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A DEMATEL Method for Identifying Critical Success Factors in an Implementation of Information System Project

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ABSTRACT

According to latest publication of research papers, the numbers of successfully completed projects are remarkably limited and have not yet reached at a desirable level. The projects are often prepared and delivered bearing at least one problem of their own. The foremost major problems confronted are: lack of functionality, the failure of an activity preventing itself from proper outcome, very highly demanding project schedules and insufficient budgetary allocation. Despite the fact that unsuccessful project outcomes are not overlooked, the reasons for failures or emerging setbacks have not yet been wholly established and they tend to vary from one project to the another.

The process of identifying the activities that are influenced by others or that influence others are very important for establishing successful project completion. In this context, the determination of critical success factors (CSF) is central part of project implementation. By determining the important factors and their interconnectedness, a possibility that a particular activity might fail can be prevented. By this provision, the chances of success for the whole project will be enhanced. It is for this reason that academic studies attempting to establish how to determine the major and CSFs -remain to be a challenging issue up to the present day.

This research paper is intended to contribute to the present day present literature by selectively determining CSFs in IS project. For attainment of this purpose, initially DEMATEL method has been applied. Respectively -in the light of findings- CSFs in respected projects have been identified. The empirical results reveal that CSFs in IS implementation are mainly related to the managerial and operational activities.

Keywords: Multi criteria decision making, DEMATEL method, Critical success factor, Information systems, Project management

JEL Classification: C02, C44, C63

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ÖZET

Son yapılan araştırmalara göre, başarılı bilgi sistemi projeleri sınırlı sayıdadır ve istenilen seviyede değildir. Projeler bazen sorunlarla birlikte teslim edilmektedir. Karşılaşılan en önemli sorunlar; işlevsellik eksikliği, uygun sonucun elde edilmesini engelleyen faaliyet başarısızlığı, proje bütçe ve takviminin aşılmadır. Başarısız proje teslimlerinin

azımsanamayacak kadar çok olmasına rağmen problemlerin nedenleri hala genelleştirilememiş olup projeden projeye farklılık göstermektedir. Başka faktörler tarafından etkilenen veya diğer faktörleri etkileyen faktörlerin belirlenmesi projenin tamamlanması ve başarısı açısından önemlidir. Bu bağlamda kritik başarı faktörlerinin (CSFs) değerlendirilmesi bilgi sistemi geliştirmenin önemli bir parçasıdır. Önemli faktörleri ve faktörlerin birbiriyle ilişkilerini belirlemek belirli faaliyetlerin başarısızlığını önlemeye yardımcı olabilir. Bu nedenle, önemli ve kritik faktörlerin belirlenmesi ile ilgili çalışmalar günümüzde hala ilgi çekici olmaya devam etmektedir.
Çalışmanın amacı, bilgi sistemi projesinde kritik başarı faktörlerinin belirlenmesine katkıda bulunmaktır. Bu amaç için önce DEMATEL metodu uygulanmış, sonra sonuçları değerlendirilerek kritik başarı faktörleri belirlenmiştir. Çalışmada sunulan deneysel sonuçlar, belirlenen kritik başarı faktörlerinin büyük ölçüde yönetsel ve operasyonel faaliyetlerle ilişkili olduğunu göstermektedir.

Anahtar Kelimeler: Çok kriterli karar verme, DEMATEL yöntemi, Kritik başarı faktörü, Bilgi sistemi, Proje yönetimi

1. Introduction

The 1980s were a decade of development in computer and information technologies as well as statistical software formation demanded by the organizations. During the highlighted period, only three factors are considered as success criteria in the field of project management for IT/IS. They were to meet the budget constraints, implement time-constraints and end users requirements. These factors have not considered the quality and integration as important criteria since development of the computer capacity and equally software programs in resolving complex problems were not feasible. Moreover, the issue of quality and integration of IS projects have become highly important in following years, in 1990s. However the 2000s were a decade of functionality and integration of computerized operations in organizations. These trends have become more important, and project managers and teams were not only highly concentrated on meeting timescales and budget constraints, but also keenly focused on meeting the required quality and commercial success. It is remarkable to emphasize that developments both in the sphere of hardware and software technologies; and increased influence of globalization process have had profound impact on the changing nature of project success criteria and in the the way how it was perceived.

In spite of increasing the popularity of IT/IS projects in the years between the mid 1980s and 2000s, some surveys stresses the fact that twice as many IT/IS projects had been considered were less successful than expected. Project failures have incurred a heavy financial burden on the organizations while influencing government expenditures indirectly. Therefore, these issues constituted as an important domestic matter. Despite the fact that some improvements had been made on these issues, failures have still continued to exist (Wateridge, 1995). According to the findings of annual report of the Standish Group - data collection on IT development projects since 1985-approximately 30 percent of projects had been successful when judged on the criteria of “budget, time and all planned features”. 25 percent of failed projects have run with deficiency, 45 percent of projects are inundated with cost or time overruns or not being delivered with the desired functionality (Buddle, 2013).
These past years have highlighted the fact that structural analysis, project management methodologies and user friendly tools have been gradually improved to meet the dynamic and integrated requirements. Nevertheless, there are still challenges to overcome. In parallel with

these challenges, IT/IS project failures are not common, and still there has not yet been any consensus on the criteria for the project success. For that reason, various factors are likely to influence the success of projects- so that have often been subjected to academic investigations in this respect.

The Chaos Report (2015), regularly published by the Standish Group since 1994, including new successful factors to the software development projects, with the 50000 projects selected for the research, announced that 29%, 52% and 19% of all projects were- successful, challenged; and failed- respectively. In the year 2014, these percentages were 28%, 55% and 17% for successful, challenged and failed projects respectively (Hastie and Wojewoda, 2015). In accordance with the Gartner Institute report; 50% of all projects were delivered beyond the determined schedule and/or budget constraint. Many projects were delivered with the lack of functionality or cancelled due to its inadequacy. Identifying the factors that are influenced by other functions or that influence other are very important for the project completion and success. Furthermore if the risk factors are not accurately addressed at the start of the initiation phase, it will lead to further complications in the execution and evaluation phases of the project (Morrison, 2012).

Over the years, the key aspects of a successful project have urged project managers to accommodate critical success factors (CSFs) in their projects. CSFs are the factors or activities that have been performed to achieve the goals in business or project management. Determination of the CFSs is very important to achieve the project success on its timely completion and quality, since some CSFs have the influence on other CSFs or factors. If CSFs are addressed properly and correctly, the complications in further steps can be eliminated by adapting to measures. So, successfully complying with the CSFs will ensure a satisfactory performance of the project. Conversely, a failure and/or a lack of functionality on CSFs in the project can automatically diminish the performance of the related factors-both directly and indirectly. Emergence of situations as such can create failures on some projects.
Wateridge (1995) has investigated the important factors in failures and successes of IS projects. The result of this study implies the fact that associated factors that influence the project success also need to be defined clearly by all participants from the very start. Managers must also concentrate on the success criteria from the beginning of the project to the end. The survey research study of BGM (2014) seeks to identify and determine the factors which lead to successful completion of projects. This has indicated “project planning and review”, “subsidiary factors”, “pre-project planning” and “realistic time schedules” are highlighted as main factors in project planning.

Similarly Nilashi et al.(2015) have stressed the importance of interdependency among the factors. The result of the study has highlighted the importance of levels of interdependency among the CSFs in construction of projects. The author has used a novel hybrid multi criteria decision making model to address the dependence relationships of criteria with the aid of three methods. They are grey relational analysis, analytic network process (ANP) and DEMATEL.

Hussein (2013) is another example to investigate the statistical correlations between factors in project management. In his study, twelve factors that influence project success were accounted for. By means of the regression analysis, he has also investigated the most predominant risk factors in the initiation/planning phase impacting other factors in the implementation and evaluation stage. According to result of this study, there were four factors in the initiation phase which would trigger additional risks factors in the implementation and evaluation phases. These factors affect all aspects of management and evaluation. The presence of such factors has appeared to be significantly correlated with some other factors. Selected four important factors are 1) having an incomplete set of criteria due to lack of knowledge about project context, 2) diverse and competing expectations about gains and benefits, 3) basing the project on unrealistic targets, and 4) employment of ambiguous criteria in describing the expected benefits or gains from the product and the project result.

Additionally, the study reveals that the factors are significantly correlated with other factors-leading to lack of organizational commitment and weakened alignment to success criteria- in performance of organization and subjective assessment of the project outcome during the evaluation phase.

Yang and Tzeng (2010) have proposed an integrated multiple criteria decision making with DEMATEL and a novel cluster-weighted ANP method. They have considered that the weighted super matrix in ANP procedure seems to be irrational because there are some sets of criteria which are influenced in different degrees. Therefore, they have employed DEMATEL method to visualize the structure of complicated causal relationships between criteria of a system. Moreover it reveals the degree of influence. Then these influence level values are used as the base of normalization super matrix for calculating ANP weights to obtain the relative importance. Zhou et.al. (2011) have used DEMATEL method to form a structural model and visualize the causal relationships among factors through a cause-effect relationship diagram. Then they figure out CSFs of emergency management. They have finally reported 5 CSFs which are identified out of 20 influencing factors in emergency management.

Some other scholars (Cheng and Li, 2004; Pezeshki and Ansari, 2013; Shahriari et al. 2016) have employed integrated two multi criteria decision methods, DEMATEL and ANP, to select the best alternatives -among the constructors, vendors or insurance organizations respectively-considering the interdependency in defining the importance of criteria. The others, for example Organ (2013) and Uğur et al.(2011) have employed DEMATEL in machine selection for businesses and in analyzing the financial factors that prevent the innovation process for both SMEs (Small and Medium Enterprises) and large-scale enterprises, respectively.

In this study, the most influential factors (criteria) in completing projects have been initially investigated by using DEMATEL. Then, a structural model of dimensions has been formed in order to visualize the relationship diagram. Finally, CSFs for IS project have been identified.

2. Project Management for IS and Critical Success Factors

2.1. Project Management for IS

In the industries, firms have utilized a project management for information system (IS) to gather the accurate and relevant information for management within the required time and standard. It helps to speed up the decision making process which is necessary to ensure the monitoring and controlling the tasks in any action within the given project. Firms' success depends heavily on well managed and well executed projects. Project management is the discipline of using established principles, procedures and policies for managing a project beginning from the conception stage to the completion. Generally all project management includes the basic phases; initiation, definition, design, development and implementation, and finally maintenance. IS projects have been encountered in various names and phases in the existing literature. Whatever the names are, the concepts and processes do not change in general.

Table 1: Project phases

Project phases for IS	Description
P1- Definition	This phase includes all initial activities
P2- Planning and design	This phase prepares all essentials for the project before execution of the project.
P3- Development	Modular programs are coded and integrated, and databases are created to realize the objectives and agreements
P4- Testing and delivering	Testing is vital phase to determine that the application program will work in the course of expectations, without errors in the installed organization.
P5- Maintenance	This phase includes the technical supports to the system users.

This study categorizes project phases as follows: “definition”, “planning and design”, “development”, “testing and delivering”, and “maintenance” for an application development for IS project. This type of project aims to create a customized program that addresses a specific information needed and/or to automate the regular known process. Each phase is described in detail in Table 1 and they are briefly shown in terms of activities, in the following Table 2.

2.2. Critical success factors

The concept, critical success factor (CSF) was first used and introduced in the study of project management in 1979 by Rockart (Zhou et al., 2011:245). It has been widely applied in various contexts such as organizational management, operational management and supply chain management. Because, every activities in these projects can be illustrated as factors. According to BMG Research (2014), main success factors had the importance on project success in general ranges between 8.2 and 8.7 on a 10-point scale. CSFs as the highly important factors are predominant factors. That means, if they are adequately performed together with non CSFs, they will strengthen and guarantee to get a favorable result. CSFs therefore must provide more attention than the others for reaching a particular goal and obtaining project success. They are strictly important factors. The lack of success on these activities is likely to diminish some efforts and lead to failure of the system or the project.

Table 2: Phases and related activities

Phases	Activities in the phases
P1	Determining the objective and scope Participation of stakeholders, managers and project leader Top management and stakeholders support Feasibility study Boundaries of the project List of requirements from various parties to prevent conflicts Defining the acceptance criteria Agreements on the project Project budget Time schedule and delivery date
P2	Participation of the client, business experts and IS/IT experts Creation of whole flowchart for the project Definition of project requirements Creation of detailed flowcharts for the specific modules Building a well structured database Composition of project team Assignment of tasks for members Developing end user interface needs Acceptance criteria on user interface Preparing documentation standards Preparing communication standards Identifying controlling and monitoring actions
P3	Task assignment to the modules Task assignment to development teams and members Encouraging customers to develop a repeatable and consistent processes, if it is not specified Coding the modules Training support to the staffs, if necessary Uninterrupted communication channels to get detailed information from end user for the efficient coding Create a guideline to use the application properly Quality control Create a tip sheet for the end user, if necessary information is not included in the interface
P4	Preparation of the test scripts that involves all possible scenarios Testing modules with standard operations together with irrational operations Determine security Document all activities to ensure data migration to new environment Training the end user to be able to use the application End user contribution for testing the application Authority distribution for accessing secured and confidential information
P5	Assign maintenance team for the customer Monitoring the system Debugging the probable errors Adding new user interfaces, if necessary Adding new modules by retesting related modules carefully

As far as related literature is concerned, many studies have demonstrated various CSFs for the particular project using different techniques. Therefore, there are several CSFs identified for the IS project and project management. For example, Bassam (2013) presents the four factors that are expected to be most common success criteria through a project's entire life cycle. He concluded that identified four factors in the initiation phase may lead to the occurrence of additional risk factors in the implementation and evaluation phases. These factors are: 1) having an incomplete set of criteria due to the lack of knowledge about project context 2) diversifying and competing expectations about gains and benefits 3) basing project on unrealistic targets 4) using ambiguous criteria to describe the expected benefits or gains from the product or the project result.

On the other hand, the result of BMG Research (2014)'s empirical study has introduced ten CSFs and four possible CSFs. In this study, DEMATEL is adopted to identify the CSFs in IS project.

3. Methodology

Initially, the decision variables and criteria are formed to analyze the different factors/criteria affecting the IS project and to use the expert knowledge. The variables of DEMATEL (Decision Making Trial and Evaluation Laboratory) method is composed of determined project dimensions and criteria described in Table 3. Using expert opinions, the comparison matrices for DEMATEL are constructed to obtain the data.

DEMATEL method was used to investigate different criteria that affects the system and to map relationships of dimensions. Thereby the influences of the clusters (dimensions) depending on the experts' opinions have been included initially in this process. Hence, the influences of the criteria within each dimension have been spared in accordance with the experts' opinion.

Using the DEMATEL's algorithm the interdependence matrix is obtained from the total relation matrix T. The sum of each column in matrix T has been equalized to 1 by the normalization method, and then the interdependence matrix can be acquired.

Finally all criteria are analyzed to reveal whether they influenced the others or being influenced by others or CSFs. Also DEMATEL results are used to rank CSFs in project management for IS.

Table 3: Dimensions and related factors

Dimensions		Description of the criteria
D1-Project related	C1	Size of project
	C2	Complexity of the project
D2-Management related	C3	Development of an appropriate circumstances
	C4	Control mechanism for project budget and completion of date
	C5	Feedback mechanisms to prevent repeated jobs
	C6	Communication standards and system
	C7	Effective technical support
	C8	Provision of resources
	C9	Planning effort
	C10	Overall managerial capabilities
	C11	Forming the appropriate work groups
	C12	Controlling and monitoring actions for the task
D3-Participant related	C13	Size of client's organization
	C14	Client experience
	C15	Client emphasis on low cost tendency
	C16	Client impacts on the quality of project
	C17	Client impact on timeliness of project
	C18	Client contribution to effective design
	C19	Project team leaders' experience
	C20	Project team leaders' technical skills
	C21	Project team leaders' planning skills
	C22	Project team leaders' organizing skills
	C23	Project team leaders' motivational skills
	C24	Project team leaders' adaptability to changes
	C25	Project team leaders' working relations with others
	C26	Effective collaboration of participants
D4-Delivering related	C27	Testing modules with standard operations together with irrational operations
	C28	End user contributions for testing the application
	C29	Documentation of all activities for ensuring data migration to new environment
	C30	Training the end user to be able to use application
	C31	Authority distribution for accessing secured and confidential information
	C32	Delivering on time and balanced budget
	C33	Run the implemented project with old system in parallel with a particular time
D5-Maintenance related	C34	Qualified maintenance team
	C35	Monitoring the system
	C36	Debugging the probable errors
	C37	Adding new user interfaces when necessary
	C38	Adding new modules by retesting related modules carefully

3.1. DEMATEL method

Decision making trial and evaluation laboratory (DEMATEL) method was developed at Genova Research Center to overcome many complex problems in science, politics, and economics. The main purpose of this method is to analyze the factors influencing a system using expert knowledge. The method can extract considerable factors and relations among the factors.

Experts' knowledge or opinions are represented in the pair wise comparison matrix. The first step is to prepare the pair wise comparison of all clusters and criteria in whole system to form the total influence (relation) matrix. The comparison matrix is constructed by using DEMATEL influence scale. The scale is given as follows: 0-no influence, 1- low influence, 2- medium influence, 3- high influence and 4- very high influence. The experts have the ability to estimate direct effects only, but it is assumed that the factor affecting another factor may have influenced on the other factor indirectly, if only it is influenced by the same factor. DEMATEL method is employed to show the relationship among factors (dimensions and criteria) as well as to draw the impact- direction map to indicate causal relationship among "dispatchers" and "receivers" (Pezeshki and Ansari, 2013). This method has been broadly applied in more and more domains, and so that current study follows the suit. The steps of DEMATEL method are as follows:

Step 1: Create the direct relation matrix

From every expert, an answer matrix, namely a pair wise comparison matrix is obtained, and then all of them are put into a single average matrix to reflect the group decisions. In the pair wise comparison matrix A, the diagonal elements must be zero, since they are compared with themselves in the diagonal wise. Other elements reflect the experts' opinion in comparison of two different factors.

$$A=\begin{bmatrix} 0 & \cdots & a_{1n} \\ \vdots & \ddots & \vdots \\ a_{n1} & \cdots & 0 \end{bmatrix}$$

Step 2: Obtain the normalized direct relation matrix

The direct relation matrix is normalized in using the following formula (1) and (2),

$$D=\lambda .A \quad \text{where} \quad \lambda = min\left\{\frac{1}{max \sum_{j=1}^{n} |a_{ij}|}, \frac{1}{max \sum_{i=1}^{n} |a_{ij}|}\right\} \text{ or} \tag{1}$$

$$\lambda = \frac{1}{max_{1\leq i\leq n}\sum_{j=1}^{n} a_{ij}} \tag{2}$$

Formula (1), representing the minimum ratio of the largest row or column sum is total direct effects or total influence on others. Formula (2) represents the ratio of the total direct influence of the factor which affects most other factors. So, all elements of the matrix D hold a value within the interval [0,1] and $0 \leq x_{ij} \leq 1$ condition is satisfied for the normalization.

Step 3: Calculate the total influence (relation) matrix

Total influence matrix, T provides information on how one factor influences another. It is calculated using the average relation matrix D with formula (3).

$$T = D(I-D)^{-1}, \text{ where I is an identity matrix} \tag{3}$$

Since $\lim_{x\to\infty} D^k = [0]_{nxn}$ where then

$$T = D + D^2 + D^3 \dots + D^k = D(I + D + D^2 + \cdots D^{k-1})(I-D)(I-D)^{-1}$$

$$= D(I-D^k)(I-D)^{-1} = D(I-D)^{-1}, \quad \text{when } \lim_{x\to\infty} D^k = [0]_{nxn}$$

Additionally, we define the sum of each row R_i and sum of each column C_i of the total relation matrix T in order to obtain the prominence and relations of the criteria. R_i shows the total direct and indirect effects of criterion *i* on the other criteria. C_i shows the total effects received by criterion *i* from the other criteria. The sum $R_i + C_i$ represents the total effects given and received by criterion *i*. This summation denotes the degree of importance of criterion *i* in the system as a score.

On the other side, $R_i - C_i$ represents the net effects and the contribution of the criterion *i* in the system. If the difference $R_i - C_i$ has positive value, the criterion *i* is a net causer. Otherwise the criterion *i* is a net receiver and in a wide manner, it is influenced by other criteria in the system (Yang and Tzeng, 2010; Zhou et.al.2011).

Step 4: Set a threshold value and obtain the network relationship map NRM

In order to explain the structural relation among the criteria and to mitigate the complexity of the system, some negligible effects of the criteria in matrix T is filtered by means of a threshold value α (Kashi, 2015, 725). The threshold value decided by experts has been assumed to be suitable for the filtering in the analysis. The element greater than threshold value α in matrix T should be chosen to obtain T_α. If the elements $t_{ij} < \alpha$ then corresponding element in the matrix T_α is assumed to be zero (t_{ij}^{α} =0). That means only the criteria whose effect in the matrix T is greater than the threshold value should be chosen and shown in a NRM map for influence (Tzeng et al., 2007). After this arrangement, the values $R_i + C_i$ and $R_i - C_i$ are calculated for each criterion *i* using matrix T_α , the NRM map is drawn. So the complex interrelationships among criteria in the system are visualized through this map.

By applying aformentioned steps, DEMATEL method has the ability to demonstrate interrelations among criteria and ability to find effectiveness of each criterion. By utilizing this certain features, it has been applied for investigation of the CSFs in different areas. The results will aid the decision makers in the determination of the degree of importance of critical factors and their influences on operations of the business sectors.

4. Empirical Study

Data related to this study on DEMATEL method is obtained from experts by means of the common questionnaires of comparison matrix. In the first stage, the individual experts' opinions on the influence criteria have been put into matrices separately, and then average matrix is calculated in the form of combined rating, and called as direct relation matrix. The direct relation matrix A is calculated for dimensions (criteria/factors) in Table 4. Experts have used the DEMATEL scale from 0 (no influence) to 4 (very high influence) to estimate the direct effects only.

Then we operate DEMATEL method from Step 1 to Step 4 to derive the total influence matrix T; then we set a threshold value to filter the minor effects in the elements of matrix T, consulting with 5 expert people. That is necessary to decrease the complexity of the NRM. When the influence level of an element in matrix T is higher than the threshold value α, this element t_{ij} is included in T_α . Otherwise, values of each element/cluster is set to zero (t_{ij}^{α} =0). So, matrix T_α is called as α-cut total influence matrix.

Table 4: The direct relation matrix A for dimensions

Dimensions	D1	D2	D3	D4	D5	Total
D1	0	3	3	3,25	3	12,25
D2	2,5	0	2,5	1,85	1,65	7,7
D3	2,65	1,95	0	2,85	2,7	10,15
D4	2,9	2,5	3,5	0	3,75	12,65
D5	3,5	2,75	1,9	3,5	0	11,65

The direct relation matrix is normalized using largest row sum, column can also be used, since it is commonly preferred standardization method ($D=A/\lambda$). It is shown in Table 5. Total relation matrix T is calculated using the equation $T= D(I-D)^{-1}$.

Table 5: The normalized direct relation matrix D for dimensions

Dimensions	D1	D2	D3	D4	D5
D1	0,000	0,237	0,237	0,257	0,237
D2	0,198	0,000	0,134	0,146	0,130
D3	0,209	0,154	0,000	0,225	0,213
D4	0,229	0,198	0,277	0,000	0,296
D5	0,277	0,217	0,150	0,277	0,000

Table 6: The total relation matrix T for dimensions

Dimensions	D1	D2	D3	D4	D5
D1	1,313	1,378	1,373	1,512	1,470
D2	1,055*	0,806*	0,921*	1,015*	0,983*
D3	1,314	1,165	1,027*	1,321	1,288*
D4	1,545	1,391	1,438	1,354	1,553
D5	1,494	1,334	1,282*	1,489	1,243*

*Elements are smaller than the threshold value α=1,3

Table 7: Impacts of dimensions

Dimensions	R_i	C_i	R_i+Ci	R_i-C_i	Result	Order of Affecting Factor	Order of Affected Factor
D1	7,046	6,722	13,767	0,324	Affecting	2	3
D2	4,780	5,408	10,189	0,628	Affected	5	4
D3	6,116	4,354	10,470	1,762	Affecting	4	5
D4	7,280	10,085	17,366	2,805	Affected	1	2
D5	6,842	13,320	20,163	6,478	Affected	3	1

After these calculations, the results achieved in Table 6 can be shown in a direction graph NRM to extract the bilateral relations between the criteria (dimensions). Figure 1 is presented for the structure of the dimensions. It reveals the bilateral relation of dimensions. In the graph, negligible effects of factors are filtered with threshold value α =1,3. In order to reflect the effects of the eligible criteria visibly, the threshold value is utilized.

The direct-indirect effects of each dimension have been shown in Table 7 and the NRM has been drawn with the data of total effects (R_i+C_i) and net effects (R_i-C_i).

According to DEMATEL method, when the result of R_i-C_i is negative and the sum of R_i+C_i is small, characteristics of criterion i is less likely to be influenced by others and considered as more independent. Similarly, when the result of R_i-C_i is positive and of R_i+C_i is small, criterion i is considered as not predominant.

In case of the difference R_i-C_i is about zero and the sum R_i+C_i and the value of R_i are highly big, criterion i is considered to have contributed most in the process. The dominant criterion i, is evaluated as CSFs in the analysis. The activity associated with the criterion i must be performed at the specific time and standard to implement the projects successfully. Otherwise the failure of CSF is likely to engage in problems during the project development and implementation. The problem in question might stand a potential hazard or likely to trigger another one.

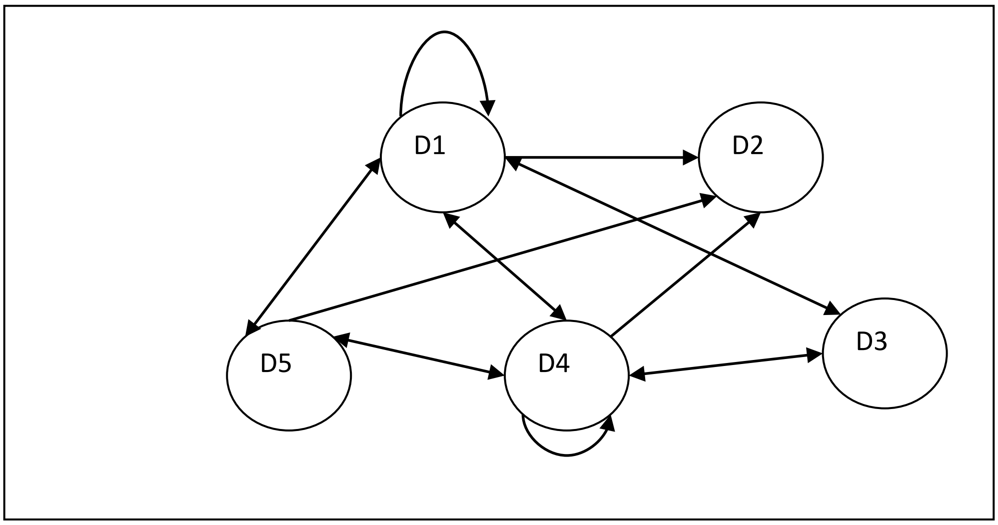

Figure 1: Network relationship map for dimensions

In Table 7, the column R_i+C_i represents the total effects that dimension *i* contributes to the system. The difference R_i-C_i indicates the net effects or contribution that dimension *i* has on the system. As illustrated above, the dimension related to maintenance shares the highest percentage (20%), and the dimension related to delivery holds the second highest percentage (17%) with respect to the total influence R_i+C_i. This result stresses a broader agreement on following domains of the project required for the users and importance of functionality, and importance of its completion on time and compliance with budget restraint and importance of effective testing modules or programs. It is very likely that training the users and documentation of user guide are highly important.

The last two columns of Table 7 show the dimensions in sequences of importance. The most influential factor is maintenance related dimension, D5 and the most influencing one is the participant related dimension, D3.

Similar procedure, mentioned above is applied for the criteria (activities) in all dimensions. The some of the remaining results of DEMATEL method for the criteria are presented in Tables 8, 9, 10, 11, 12, 13 and 14. Specifically, tables from 10 to 14 have been used to analyze most influential criteria that can influence others or can be influenced by others.

Table 8: The total relation matrix T for D1

Criteria	C1	C2
C1	1,143	2,143
C2	1,143	1,143

Table 9: The total relation matrix T for D2

Criteria	C3	C4	C5	C6	C7	C8	C9	C10	C11
C3	0,073	0,255	0,183	0,166	0,149	0,154	0,250	0,305	0,242
C4	0,098	0,127	0,157	0,143	0,108	0,109	0,222	0,278	0,185
C5	0,051	0,196	0,072	0,175	0,076	0,057	0,206	0,147	0,093
C6	0,109	0,186	0,169	0,116	0,146	0,112	0,241	0,282	0,202
C7	0,162	0,303	0,175	0,233	0,103	0,181	0,323	0,347	0,273
C8	0,073	0,255	0,183	0,166	0,149	0,154	0,250	0,305	0,242
C9	0,098	0,127	0,157	0,143	0,108	0,109	0,222	0,278	0,185
C10	0,051	0,196	0,072	0,175	0,076	0,057	0,206	0,147	0,093
C11	0,109	0,186	0,169	0,116	0,146	0,112	0,241	0,282	0,202
C12	0,162	0,303	0,175	0,233	0,103	0,181	0,323	0,347	0,273

Table 10: Direct or indirect effects of D1

Criteria	R_i	C_i	R_i+C_i	R_i-C_i	Impact
C1	3,286	2,286	5,571	1,000	Affecting
C2	2,286	1,143	3,429	1,143	Affecting

Table 11: Direct or indirect effects of D2

Criteria	R_i	C_i	R_i+C_i	R_i-C_i	Impact
C3	2,075	0,986	3,061	1,089	Affecting
C4	1,662	0,913	2,574	0,749	Affecting
C5	1,294	0,815	2,108	0,479	Affecting
C6	1,859	0,763	2,622	1,096	Affecting
C7	2,470	2,730	5,200	-0,260	Affected
C8	2,075	4,230	6,306	-2,155	Affected
C9	1,662	5,450	7,112	-3,789	Affected
C10	1,294	7,211	8,505	-5,917	Affected
C11	1,859	9,629	11,488	-7,771	Affected
C12	2,470	11,596	14,066	-9,127	Affected

Table 12: Direct or indirect effects of D3

Criteria	R_i	C_i	R_i+C_i	R_i-C_i	Impact
C13	4,546	0,000	4,546	4,546	Affecting
C14	4,467	1,430	5,897	3,037	Affecting
C15	2,001	1,732	3,732	0,269	Affecting
C16	4,762	5,453	10,215	-0,691	Affected
C17	5,194	5,279	10,473	-0,084	Affected
C18	4,755	5,209	9,965	-0,454	Affected
C19	4,565	4,329	8,895	0,236	Affecting
C20	3,733	3,508	7,241	0,225	Affecting
C21	4,383	5,484	9,867	-1,101	Affected
C22	3,324	5,467	8,791	-2,143	Affected
C23	4,358	5,073	9,430	-0,715	Affected
C24	3,965	4,864	8,829	-0,899	Affected
C25	3,988	4,917	8,905	-0,929	Affected
C26	3,840	5,136	8,976	-1,295	Affected

Table 13: Direct or indirect effects of D4

Criteria	R_i	C_i	R_i+C_i	R_i-C_i	Impact
C27	5,393	4,317	9,710	1,076	Affecting
C28	5,762	4,317	10,080	1,445	Affecting
C29	4,175	4,548	8,723	-0,374	Affected
C30	4,866	4,676	9,543	0,190	Affecting
C31	2,931	3,915	6,846	-0,985	Affected
C32	5,402	5,907	11,310	-0,505	Affected
C33	5,051	5,898	10,949	-0,848	Affected

Table 14: Direct or indirect effects of D5

Criteria	R_i	C_i	R_i+C_i	R_i-C_i	Impact
C34	1,849	0,385	2,234	1,463	Effecting
C35	1,148	0,837	1,985	0,311	Effecting
C36	0,353	1,436	1,789	-1,082	Effected
C37	1,610	1,214	2,824	0,396	Effecting
C38	0,454	1,542	1,996	-1,088	Effected

Criterion C28 (End user contribution for testing the application) is the most influential factor with the score of 5,762. Then the criteria C32 (Delivering on time and balanced budget) with the score of 5,402, C27 (Testing modules with standard operations together with irrational operations) with the score of 5,393, C17 (Client impact on timeliness of project) with the score 5,194 and C33 (Run the implemented project with old system in parallel with a particular time) with the score of 5,051 are followed respectively.

The criterion C12 (Controlling and monitoring actions for the task) is the most influential factor by others when its correspondence to C_i score (11,596) is considered. This result of Phase 2 briefly stresses the fact that it has also been influenced by the following phases. The criteria that has maximum positive net value of R_i-C_i is prior in influencing the others even though they have been influenced by others. The criterion C13 (Size of client's organization in participant-related dimension) is the most influential factor when net score is considered. It is followed by the factors C12, C11, C10 and C14 (client experience) with the value 3,037.
These results are summarized in Table 15. This table is obtained by ranking the five factors which are in the good position in each category aforementioned as influencing (R_i), influenced (C_i), total effect and net effect. The research findings reinforce the common belief that the criterion C12 (the control and monitoring action for the task) holds the highest total influence on the success of IS project. This is followed by the criterion C11 (Forming the appropriate work groups), C32 (Delivering on time and balanced budget) and C17 (Client impact on timeliness of project) in accordance with R_i+C_i scores. Besides that, for successful IS project implementation C13, C12, C11, C10, and C14 predominantly effect on the other criteria.

Table 15: Important five criteria in each category

Rank	R_i	C_i	R_i+C_i	R_i-C_i
1	C28	C12	C12	C13
2	C32	C11	C11	C12
3	C27	C10	C32	C11
4	C33	C32	C33	C10
5	C17	C33	C17	C14

Finally we can conclude that C12 (Controlling and monitoring actions for the task) and C11 (Forming the appropriate work groups) are CSFs, since both of them have influences on other criteria with highly effective scores which are 11,596 and 9,629 respectively. And C32 (Delivering on time and balanced budget) and C33 (Run the implemented project with old system in parallel with a particular time) can also be considered as CSFs since they have been influencing others and have been influenced by others with by the score of 5. As a result, this study evaluates only four (4) criteria as CSFs. That means, all criteria associated with the CSFs must be performed at the highest possible standard and timeliness for successful implementation of the project. They may have impact on the success or failure of a project in terms of “cost”, “time”, and “scope”.

5. Conclusion

Each implementation projects covers different user requirements to satisfy fundamental needs. These requirements are frequently dictated by the budget and business needs with various legal and governmental regulatory rules (Khan and Pessoa, 2010:4). These needs are converted into the activities to be satisfied in the project implementation. Therefore, in a project, activities may have similar attitudes, but not wholly same in all projects. Different activity (criteria) mix in the project phases has a different impact not only on the specific phase, but also on the success of the whole project. In addition, there is no way to measure optimum performance of the criteria since different people (managers, project leaders) are interested in different performance indicators for the proposed criteria. Furthermore, some criteria are positively related to the others while some others are negatively related. As result, managers encounter the decision-making problems which require special techniques in dealing with complexity and interactions of the important criteria.

This study examines the dimensions and the criteria for the IS projects by means of DEMATEL method. Only four (4) criteria are identified as CSFs. That means all criteria named as CSFs must be performed at the highest possible standard and timeliness to achieve the project successfully. Because of presence of interdependency among criteria; criteria associated with the CSFs have been highly affected by a failure of CSFs. To enhance the success level of the project, existing inner dependency and activities related to CSFs must be identified. They may have impact on the success or failure of a project in terms of cost, time and scope. The empirical results of this study is presented that CSFs in IS implementation are not related to technical efforts, but related to managerial and operational efforts such as formation of the appropriate work groups and controlling and monitoring actions. It is also expected that results can support the decision makers in their assessment concerning degree of importance; and their influences on business operations. This study finally stresses and highlights the importance of managerial role in IS projects.

For the further study considerations, some techniques may be combined with another MCDM approach such as analytic network process (ANP). Additionally, this technique can be applied in different types of projects in numerous fields- including government sector, institution or private sectors- to identify the important factors. It can also be used to prioritize, rank or choose the most effective ones, if a project is to be put into separate stages and sub stages with related elements (or factors).

REFERENCES

- Bassam, A. H. (2013). Factors influencing project success criteria. The 7th IEEE International Conference on Intelligent Data Acquisition and Advanced Computing Systems: Technology and Applications, 12-14 September Berlin, Germany.
- BMG Research. (2014). Factors in project success. The Association for Project Management (APM), November, Bostock Marketing Group Ltd, 1-68.
- Budde, W. T. (2013). Counting the costs of project failure. Property Causality 360, Filed Under: Carrier Innovations, Technology Solutions, http://www.propertycasualty360.com/2013/04/10/counting-the-costs-of-project-failure ,11.8 2016.
- Cheng, E. W.L. & Li, H. (2004). Contractor selection using the analytic network process. Construction Management and Economics, 22, 1021-1032.
- Hastie,S. & Wojewoda, S. (2015). Standish Group 2015 Chaos Report - Q&A with Jennifer Lynch. https://www.infoq.com/articles/standish-chaos-2015, 5.10.2016.
- Khan, A. and Pessoa, M. (2010). Conceptual design: A critical element of a government financial management information system project. Technical Notes and Manuels, International Monetary Fund, Fiscal Affairs Department, 1-27. http://blog-pfm.imf.org/files/tnm1007.pdf
- Nilashi, M., Zakari, R., Ibrahim, O., Majid, M. Z. A., Zin, R. M. & Farahmand, M. (2015). MCPCM: A DEMATEL-ANP- based multi criteria decision making approach to evaluate the critical success factors in construction projects. Arab J. Sci Eng,40:343-361.
- Morrison, M. (2012). How to write a critical success factor (CSF). https://rapidbi.com/criticalsuccessfactors , 15.10.2016.
- Organ, Arzu. (2013). Bulanık DEMATEL yöntemiyle makine seçimini etkileyen kriterlerin değerlendirilmesi. Çukurova Üniversitesi Sosyal Bilimler Enstitüsü Dergisi, 22(1), 157-172.
- Pezeshki, M. & Ansari, R. (2013). Choosing technology by using a combined ANP and DEMATEL in cellulose industry (A case study: tissue paper manufacturing technologies). International Journal of Advanced Studies in Humanities and Social Science, 1(10), 1797-1814.
- Shahriari, M., Pilevari, N. & Shahrokhi, R. (2016). Combination of ANP and DEMATEL techniques for ranking insurance organizations based on electronic readiness. Oxford Journal of Intelligent Decision and Data Science , 1, 1-12.
- Uğur, S., Ar, İ.M. & Birdoğan, B. (2011). Yeniliği engelleyen finansal faktörlerin DEMATEL yöntemi ile değerlendirilmesi. İstanbul Ticaret Üniversitesi Akademik Arşiv, http://acikerisim.ticaret.edu.tr:8080/xmlui/handle/11467/522 , 6.8.2016
- Yang, J. L. & Tzeng, G.-H. (2010). An integrated MCDM technique combined with DEMATEL for a novel 3 cluster-weighted with ANP method. Expert Systems with Applications , DOI:10.1016/j.eswa.2010.07.048.
- Wateridge, J. (1995). IT projects: a basis for success. International Journal of Project Management, 13(3), 169-172.
- Zhou,Q., Huang,W. and Zhang,Y. (2011). Identifying critical success factors in emergency management using a fuzzy DEMATEL method. Safety Science, 49, 243–252.