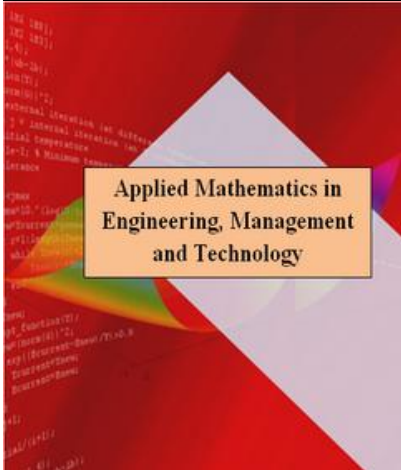


The relationship analysis of the project, program and portfolio success criteria by Using DEMATEL method –A case study

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Abstract

In this study, unlike other studies in the success literature, success criteria have been identified and also classified with a new approach in terms of distinctions of project, program and portfolio. By reviewing the literature of construction investment projects and also meeting with the directors of the client, operator, contractor and management contractor, 24 success criteria have been selected. Also their validity has been surveyed by using Likert scale questionnaire. With regard to the main purpose of this study, internal relationship of success criteria in an investment case study have been analyzed by using DEMATEL method. The results of this study determine the most affecting and important criteria in categorizations of project, program and portfolio. This study also shows that how the identified criteria impact on each other by applying "NRM" diagrams.

Keywords: Success Criteria of Project; Success Criteria of Program; Success Criteria of Portfolio; Investment Projects; Internal Relationship of Success Criteria; DEMATEL Method.

1- Introduction

Reviewing the related literature reveals that determining success criteria are neglected in this aspect in terms of project, program and portfolio concepts. With reference to nature and management of structural activities in each mentioned levels, appropriate evaluation of them in each time period is based upon their specific criteria. Therefore, studying success criteria based on distinguishing project, program and portfolio concepts is remarkably important.

In fact, the essence of studying success criteria is noteworthy in terms of the following reasons. First, success criteria play an important role in evaluation of project, program and portfolio. And level of achievement is measured through these criteria. Second, regarding the success estimation based on exact determination of success criteria and their correlation, great achievements in project management, program and portfolio is more likely. Also, excessive attention to marginal criteria should be avoided.

For more than fifty years, a successful project was known by its duration, budget, deliverability and quality. Being mindful of the related literature, most of the researchers agree that in primary conducted researches generally, if the project's finish time violates its due date, or the considered budget is underestimated, dissatisfaction and is happened and consequently project is failed. Obtained results in 1960s and 1970s indicate that in addition to iron triangular (time, cost and quality) and project management technique, other factors are considerably affecting project's success and failure.

In order to enrich conventional criteria (cost, time and quality) and to determine other affecting ones, this study fully reviews the discussed factors in the related literature. Moreover, in contrast with previous studies, a new categorization is presented for success criteria by differentiating between concepts of project, program and portfolio. Afterwards, DEMATEL method is used to determine and analyze the relation between identified criteria.

2- Literature Review

The need of western industry and military establishments to plan, schedule and control complex projects have caused the emergence of project management. The main focus of project management practices are research and development. Part of this development is the notion of project success, success criteria and success factors.

According to Baccarini (1999), the literatures on project management provide no consistent interpretation of the term “project success”. Determining how success is to be defined for a project is a necessary precursor to establishment of appropriate methods for managing the project life cycle and for the selection of suitable measurement techniques (Bryde, 2005).

From the 1950's, Oisen may have been one of the early attempts to define project success by the criteria of time, cost and quality (Oisen, 1997). In fact, these three criteria may be considered a necessary condition for project success, but certainly will not be a sufficient condition for achieving project success. In the 1980's until 1990's, further studies began to research deeper in defining project success.

“Success criteria” is a key step to understand the importance of “success factors”. Project success criteria are the set of principles or standards by which project success can be judged. On the other hand, factors for project success are the set of circumstances, facts, or influence which contribute to the project outcomes. These are the influential forces which either facilitate or impede project success. They contribute to the success or failure of a project, but do not form the basis of the judgment (Lim & Mohamed (1999).

Bernstein (1996) had stated in his study that if the criteria we measure are in error, it is not unreasonable to suggest that the factors we have been focusing on over the years to meet those criteria, may also have been in error.

The need to relate critical success factors to project success criteria is identified in both theory and practice. Westerveld (2003) constructed a model that links 6 groups success criteria and 6 groups success factors together in one coherent model which he named Project Excellence Model. The model is also based on the assumption that in order to manage a project successfully, the project organization has to focus on Result Areas containing project success criteria and Organization Areas containing critical success factors.

Turner (2007) surveyed the influence of project managers on project success criteria and project success by type of project. Then he modeled the relationship between rating of importance of success criteria and perceived success in projects to identify whether higher importance in success criteria leads to higher success ratings in the same or other criteria. He pointed out these 7 success criteria: meeting scheduled and budget goals, providing owner's satisfaction, meeting predefined project purposes, satisfying team and supplier requirements, reoccurring business, meeting user requirements, meeting other stakeholder requirements.

In another research by Turner (2009) considers the issue of project success in the 3rd chapter of his book. He defines two components of project success:

- Success Criteria: The dependent variables by which will be judged the successful outcome of the project.
- Success Factors: The independent variables which will be influenced the successful achievement of the success criteria.

Here represents 9 different perceptions of success criteria by different stakeholders over different timescales.

Success concept developed by Kerzner (2001) who states that in the past (at least 20 years ago) project success was related to the completion of project activities in the due time, budget and expected quality as immature criteria. Later the understanding of project success has been altered as mature criteria by including the limitation of minimum changes in the scope of activities without interruptions in the workflow, without shifts in the corporate culture, and with full acceptance of results by the project client.

Baccarini (1999) points out that project management literature often confusingly intertwine two separate dimensions of project success-product success and project management success.

- Project Management Success focuses on fulfilling the cost, time and quality criteria.
- Project Success deals with the effect of the project's final deliverable, namely project goals, project purpose and satisfaction of stakeholders.

Lim and Mohamed (1999) propose to classify project success into two categorizations: the macro and the micro viewpoints. His paper is suggested that two criteria are sufficient to determine the macro viewpoint of project success: completion and satisfaction. Whereas the completion criterion alone is enough to determine the micro viewpoint of project success.

In a paper by Atkinson (1999), where a new framework for success criteria is proposed, he suggests the Iron Triangle (time, cost and quality) could be developed to become the Square-Route of success criteria. The technical strength of the resultant information system, the benefits to the resultant organization (direct benefits) and the benefits to a wider stakeholder community (indirect benefits) are three categorizations could be represented as the Square-Route to understanding project management success criteria.

Shenhar et al.'s analysis (2001) identified four major distinct success dimensions: (1) project efficiency, (2) impact on customer, (3) direct business and organizational success, and (4) preparing for the future. By using evidence from the literature, as well as their own observations during the qualitative part, they developed a list

of fourteen specific measures with which project success could be assessed. Their goal during the quantitative part was to test the behavior of these measures in their second database of 127 projects from a total number of 182 project managers. To address this issue, one of the questions was asked: "How would these measures be assessed for each project, and what is the relationship between the measures?" Data analysis involved calculating the descriptive statistics and Pearson Correlation coefficients between the fourteen measures and performing factor analysis on these measures.

Shnehar and Dvir (2007) published a book on project success that represents a new dimensional model for assessing and planning project success beyond the Iron Triangle. The model considers strategic and tactical aspects of project performance in the short and the long term. The authors present a diamond-shape framework to help managers distinguish among projects according to four dimensions: (1) novelty, (2) technology, (3) complexity, and (4) pace. These four dimensions the authors define as the four bases of successful projects.

Elattar (2009) and Chan et al. (2002) establish a conceptual framework for measuring construction project success criteria from both objective and subjective viewpoints. The construction processes can be divided into phases including: pre-construction, project construction and post construction. In another study by Bryde and Robinson (2005) emphasizes on minimizing project cost, satisfying the customer's needs, minimizing the project duration, meeting the technical specification, and satisfying the needs of stakeholder (other than the customer) as main project success criteria by the business sector.

Turner and Zolin (2012) developed a set of leading performance indicators for large projects that can be measured during project delivery to predict project success. With regard to the studies of Turner (2009), Shnehar et al (2007) and Westerveld (2003), their models are integrated into single model in Turner and Zolin paper. Their model of project success address the views of multiple stakeholder group from the end of the project (outputs) to shortly after the projects (outcomes) to the longer term (impacts). Their major contributions are the recognition of stakeholders as the evaluators of project success combined with their method of evaluating project success across a range of time frames.

According to previous studies, Iron triangle (time, cost, and quality) have long been the success criteria used to evaluate the performance of a construction project. However such a list has been criticized as not being sufficient. Nowadays project success is a dimensional concept that associated with technical, economic, functional, business, and strategic aspects. Therefore project, program, and portfolio managers should determine and classify appropriate framework of success criteria related to each of these levels before implementing project, program, and portfolio.

Being mindful of the fact that success criteria and success factors are not the same, some studies have investigated to determine the relation between success factors. Among them are Amalnik et al. (2010), Carpak and Topcu (2010), and Nilashi et al. (2014) and Amalnik et al. (2010) identified success factors in implementing ERP projects. They also used DEMATEL to recognize the relation between those factors. Nilashi et al. (2014) identified success factors in construction projects and used DEMATEL to define and analyze the relations, as well. Caprak and Topcu (2010) investigated success factors in small production companies through ANP method. Despite the fact that these studies have considered relations between success factors, only few ones have precisely investigated the relation between success criteria in their research. Also, just in some of them it is studied briefly and conceptually. Therefore, this study is to evaluate the cause and effect between key success criteria through DEMATEL method.

3- Research Methodology

This research methodology is implemented on a case study called as "telecommunication master plan in Masjed Soleyman city". This case study is a construction investment project and the contract type is EPC and conducted under supervision of National Iranian South Oil Company. The main pillars of this project are, namely, Client, enduser, contractor, and management contractor. According to Figure 1, success criteria are identified and categorized with regard to project, program and portfolio concepts. And finally, the relations among these criteria are analyzed by DEMATEL method. In the following, each phase of methodology is described and implemented for the mentioned case study.

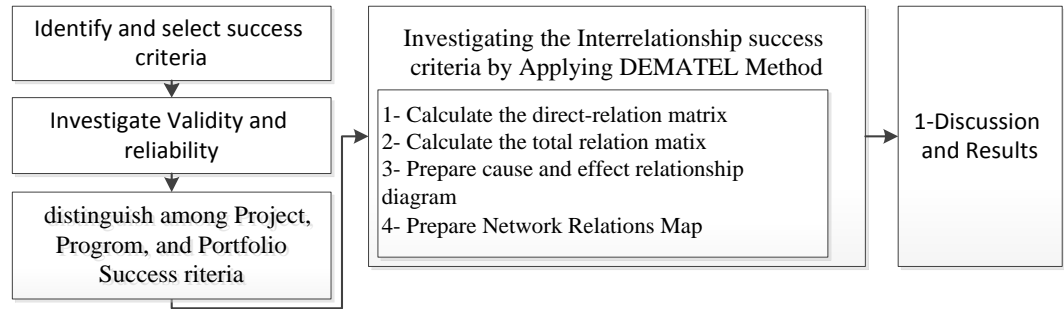


Fig. 1. Research Methodology

3.1. Identified and Selected Success Criteria

According to different success criteria from the literature reviewed in this study, a list of success criteria was prepared. To confirm the list of identified success criteria, a meeting with the directors of client, operator, contractor and management contractor was held. By considering on a case study, 24 success criteria have been selected as shown in Table 1. It should be noted that “experiment of general contractor” criterion is added by the experts.

Table 1 Selected success criteria

Criteria	Author
Time	De wit(1988),Maloney(1990),Freeman&Beal(1992), Riggset al. (1992) , Tyler (1992), Parfitt&Sanvido(1993),Bushait&Almohawis(1994),Noam(1994),Kumaraswamy&Thorp(1995),Chan(1996), Shenhar et al(1997), Chua et al. (1999) , Atkinson (1999) , Baccarini(1999),Lim & Mohamed(1999),Brown & Adams(2000),Cheung et al .(2000), Shenhar(2001),Chan et al .(2002), Westerveld(2003) ,Bryde(2005), Blindenbach(2006), Shenhar(2007),Ahadzie et al.(2008),Elattar(2009),Turner(2009), Al-Tmeemy et al.(2011), Shao et al.(2011).
Cost	De wit(1988),Maloney(1990),Freeman&Beal(1992), Riggset al. (1992) , Tyler (1992), Parfitt&Sanvido(1993),Bushait&Almohawis(1994),Noam(1994),Kumaraswamy&Thorp(1995),Chan(1996),Shenhar et al(1997),Chua et al. (1999) , Atkinson (1999) , Baccarini(1999),Lim & Mohamed(1999),Brown & Adams(2000),Cheung et al .(2000), Shenhar(2001),Chan et al .(2002), Westerveld(2003) ,Bryde(2005), Blindenbach(2006), Shenhar(2007),Ahadzie et al.(2008),Elattar(2009),Turner(2009),Al-Tmeemy et al.(2011), Shao et al.(2011).
Scope	Baccarini(2004).
Health and Safty	Tyler(1992),Parfitt&Sanvido(1993),Bushait&Almohawis (1994) , Kumaraswamy& Thorp(1995) , Liu & Walker(1998),Lim & Mohamed(1999),Chan et al.(2002),,Ahadzie et al.(2008),Elattar(2009),Shao et al.(2011).
Meeting technical specification and contract requirements	De wit(1988),Freeman&Beal(1992), Riggset al. (1992) ,Parfitt&Sanvido(1993) ,Shenhar(2001), Chan et al .(2002), Shenhar(2007),Al-Tmeemy et al.(2011).
Functional capabilities required byclient	Shenhar(2001),Shenhar(2007),Frödell(2008),Elattar(2009),Al-Tmeemy et al.(2011).
General contractor Profit	Norris(1990),Freeman&Beal(1992), Tyler (1992), Parfitt&Sanvido(1993), Shenhar et al(1997), Atkinson (1999) , Shenhar(2001),Chan et al .(2002), Blindenbach(2006), Shenhar(2007),Frödell(2008),Al-Tmeemy et al.(2011), Rashvand(2014).
Credibility of general Contractor	Al-Tmeemy et al.(2011).

A market share of general contractor	Shenhar(2001),Shenhar(2007),Frödell(2008),Al-Tmeemy et al.(2011).
Experiment of general contractor	
Management contractor satisfaction	Freeman&Beal(1992),Parfitt&Sanvido(1993), Noam(1994), Kumaraswamy&Thorp(1995), Larson(1995), Chan(1996),Atkinson (1999) , Baccarini(1999),Lim & Mohamed(1999), Al-Tmeemy et al.(2011).
Suppliers satisfaction	Frödell(2008),Turner(2009).
Project team satisfaction	Freeman&Beal(1992),Parfitt&Sanvido(1993),Noam(1994),Kumaraswamy&Thorp(1995), Larson(1995),Chan(1996),Atkinson (1999) , Baccarini(1999),Lim & Mohamed(1999),Turner(2009),Al-Tmeemy et al.(2011).
Other stakeholders' satisfaction	Freeman&Beal(1992),Parfitt&Sanvido(1993),Noam(1994),Kumaraswamy&Thorp(1995), Larson(1995),Chan(1996),Atkinson (1999) , Baccarini(1999),Lim & Mohamed(1999),Bryde(2005),Turner(2009),Al-Tmeemy et al.(2011).
Meeting expected efficiency during operation	Maloney(1990),Freeman&Beal(1992), Tyler (1992), Atkinson (1999),Shenhar(2001),Chan et al . (2002),Baccarini(2004),Shenhar(2007),Shao et al.(2011) .
Easy usage of project outputs	,Baccarini(1999),Shenhar(2001),Baccarini(2004),Bryde(2005),Shenhar(2007).
Safety during operation	Tyler(1992),Parfitt&Sanvido(1993),Bushait&Almohawis (1994) , Kumaraswamy& Thorp(1995) , Liu & Walker(1998),Lim & Mohamed(1999),Chan et al.(2002) ,Ahadzie et al.(2008), Elattar(2009),Shao et al.(2011) .
Project owner profitability	Norris(1990),Freeman&Beal(1992), Tyler (1992), Parfitt&Sanvido(1993), Shenhar et al(1997), Atkinson (1999) , Shenhar(2001),Chan et al .(2002), Blindenbach(2006), Shenhar(2007), Frödell(2008), Al-Tmeemy et al.(2011), Rashvand(2014).
Increased project owner's production	Shenhar(2001),Shenhar(2007).
Increased public satisfaction	Shenhar(2001),Bryde(2005),Shenhar(2007),Frödell(2008).
Competitive advantage of project owner	Al-Tmeemy et al.(2011),Rashvand(2014).
Increased health and safety	Tyler(1992),Parfitt&Sanvido(1993),Bushait&Almohawis (1994) , Kumaraswamy& Thorp(1995), Liu & Walker(1998),Lim & Mohamed(1999),Chan et al.(2002),Ahadzie et al.(2008), Elattar(2009), Shao et al.(2011).
Achieving a symbol and a sense of social honor	Atkinson (1999),Shenhar(2001),Shenhar(2007)..
Preparation for the future	Shenhar(2001),Blindenbach(2006),Shenhar(2007),Ahadzie et al.(2008),Shao et al.(2011).

3.2.The Reliability and Validity of Questionnaire

In the expert questionnaire which is based on pairwise comparisons, probability of neglecting a relation is equal to zero. Since all the possible cases are taken into account, pairwise comparison based questionnaires are per se valid. Thus, if the criteria and sub-criteria are selected appropriately, its validity is confirmed (Habibi, 2014). As it was mentioned in stage 1-3, considered criteria are extracted from previous researches. So, in order to make sure that selected criteria are suitable for the considered case study, a questionnaire is provided. Respecting this questionnaire, 36 experts in project management, who are authorities in investment and construction projects, are employed to provide pairwise comparisons based on Likert scale (number 5 for "very important", number 1 for "unimportant"). Regarding the obtained results, the average importance is more than 3 and Cronbach's alpha is equal to 0.889. Then, reliability and validity of this research is approved.

3.3. Distinctions among Project, Program, and Portfolio Success criteria

Investment projects are those that their benefit is gained when the deliverable products are exploited. In other words, transiting the deliverable product to service units of the organization, results in changes of business capacities. In fact, continuous usage of changed capacity in business leads to desired consequences in company. These desired consequences also results in realization of benefits and accordingly realization of strategic goals of the company (Haji Yakhchali, 2014). So, it is necessary to divide concepts into project, program and portfolio to better description and evaluation of this kind of projects. This is because each categorie's evaluation regarding their output and evaluation time is totally different. In this paper, based on Elena's project, program and portfolio (Haji Yakhchali, 2014) and for the selected investment project as a case study, the success criteria are extracted as it follows. For each criterion a code is generated for refering to it.

Project Success Criteria: Project is a set of processes, tools and temporary organizational structure in line with producing one or more deliverable outputs that could have various functional goals. So, projects are being processed until gaining deliverables (haji Yakhchali, 2014). This is noteworthy that projects's success or failure is realized when deliverables and evaluated. Time (C111), cost (C112), scope (C113), and health & safety (C114) are common project success criteria. From the majority of stakeholders' viewpoints, these are important. Therefore, they consider these criteria to evaluate success.

Correspondence criteria in technical specifications of contracts (C121) and required applicability for client (C122) are two criteria that mainly indicate level of achievements in projects. In EPC projects, required applicability for client plays an important role since in these kinds of projects, contractor is to deliver an output corresponding with client's requirements. Surely, to reach these features, some requirements, have to be fulfilled. Although, these requirements are not explicitly mentioned in contract, they have to be respected as client's needs. General contractor profit (C131), credibility of the general contractor (C132), a market share of general contractor (C133), and experiment of the general contractor (C134) are the criteria of the general contractor. In addition, part of the success evaluation is related to other stakeholdessatisfaction. Management contractor satisfaction (C141), suppliers satisfaction (C142), project team's satisfaction (C143), other stakeholders' satisfaction such as public (C144) are also project success criteria.

Program Success Criteria: Program is a set of processes, tools and temporary flexible organizational structure for coordination, high supervision and conducting a set of related projects and service in order to synergic consequences and in line with strategic goals of organization. Projects focus on deliverables, while programs focus on desired outcomes. To put it in another way, deliverables should be transited to service units of organization to utilize new capacities of business. When a new capacity is created in organization, it should be utilized so as to gain desired outcomes. Thus, success or failure of a project is according to deliverables and success or failure of a prpgram is based on obtained desired outcomes (Haji Yakhchali, 2014). According to program concept and the most important stakeholder according to yhis phase (that is ,operator), meeting expected efficiency during operation (C211), easy usage of project outputs (C212), safety during operation (C213) are considered to evaluate the program success.

Portfolio Success Criteria: Portfolio is a set of processes, tools and permanent organizational structure that monitor and control the whole projects, plans and services in organization so as to fulfill strategic goals. Portfolio is connecting programs with projects in line with strategies of organization. In fact, portfolio is concentrated on achieving strategic goals and its success or failure is evaluated achieveing that goals (Haji Yakhchali, 2014). According to Interviewing by a project owner and identifying his strategies, success criteria to evaluate portfolio success regarding "telecommunication master plan in MasjedSoleyman city" are determined as project owner profitability (C311), increased project owner's production (C312), increased public satisfaction (C313), Competitive advantage of project owner (C314), increased health and safety (C315), achieving a symbol and a sense of social honor (C316), and preparation for the future (C317).

3.4. Investigating the Interrelationship success criteria by Applying DEMATEL Method

The criteria and objectives of project, program and portfolio quietly affected each other. It is impossible to optimize all of these criteria and objectives independently, so one of the main tasks of project, program and portfolio managers is balancing between criteria and objectives. Therefore, in an attempt to investigate the structural relations among success criteria and objectives in categorizations of project, program and portfolio, DEMATEL method is applied.

DEMATEL method was proposed by Fontla and gabus (1973) in Battle memorial institute. This method is to analyze the inner correlation between criteria in a way that experts are dominantly able to express their opinion on relation (direction and severity of influence) between criteria. DEMATEL has two main functions; first, determining cause and effect between criteria and second, obtaining internal relation matrix so as to use it in analysis of network structure. In this paper, criteria in project, program and portfolio are evaluated generally and then separately through this method.

The process of DEMATEL methods are as following (Habibi, 2014):

1. Calculate the direct-relation matrix (M):

By designing questionnaire, the view of each expert is asked regarding the direct influence of each criterion among others. Their views are ranged by integer score from 0 to 4, and are determined that criterion x affect criterion y in which zero represents no influence and 4 represent very high influence. Finally the views of 12 experts related to a case study are aggregated by using the average matrix. In this step, an n*n non-negative matrix (M) is constructed to show direct influence between two criteria based on pair-wise comparison. (N is the number of criteria.)

2. The normalized direct-relation matrix (N)

The matrix (N) is defined by utilizing Eq. (1) and Eq. (2), where the value of each element in matrix (N) is calculated by multiplying the elements of the direct-relation matrix (M) and (K), the inverse of the maximum sums of its rows and columns (X_{ij} is the entry of the matrix (M)).

$$K = \max \left\{ \max \sum_{i=1}^n X_{ij}, \sum_{j=1}^n X_{ij} \right\} \quad (1)$$

$$N = \frac{1}{K} * M \quad (2)$$

3. Calculate the total relation matrix (T)

The total relation matrix (T) is obtained by utilizing Eq. (3), in which, matrix (I) is an identity matrix. Actually the total relation matrix (T) shows both the direct-relation matrix and the indirect-relation matrix.

$$T = N \times (I - N)^{-1} \quad (3)$$

The calculated matrices of the steps 1 and 2 are not represented in this study, because of their large dimensions and the writing restrictions. With regard to figure 2, the matrix (T) is reflected the total relationship among all identified success criteria related to a case study.

	SC11	SC12	SC13	SC14	SC121	SC122	SC131	SC132	SC133	SC134	SC141	SC142	SC143	SC144	SC211	SC212	SC213	SC311	SC312	SC313	SC314	SC315	SC316	SC317	D (SUM)
SC11	0.13	0.24	0.17	0.16	0.18	0.16	0.23	0.23	0.19	0.18	0.19	0.18	0.24	0.17	0.18	0.16	0.15	0.22	0.16	0.18	0.18	0.15	0.19	0.15	4.38
SC112	0.18	0.16	0.16	0.16	0.19	0.16	0.22	0.20	0.18	0.18	0.18	0.18	0.23	0.15	0.16	0.15	0.15	0.19	0.14	0.17	0.17	0.15	0.18	0.15	4.14
SC113	0.19	0.24	0.14	0.19	0.21	0.19	0.21	0.22	0.19	0.18	0.19	0.18	0.23	0.18	0.20	0.18	0.17	0.20	0.16	0.19	0.18	0.18	0.19	0.15	4.56
SC114	0.13	0.18	0.14	0.12	0.16	0.13	0.16	0.17	0.15	0.15	0.16	0.14	0.20	0.15	0.15	0.13	0.16	0.15	0.12	0.16	0.15	0.17	0.16	0.12	3.62
SC121	0.17	0.24	0.21	0.19	0.17	0.20	0.21	0.23	0.20	0.19	0.22	0.19	0.23	0.18	0.21	0.18	0.18	0.21	0.16	0.20	0.19	0.17	0.20	0.17	4.70
SC122	0.15	0.20	0.18	0.16	0.20	0.13	0.17	0.20	0.17	0.17	0.18	0.17	0.21	0.16	0.19	0.18	0.16	0.18	0.14	0.16	0.17	0.15	0.17	0.14	4.10
SC131	0.16	0.20	0.15	0.15	0.15	0.13	0.13	0.17	0.15	0.14	0.15	0.15	0.21	0.13	0.14	0.12	0.12	0.14	0.10	0.13	0.12	0.11	0.14	0.11	3.39
SC132	0.16	0.21	0.18	0.18	0.19	0.17	0.21	0.17	0.21	0.19	0.19	0.17	0.24	0.16	0.17	0.16	0.16	0.17	0.14	0.16	0.16	0.16	0.18	0.15	4.23
SC133	0.14	0.17	0.15	0.14	0.16	0.14	0.17	0.20	0.12	0.16	0.16	0.15	0.19	0.13	0.13	0.13	0.13	0.15	0.12	0.14	0.14	0.13	0.15	0.13	3.51
SC134	0.17	0.21	0.17	0.18	0.20	0.17	0.21	0.22	0.20	0.14	0.19	0.18	0.23	0.17	0.17	0.15	0.16	0.18	0.14	0.17	0.16	0.17	0.18	0.15	4.26
SC141	0.15	0.20	0.16	0.17	0.20	0.16	0.18	0.20	0.17	0.17	0.14	0.16	0.22	0.15	0.17	0.16	0.16	0.17	0.14	0.16	0.15	0.15	0.17	0.14	4.00
SC142	0.13	0.16	0.13	0.14	0.18	0.14	0.15	0.16	0.15	0.13	0.14	0.11	0.17	0.12	0.15	0.13	0.12	0.13	0.10	0.13	0.12	0.12	0.13	0.11	3.26
SC143	0.16	0.20	0.16	0.18	0.18	0.14	0.19	0.20	0.18	0.16	0.19	0.16	0.17	0.17	0.17	0.15	0.16	0.17	0.13	0.16	0.14	0.14	0.16	0.13	3.95
SC144	0.10	0.13	0.11	0.12	0.12	0.10	0.13	0.14	0.13	0.12	0.12	0.12	0.16	0.09	0.12	0.10	0.10	0.12	0.10	0.13	0.10	0.10	0.12	0.09	2.76
SC211	0.12	0.17	0.15	0.15	0.19	0.16	0.17	0.18	0.17	0.15	0.17	0.16	0.20	0.15	0.13	0.16	0.15	0.18	0.14	0.17	0.15	0.15	0.16	0.15	3.82
SC212	0.11	0.17	0.13	0.15	0.17	0.15	0.14	0.18	0.16	0.15	0.15	0.15	0.18	0.14	0.16	0.11	0.16	0.17	0.13	0.17	0.15	0.15	0.16	0.14	3.65
SC213	0.12	0.17	0.14	0.15	0.16	0.15	0.15	0.18	0.15	0.15	0.16	0.15	0.19	0.15	0.17	0.16	0.12	0.16	0.14	0.17	0.16	0.15	0.18	0.14	3.71
SC311	0.11	0.16	0.14	0.14	0.16	0.13	0.15	0.16	0.14	0.13	0.15	0.14	0.18	0.13	0.14	0.13	0.14	0.12	0.14	0.14	0.15	0.14	0.16	0.13	3.42
SC312	0.11	0.17	0.14	0.14	0.15	0.13	0.15	0.17	0.14	0.13	0.14	0.14	0.17	0.13	0.15	0.14	0.14	0.18	0.10	0.15	0.16	0.13	0.18	0.16	3.49
SC313	0.11	0.16	0.13	0.14	0.15	0.12	0.15	0.17	0.15	0.14	0.14	0.14	0.19	0.15	0.14	0.13	0.14	0.16	0.13	0.11	0.15	0.14	0.17	0.14	3.45
SC314	0.11	0.14	0.12	0.13	0.15	0.13	0.14	0.16	0.14	0.14	0.14	0.14	0.17	0.13	0.13	0.12	0.13	0.16	0.13	0.13	0.10	0.12	0.15	0.13	3.27
SC315	0.12	0.16	0.13	0.17	0.16	0.14	0.14	0.17	0.15	0.14	0.16	0.15	0.19	0.14	0.15	0.14	0.16	0.16	0.13	0.17	0.15	0.11	0.17	0.13	3.58
SC316	0.12	0.16	0.14	0.14	0.16	0.13	0.15	0.17	0.15	0.14	0.16	0.14	0.18	0.14	0.15	0.14	0.13	0.15	0.14	0.17	0.15	0.14	0.12	0.15	3.50
SC317	0.12	0.17	0.14	0.14	0.16	0.14	0.14	0.16	0.14	0.14	0.14	0.14	0.17	0.13	0.15	0.14	0.14	0.16	0.14	0.15	0.15	0.13	0.16	0.10	3.47
R (SUM)	3.28	4.35	3.58	3.69	4.10	3.50	4.06	4.38	3.87	3.69	3.89	3.68	4.76	3.49	3.80	3.45	3.49	3.99	3.19	3.77	3.60	3.40	3.93	3.29	

Fig. 2. The total relation matrix (T) and the values of D & R related to success criteria in general mode

4. Build a cause and effect relationship diagram and determine the influential and affecting criteria

One of the outputs of Dematel method is a cause and effect relationship diagram. Therefore, the total relation matrix (T) is utilized. Let D and R be the sums of rows and columns, respectively, in matrix (T). If D_i is the sum of i^{th} row in matrix (T), then the value of D_i represents the total given both directly and indirectly effects that i^{th} criterion has on the other ones. Also, if R_j is the sum of j^{th} column in matrix (T), then the value of R_j shows the total received effects, that all other criteria have on criterion j. If $i = j$, the value of $(D_i + R_i)$ indicates the total effects both given and received by criterion i. In fact, the importance of criterion i is shown on the system. In contrast, the value of $(D_i - R_i)$ is the net contribution by criterion i on the system. In other words (Eshgeraf, 2014):

- If $D_i > R_i \rightarrow (D_i - R_i > 0)$, criterion i is a net cause.
- If $D_i < R_i \rightarrow (D_i - R_i < 0)$, criterion i is a net receiver.

$D+R$ is an indicator that can be used to prioritize criteria regarding the pairwise relations. Generally, R and D are shown in Figure 2. Through DEMATEL steps, R and D values are determined independently for project, program and portfolio criteria and also $R+D$ is calculated for each concept. Prioritized criteria, according to $D+R$ values, for each group of project, program and portfolio are presented in Tables 2, 3, and 4.

Table 2 Ranking project success criteria based on D+R index

Criteria	Code	D+R	Rank
Project team satisfaction	SC111	10.187	1
Credibility of general Contractor	SC112	10.172	2
Cost	SC113	10.168	3
General contractor Profit	SC114	9.683	4
Time	SC121	9.559	5
Meeting technical specification and contract requirements	SC122	9.519	6
Experiment of general contractor	SC131	9.301	7
Scope	SC132	9.138	8
Management contractor satisfaction	SC133	8.812	9

A market share of general contractor	SC134	8.790	10
Functional capabilities required by client	SC141	8.087	11
Suppliers satisfaction	SC142	7.750	12
Health and Safty	SC143	7.629	13
Other stakeholders' satisfaction	SC144	6.745	14

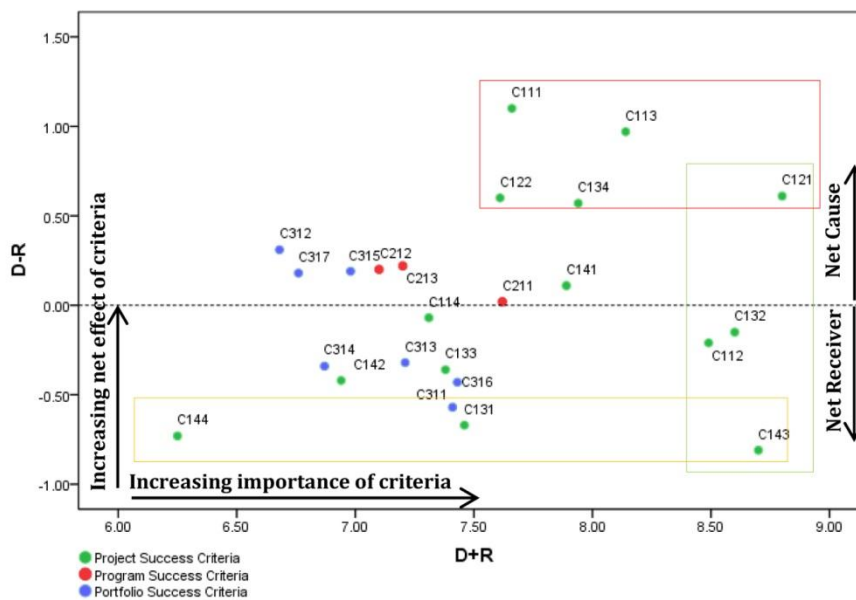
Table 3 Ranking program success criteria based on D+R index

Criteria	Code	D+R	Rank
Easy usage of project outputs	SC212	19.969	1
Expected efficiency during operation	SC211	19.630	2
Safety during operation	SC213	19.395	3

Table 4 Ranking portfolio success criteria based on D+R index

Criteria	Code	D+R	Rank
Increased project owner's production	SC312	10.053	1
Achieving a symbol and a sense of social honor	SC316	9.997	2
Preparation for the future	SC317	9.274	3
Increased public satisfaction	SC313	9.199	4
Project owner profitability	SC311	9.166	5
Competitive advantage of project owner	SC314	9.071	6
Increased health and safety	SC315	8.216	7

Moreover, final diagram is depicted in a Cartesian coordinate system in which horizontal axis shows D+R and vertical axis shows D-R. So, each criterion's position is defined by coordination (D+R, D-R) in this system. Figure 3 presents the general cause and effect of success criteria. By following DEMATEL steps, final cause and effect diagram for each group of success criteria in project, program and portfolio are acquired separately in figures 4, 5, and 6, respectively.


Fig. 3. The cause and effect diagram of success criteria in general mode

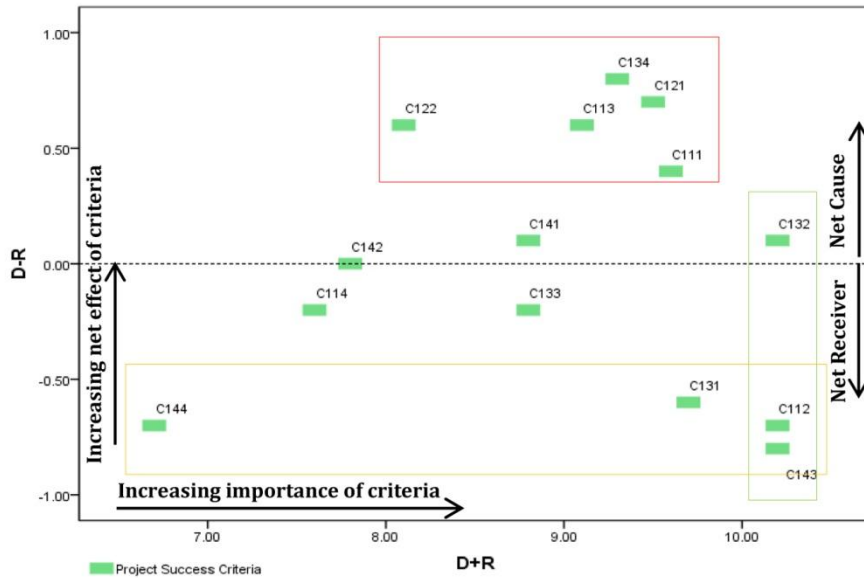


Fig. 4. The cause and effect diagram of project success criteria

5. The preparation of the Network Relations Map (NRM)

To visualizing the (NRM), the threshold value (α) should be derived from the average of elements in matrix (T). By setting up the threshold value (α), some minor effects elements in matrix (T) can be eliminated and notable network relations can be drawn. The values of the elements in matrix (T), which are greater than (α), just be represented in (NRM). Therefore, all elements in matrix (T), which are smaller than (α), are equaled zero and are not considered in a cause relation (Sumrit&Anuntavoranich, 2013).

According to alarge numbers of relations in total and project groups,only the network relations map of program and potfolio success criteria are shown as figures 5 and 6.

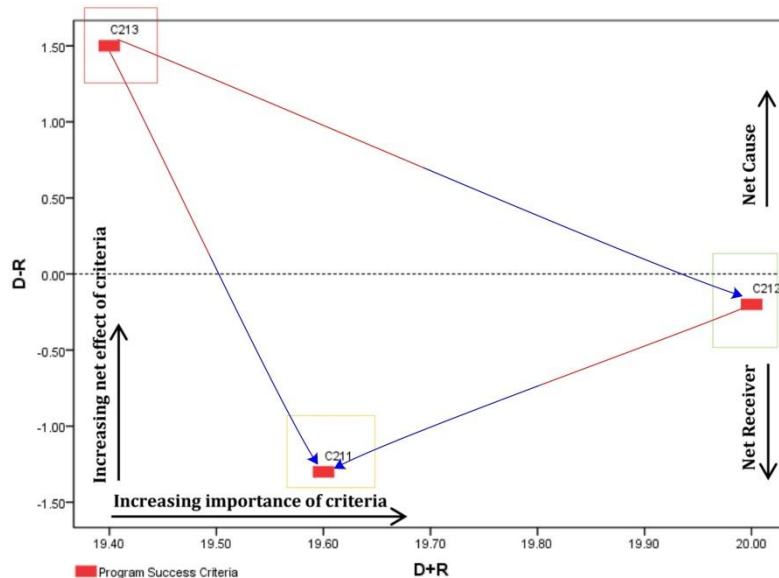


Fig. 5. The cause and effect diagram of program success criteria group with NRM

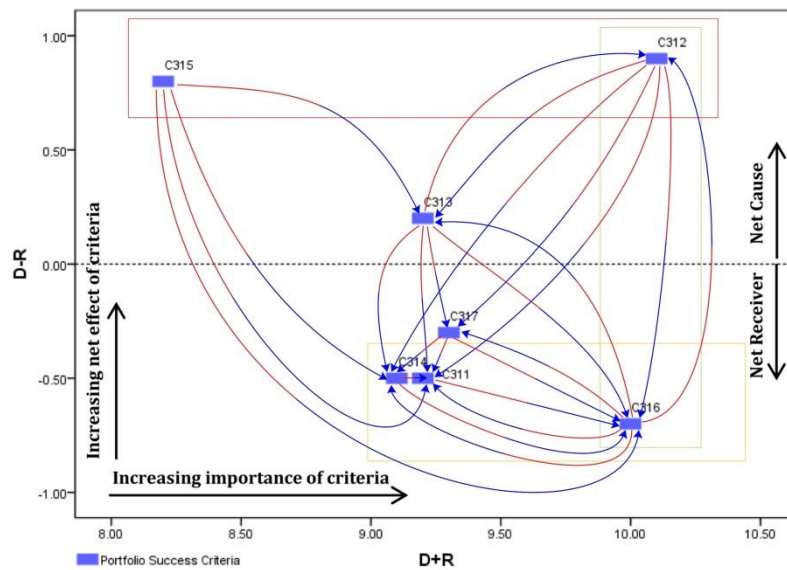


Fig. 6. The cause and effect diagram of portfolio success criteria group with NRM

4- Discussion and Results

The cause and effect diagram of project, program and portfolio success criteria were constructed in general by considering all interrelationship among them as shown in figure 3. With regard to the figure 3, the most positive value of (D-R) related to the criteria were the above of the diagram and indicated the most impact criteria on the others. These criteria were: “time (C111)”, “scope (C113)”, “meeting technical specification and contract requirements (C121)”, “functional capabilities required by client (C122)”, “experiment of general contractor (C134)”, respectively. All these criteria are project success criteria that represent the influence of project success on the program and portfolio success. Therefore, the increasing concentration on achieving these criteria can contribute the program and portfolio success. Also, the most negative value of (D-R) related to the criteria were the below of the diagram and indicated the most affected by the other ones. These criteria were: “general contractor Profit (C131)”, “project owner profitability (C311)”, “project team satisfaction (C143)”, and “other stakeholder satisfaction (C144)”. The right side of the diagram related to the criteria that had the highest (D+R) values. They had the most interactions on the other criteria. Also their overall effects and influence were more than the other criteria. They were: “meeting technical specification and contract requirements (C121)”, “Credibility of the general Contractor (C132)”, “cost (C112)”, and “project team satisfaction (C143)”. The cause and effect diagrams among success criteria under categorizations of project, program and portfolio were illustrated in figure 4 to figure 6. Based on the similar analysis, the most affecting, impressive and important success criteria can be determined by these diagrams. The obtained results were summarized in table

Table 5 The results of the cause and effect diagrams analysis

Criteria Category	The most affecting criteria	The most impressive criteria	The most important criteria
General Mode	Time(C111), Scope(C113), Meeting technical specification and contract requirements(C121), Functional capabilities required by client (C122), Experiment of general contractor (C134)	General contractor Profit (C131), Project owner profitability (C311), Project team satisfaction (C143), Other stakeholder satisfaction (C144)	Meeting technical specification and contract requirements (C121), Credibility of general Contractor (C132), Cost (C112), Project team satisfaction (C143)
Project	Experiment of general	Project team satisfaction	General contractor

	contractor (C134), Meeting technical specification and contract requirements (C121), Scope(C113), Functional capabilities required by client (C122)	(C143), Other stakeholder satisfaction (C144), Cost (C112), General contractor Profit (C131)	Profit (C131), Scope(C113), Project team satisfaction (C143)
Program	Safety during operation)C213(Expected efficiency during operation (C211)	Easy usage of project outputs (C212)
Portfolio	Increased project owner's production (C312), Increased health and safety (C315)	Project owner profitability(C311), Competitive advantage of project owner (C314), Achieving a symbol and a sense of social honor(C316)	Increased project owner's production (C312), Achieving a symbol and a sense of social honor(C316)

By surveying network Relations Map of portfolio success criteria group in figure 6, “increased health and safety” criterion was a key criteria. It did not influence by the other criteria. In contrast, it affected four criteria such as; “project owner profitability (C311)”, “increased public satisfaction (C313)”, “competitive advantage of project owner (C314)”, and “achieving a symbol and a sense of social honor (C316)”. Nevertheless, “increased project owner’s production (C312)” and “achieving a symbol and a sense of social honor (C316)” were the most important portfolio success criteria. Considering the position of “increased project owner’s production (C312)” in the above of diagram and its high effects on the othecriteria, cause more attention to obtain it.

5- Conclusion

This study identified 24 success criteria regarding construction investment projects, after interviewing a group of professional experts. To assure the reliability and validity of questionnaire, it is tested by using Likert scale and Cronbach’s alpha. Selected criteria are categorized into project, program and portfolio groups. By applying Dematel method and considering the relationship among success criteria, the most important criteria and the most impressible and affecting ones are provided. By the aspect of prioritizing, the most important criteria under the four categorizations of project, program, portfolio and general mode were “meeting technical specification and contract requirements (C121)”, “general contractor Profit (C131)”, “easy usage of project outputs (C212)”, and “increasing project owner’s production(C312)”, respectively. In fact, these criteria are those that are more interactive with other criteria and reaching these criteria eases reaching other success criteria. In addition to important criteria in terms of causing and effecting, network relationship map (NRM), indicating the relation between success criteria, is provided. The obtained results help managers in project, program and portfolio to make more efficient decisions in line with defined goals. Since this reaserch is conducted for an investment construction project, the future researches can adopt the proposed methodology to other projects and industries and compare the results. On the other hand, hybriding output of DEMATEL method with other multicriteria decision making methods such as ANP for prioritizing criteria and also srudying fuzzy DEMATEL method to reach much exact results could be worthwhile.

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