operations at lower levels of the organization	3.09	6.89	4.89	7.00	1.00	2.08	6.89	4.09	0.339
Preparation of a general image from organizational activities for executives	2.23	6.18	4.17	6.18	0.48	1.00	5.89	0.48	0.2037
Medium-term decisions	0.17	0.93	0.48	0.48	0.15	0.17	1.00	0.26	0.0312
Presentation of consolidated and combined reports (MRS / Excell)	0.48	2.08	2.08	2.08	0.24	2.08	3.89	1.00	0.1341

*Largest eigenvalue: 8.4709, and IR is equal to 0.048

Table-6
Weighted indexes of operational decisions level

Pairwise comparison of indexes of at operational decisions level						Weight
	Monitoring business processes	Identifying problems and bottlenecks	The best and worst analysis	Short-term decisions in commercial activities	Collecting data and storing them in private databases	
Monitoring business processes	1.00	0.48	2.08	1.07	0.32	0.1317
Identifying problems and bottlenecks	2.08	1.00	3.09	2.08	0.48	0.2362
The best and worst analysis	0.48	0.32	1.00	0.47	0.27	0.0764
Short-term decisions in commercial activities	0.93	0.48	2.14	1.00	0.20	0.1189
Collecting data and storing them in private databases	3.09	2.08	3.73	5.09	1.00	0.4368

*Largest eigenvalue: 5.0937, and IR is equal to 0.0211

Steps of this method include: Developing direct relations matrix (following gaining expert ideas, obtained matrix is shown by Z and its components are shown by Z_{ij}. Each member of Z shows degree of influence of criterion i on criterion j). Normalizing direct relations matrix (matrix X). Developing overall relations matrix (matrix T).when matrix X, normalized matrix of direct relations matrix is calculated, overall relations matrix or matrix T is obtained. Finally, weight block needed for competing unweighted super matrix in ANP method is obtained from division of overall relations matrix values by values of column sum. Weight blocks of unweight super matrix for interrelations of indexes of strategic, tactical and operational decisions levels are given in below.

Table-7
Weight block of unweight super matrix for interrelations of indexes of strategic decisions levels

Increasing overall efficiency of the organization and process optimization	0.089	0.105	0.102	0.108	0.106	0.109	0.108	0.110	0.110	0.104
Determining entry into new markets	0.092	0.079	0.102	0.098	0.090	0.094	0.093	0.095	0.090	0.098
Launching a new product	0.088	0.096	0.075	0.089	0.085	0.089	0.084	0.090	0.090	0.089
Focus on financial characteristics	0.118	0.121	0.122	0.100	0.121	0.119	0.119	0.121	0.120	0.119
Focus on other important parameters for increased work and focus on the external processes	0.090	0.082	0.082	0.085	0.071	0.086	0.085	0.082	0.087	0.085
Timely access to cost information	0.114	0.117	0.118	0.115	0.112	0.096	0.114	0.116	0.116	0.114
Helping better communication with the organization and employees	0.092	0.085	0.085	0.084	0.090	0.088	0.074	0.089	0.090	0.093
Presentation of analytical and multifaceted reports (ESS / EIS, Dashboards, Scorecards)	0.104	0.106	0.107	0.109	0.112	0.110	0.109	0.090	0.106	0.109
Allowing high processing and accessing large amounts of data using analytical and intelligent tools	0.111	0.109	0.110	0.111	0.114	0.113	0.112	0.114	0.093	0.108
Taking organization's long-term decisions in business processes	0.101	0.099	0.099	0.101	0.098	0.097	0.101	0.093	0.098	0.082

Table-8
Weight block of unweight super matrix for interrelations of indexes of tactical decisions levels

Being familiar	0.117761	0.137631	0.142893	0.144502	0.143524	0.14061	0.137413	0.139038
Analysis of deviation from the realization of special programs of organizational units, individuals or indexes	0.128667	0.109196	0.125818	0.129597	0.133574	0.131825	0.128472	0.1302
Forecasting demand for a product or service	0.082638	0.076826	0.068615	0.077382	0.082815	0.080866	0.088513	0.077953
Presentation of periodic reports from implementation of processes and finally summarizing useful data	0.136091	0.142194	0.135143	0.116491	0.136065	0.139148	0.136561	0.143873
Follow-up operations at lower levels of the organization	0.126659	0.131731	0.118056	0.127716	0.106957	0.129859	0.126321	0.128305
Preparation of a general image from organizational activities for executives	0.13457	0.128918	0.12069	0.129957	0.128725	0.109004	0.128398	0.136391
Medium-term decisions	0.121808	0.121649	0.136597	0.122495	0.122189	0.119705	0.102392	0.117861
Presentation of consolidated and combined reports (MRS / Excell)	0.151806	0.151854	0.152187	0.151859	0.146152	0.148983	0.15193	0.126378

Table-9
Weight block of unweight super matrix for interrelations of indexes of operational decisions levels

Monitoring business processes	0.202734	0.230127	0.240697	0.236234	0.236762
Identifying problems and bottlenecks	0.22822	0.198772	0.226413	0.232847	0.2318
The best and worst analysis	0.110839	0.109021	0.09499	0.109717	0.109936
Short-term decisions in commercial activities	0.215125	0.22053	0.202954	0.185635	0.215252
Collecting data and storing them in private databases	0.243082	0.241551	0.234945	0.235567	0.206249
Monitoring business processes	0.202734	0.230127	0.240697	0.236234	0.236762

Table-10
Unwegithed super matrix

	C1	**C2**	**C3**	**Goal**	**C1-1**	**C1-2**	**C1-3**	**C1-4**	**C1-5**	**C1-6**	**C1-7**	**C1-8**	**C1-9**	**C1-10**	**C2-1**	**C2-2**	**C2-3**	**C2-4**	**C2-5**	**C2-6**	**C2-7**	**C2-8**	**C3-1**	**C3-2**	**C3-3**	**C3-4**	**C3-5**
C1	0	0.855	0.869	0.625	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C2	0.871	0	0.131	0.245	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C3	0.129	0.145	0	0.130	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Goal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C1-1	0.267	0	0	0	0.106	0.106	0.106	0.106	0.106	0.109	0.108	0.110	0.110	0.104	0	0	0	0	0	0	0	0	0	0	0	0	0
C1-2	0.027	0	0	0	0.090	0.090	0.090	0.090	0.090	0.094	0.093	0.095	0.090	0.098	0	0	0	0	0	0	0	0	0	0	0	0	0
C1-3	0.023	0	0	0	0.085	0.085	0.085	0.085	0.085	0.089	0.084	0.090	0.090	0.089	0	0	0	0	0	0	0	0	0	0	0	0	0
C1-4	0.124	0	0	0	0.121	0.121	0.121	0.121	0.121	0.119	0.119	0.121	0.120	0.119	0	0	0	0	0	0	0	0	0	0	0	0	0
C1-5	0.111	0	0	0	0.071	0.071	0.071	0.071	0.071	0.086	0.085	0.082	0.087	0.085	0	0	0	0	0	0	0	0	0	0	0	0	0
C1-6	0.089	0	0	0	0.112	0.112	0.112	0.112	0.112	0.096	0.114	0.116	0.116	0.114	0	0	0	0	0	0	0	0	0	0	0	0	0
C1-7	0.030	0	0	0	0.090	0.090	0.090	0.090	0.090	0.088	0.074	0.089	0.090	0.093	0	0	0	0	0	0	0	0	0	0	0	0	0
C1-8	0.114	0	0	0	0.112	0.112	0.112	0.112	0.112	0.110	0.109	0.090	0.106	0.109	0	0	0	0	0	0	0	0	0	0	0	0	0
C1-9	0.108	0	0	0	0.114	0.114	0.114	0.114	0.114	0.113	0.112	0.114	0.093	0.108	0	0	0	0	0	0	0	0	0	0	0	0	0
C1-10	0.108	0	0	0	0.098	0.098	0.098	0.098	0.098	0.097	0.101	0.093	0.098	0.082	0	0	0	0	0	0	0	0	0	0	0	0	0
C2-1	0	0.145	0	0	0	0	0	0	0	0	0	0	0	0	0.118	0.138	0.143	0.145	0.144	0.141	0.137	0.139	0	0	0	0	0
C2-2	0	0.040	0	0	0	0	0	0	0	0	0	0	0	0	0.129	0.109	0.126	0.130	0.134	0.132	0.128	0.130	0	0	0	0	0

C2-3	0	0.060	0	0	0	0	0	0	0	0	0	0	0	0	0	0.083	0.077	0.069	0.077	0.083	0.081	0.089	0.078	0	0	0	0	0
C2-4	0	0.047	0	0	0	0	0	0	0	0	0	0	0	0	0	0.136	0.142	0.135	0.116	0.136	0.139	0.137	0.144	0	0	0	0	0
C2-5	0	0.339	0	0	0	0	0	0	0	0	0	0	0	0	0	0.127	0.132	0.118	0.128	0.107	0.130	0.126	0.128	0	0	0	0	0
C2-6	0	0.204	0	0	0	0	0	0	0	0	0	0	0	0	0	0.135	0.129	0.121	0.130	0.129	0.109	0.128	0.136	0	0	0	0	0
C2-7	0	0.031	0	0	0	0	0	0	0	0	0	0	0	0	0	0.122	0.122	0.137	0.123	0.122	0.120	0.102	0.118	0	0	0	0	0
C2-8	0	0.134	0	0	0	0	0	0	0	0	0	0	0	0	0	0.152	0.152	0.152	0.152	0.146	0.149	0.152	0.126	0	0	0	0	0
C3-1	0	0	0.123	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.203	0.230	0.241	0.236	0.237
C3-2	0	0	0.221	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.228	0.199	0.226	0.233	0.232
C3-3	0	0	0.072	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.111	0.109	0.095	0.110	0.110
C3-4	0	0	0.177	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.215	0.221	0.203	0.186	0.215
C3-5	0	0	0.408	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.243	0.242	0.235	0.236	0.206

Finally, after integration of the results of Dematel in super matrix of ANP method according to table-10, final weight of indexes was obtained using Super Decisions Matrix.

Table-11
Final weight and rate of indexes

Index	C1-1	C1-2	C1-3	C1-4	C1-5	C1-6	C1-7	C1-8	C1-9	C1-10	C2-1	C2-2	C2-3	C2-4	C2-5	C2-6	C2-7	C2-8	C3-1	C3-2	C3-3	C3-4	C3-5
Final weight of super matrix	0.056	0.048	0.045	0.062	0.041	0.058	0.046	0.056	0.057	0.050	0.049	0.045	0.028	0.048	0.045	0.045	0.043	0.052	0.028	0.028	0.013	0.026	0.029
Rank	5	10	14	1	17	2	11	4	3	7	8	13	19	9	15	12	16	6	20	21	23	22	18

As observed in table-11, indexes of focus on financial characteristics have the highest weight and they have rank 1. Ranks 2 and 3 go to other indexes at strategic level of the organization, that is, Timely access to cost information and possibility of high processing and accessing large amounts of data using analytical and intelligent tools.

Binomial Test to Determine Options of Business Intelligence at Management Decisions Levels: Binominal test was used for testing H4 so that effective options of business intelligence are determined.

Table-12
Binominal test for 6 main classes of options

		Class	No.	Observed ratio	Test ratio	Sig. level
Shareholders' satisfaction	Group 1	<= 3	1	.10	.50	.021
	Group 2	> 3	9	.90		
	Total		10	1.00		
Enhanced decision tools	Group 1	<= 3	1	.10	.50	.021
	Group 2	> 3	9	.90		
	Total		10	1.00		
Reasoning ability	Group 1	<= 3	0	.00	.50	.002
	Group 2	> 3	10	1.00		
	Total		10	1.00		
Optimization and recommending models	Group 1	<= 3	1	.10	.50	.021
	Group 2	> 3	9	.90		
	Total		10	1.00		
Providingrelated experimentand integration with environment	Group 1	<= 3	0	.00	.50	.002
	Group 2	> 3	10 10	1.00 1.00		
Analytical and Intelligent decision support	Group 1	<= 3	0	.00	.50	.002
	Group 2	> 3	10 10	1.00 1.00		

Results Analysis

In interpretation of results of binominal test, when significance level is smaller than error rate (0.05), the hypothesis assuming equality of success rate in the population is rejected with test probability (0.5). Now for specifying that if this rate is high in the population, probability is considered. Of the observed probability is larger than test probability, it is inferred that respective variable is present or high in the population. Considering results in table-12, existence of variables of main options of the research can be inferred. As mentioned, significance level was less than 0.05, thus the hypothesis that all components have test probability 0.5 is rejected. On the other hand, all components have observed ratio larger or equal to 0.9, therefore they are significant. Considering obtained results in this section, H4 is supported.

Friedman Test for Determining Most Effective Business Intelligence Options: Table-13. Friedman Test of the options using SPSS Software. According to results obtained from Friedman Test, options of analytical and intelligent decision support are selected as the most effective business intelligence option in organizational decisions, thus H5 is supported considering results of Friedman Test.

Determining Priority of Business Intelligence Options (Solutions): Following gaining final weight of indexes, TOPSIS method is used in order to find final weight and rank of options. It includes following steps: i. Taking results of the previous phase, i.e. priority (weight) of indexes, ii. Taking expert ideas concerning performance of each option versus each index, and iii. Calculating priority of options, results of which are given in below. According to results in table-14, options of analytical and intelligent decision support have highest weight and thus rank 1 is given to them. Options of providing related experiment and integration with environment assume the second rank.

Friedman Test	Options of business intelligence evaluation in organizational decisions	Mean rank
1	Options of Analytical and Intelligent decision support	4.55
2	Options of Optimization and recommending models	3.75
3	Options of Providing related experiment and integration with environment	3.4
4	Options of shareholders' satisfaction	3.3
5	Options of reasoning ability	3.1
6	Options of Enhanceddecision tools	2.9

Table-14
Closeness coefficients, rank, and final weight of options

	Cci	Rank	Weight
Options of Analytical and Intelligent decision support	0.9432	1	0.3124
Options of Providing related experiment and integration with environment	0.7981	2	0.2644
Options of optimization and recommending models	0.1971	5	0.0653
Options of reasoning ability	0.3841	4	0.1272
Options of Enhanced decision tools	0.1583	6	0.0524
Options of shareholders' satisfaction	0.5382	3	0.1783

Final Ranking of Business Intelligence Tools: For final ranking of tools, pair wise comparison tables for each tool in each class versus each option of the classes are formed. Then the tables of pair wise comparison are combined using Geometric mean method, their consistency and weights are calculated. Finally, final weight of tools is obtained from multiplying obtained weight in TOPSIS method (table-14) by weight values of pair wise comparison tables.

Table-15 shows final weight and rank of tools. According to the table it can be found Reliability and accuracy of analysis in the main class of Options of shareholders' satisfaction has the rank 1 and data warehouse related to the main class of Options of analytical and intelligent decision support has the second rank.

Conclusion

Findings for prioritization of the main business intelligence indexes at management decisions levels of the organization indicate that indexes of focus on financial characteristics have rank 1 and highest weight and ranks 2 and 3 go to other indexes at organization's strategic level, i.e. Timely access to cost information and Allowing high processing and accessing large amounts of data using analytical and intelligent tools. These results were confirmed by assumption tests and modeling methods. Findings of the current work show status and importance of strategic management

Table-15
Final weight and rank of sub-options

Weight of main option class from TOPSIS method	Sub-option weight from pairwise comparisons	Business intelligence tools	Final weight	Final rank of tools
0.3124 23options of analytical and intelligent decision support 295	0.0519	Visual graphs	0.0162	17
	0.2217	Online analytical processing (OLAP)	0.0693	5
	0.1579	Data Mining Techniques	0.0493	8
	0.3742	Data Warehouse	0.1169	2
	0.0956	Intelligent agent	0.0299	11
	0.0386	Multi-functionality	0.0121	19
	0.06	Summarization	0.0187	15
0.2644 Options of Providingrelated experimentand integration with environment	0.2557	Receiving data from other systems	0.0676	6
	0.1596	Sending reports to other systems.	0.0422	9
	0.0579	Combining Tests	0.0153	18
	0.4236	Modeling situation awareness	0.1120	3
	0.1032	Group decision-making	0.0273	13
0 Options of optimization and recommending models 0.0653	0.1045	Optimization Techniques	0.0068	21
	0.2582	Simulation models	0.0169	16
	0.1559	evolutionary models	0.0102	20
	0.0521	Sample dynamical model	0.0034	22
	0.4293	Dashboard / recommender	0.0280	12
0.1272 Options of reasoning ability	0.8394	backward and forward reasoning	0.1068	4
	0.1606	knowledge Reasoning	0.0204	14
Options of Enhanceddecision tools 0.0524	1	MCDM tools	0.0524	7
0.1783Options of shareholders' satisfaction 0	0.1728	Shareholders' satisfaction	0.0308	10
	0.8272	Reliability and accuracy of analysis	0.1475	1

Especially its decisions. Since at strategic level, business intelligence system is able to create competitive advantage in financial dimensions for the organization among other competitors and leads to increased profitability of the organization. In addition, timely access to costs data is provided through business intelligence system and it allows high processing and accessing large amounts of data using analytical and intelligent tools, thus many of the additional costs and overhead disappears and the organization under studycan achieve competitive advantage and develop this system in its subsets in the future. It should be noted given findings of this work, implementing business intelligence at strategic management level is more important than tactical and operational level; thus in implementation of business intelligence, more attention should be paid to top level of the organization and its decisions compared to lower tactical and operational levels. It is suggested all business intelligence research works with approach of effectiveness and supporting organizational decisions are preferably conducted at top management level of the organization. Because application of business intelligence at strategic level can be help increasing overall efficiency of the organization and process optimization through focus on financial dimensions and timely access to cost information and allowing high processing and accessing large amounts of data using analytical and intelligent tools. These systems are focused on some important financial characteristics and other major parameters in increased organization's efficiency. The other important point is that different features of applied programs at different organizational levels cause difference in tools, technique and infrastructures required by them. Analytical and intelligent tools such as options of analytical and intelligent decision support are used mostly at higher levels, which require high processing and accessing large amounts of data. It is more evident at strategic level compared to tactical and operational level. Because operational part of business intelligence is mainly responsible for data collection and storage in private databases. Findings from prioritization of the main business intelligence solutions at management levels indicate options of analytical and intelligent decision support are the main business intelligence options at management levels, and tools of reliability and accuracy of analysis and data warehouse have ranks 1 and 2 and are regarded as the main tools of business intelligence. Thus, in designing business intelligence at organizational decisions levels, the organization under study should seek for solutions and options which support decisions optimally, and these options should be consider more. Results obtained at management decisions levels show that options of analytical and intelligent decision supporthave rank 1; it has also higher weight and priority compared to 5 other option groups in business intelligence. This class of options includes 6 subsets of various tools including Visual graphs, online analytical processing (OLAP), Data Mining Techniques, Data Warehouse, Intelligent agent, Multi-functionality, Summarization. Given findings in the current research study, the organization under study is recommended to pay more attention to these tools compared to other tools of business intelligence in order to support organizational decisions. Since data in the current work were taken from expert ideas and managers judgment of the statistical population and they were basis for the research calculations, in order to higher reliability, all researchers are recommended to use other methods such as confirmatory factor analysis in addition to enhanced decision techniques so that their model and findings are more reliable. In addition, the organization under study has been implementing business intelligence successfully for over two years and it aims at developing the system in its subsets. Thus, all researchers who are going to pursue this topic with similar dimensions in this organization are suggested to use combination of ANP, Dematel and VIKOR approaches. Since VIKOR method is used for implementing top solutions rather than ranking all of them, solutions with top ranks are implemented using this method. Six classes of options were presented in this work which had their own subsets. Using this method, top options and solutions can be used for implementing and developing business intelligence in their subsets and cost and time can be saved.

References

1. Olszak C.M. and Ziemba E, Approach to building and implementing business intelligence systems, *Interdisciplinary Journal of Information, Knowledge and Management*, **2,** 135-148 **(2007)**

2. Arnott D., Gibson M. and Jagielska I., Evaluating the intangible benefits of business intelligence: Review and research agenda, The IFIP TC8/WG8.3 International Conference,1-11 **(2004)**

3. Negash S., Business intelligence, *Communications of the Association for Information Systems*, **13**, 177-195 **(2004)**

4. Matei G.A., Collaborative approach of business intelligence systems, *Journal of Applied Collaborative Systems*, **2(2),** 91-101 **(2010)**

5. Koronios A. and Yeoh W., Critical success factors for business intelligence systems, *Journal of Computer Information Systems*, 23-32 **(2010)**

6. Cody W.F., Kreulen J.T., Krishna V. and Spangler W.S., The integration of business intelligence and knowledge management, *IBM Systems Journal*, **41(4),** 697-713 **(2002)**

7. Shi Z., Wang M., Wu W., Xu L. and Zeng L., Techniques, process, and enterprise solutions of business intelligence, Systems, *Man and Cybernetics, 2006. SMC'06. IEEE International Conference*, 4722-4726 **(2006)**

8. Ghoshal S. and Kim S.K., Building Effective Intelligence Systems for Competitive Advantage, *Sloan Management Review*, **28(1),** 49–58 **(1986)**

9. Azoff M. and Charlesworth I., The New Business Intelligence, *A European Perspective, Butler Group, White Paper*, **(2004)**

10. Baars H. and Kemper H., Management support with structured and unstructured data: An integrated business intelligence framework, *Information Systems Management*, **25(2),** 132–148 **(2008)**

11. Coman M., Duica M., Radu V. and Stefan V., Enterprise performance management with business intelligence solutions, **(2010)**

12. Barone D., Jiang L., Mylopoulus J., Won J. and Yu E., Enterprise modeling for business intelligence, _c *IFIP International Federation for Information Processing,* LNBIP, **68**, 45-31 **(2010)**

13. Esat F., Hart M., Khatieb Z. and Rocha M., Introducing students to business intelligence: Acceptance and perceptions of OLAP software, *Informing Science and Information Technology*, **4**, 105-123 **(2007)**

14. Lloyd J., Identifying Key Components of Business Intelligence Systems and Their Role in Managerial Decision making, *Continuing Education, 1277 University of Oregon, Eugene,* OR 97403-1277, **(800)** 824-2714 **(2011)**

15. Watson H.J. and Wixom B.H., The current state of business intelligence, *Computer,* **40(9),** 96-99 **(2007)**

16. Ghazanfari M., Jafari M. and Rouhani S., A tool to evaluate the business intelligence of enterprise systems, Transactions E: Industrial Engineering, www.sciencedirect.com, Scientia Iranica, E18**(6),** 1579–1590 **(2011)**

17. Tzeng G, Chiang C. and Li C., Evaluating intertwined effects in e-learning programs: A novel hybrid MCDM model based on factor analysis and DEMATEL, *Expert Systems with Applicatio*ns, **32(4),** 1028–1044 **(2007)**

18. Wu W., Choosing knowledge management strategies by using a combined ANP and DEMATEL approach, *Expert Systems with Applications,* **5(3),** 828–835 **(2008)**

19. Gabus A. and Fontela E., World problems an invitation to further thought within the framework of DEMATEL , **(1972)**