USING COGNITIVE MAPS FOR MODELING PROJECT SUCCESS

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ABSTRACT

USING COGNITIVE MAPS FOR MODELING PROJECT SUCCESS

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In order to evaluate a project as successful or not, initially, the questions of "what are the factors affecting the success" and "according to whom and which criteria should the success be measured" should be answered. Both the factors and their influences vary depending on a project's specific characteristics, different environmental factors affecting it, and different parties involved. These factors are not independent of each other and the interrelationship between them should be investigated as a whole in order to model the project success. Moreover, parties involved in a project usually have different objectives and the performance indicators used to measure project success differ according to company priorities, preferences and attitudes. Thus, there exists a need to develop a project success model that contains the interrelationships between factors such as risks, decisions, and strategies, project success criteria, objectives and the relations of the factors with the objectives.

A cognitive map (CM) is a strong visual tool to reflect the beliefs and knowledge of people about a situation or domain, identifying the causes, effects and the relations between them. This qualitative technique being enhanced by quantifiable properties makes it appropriate to be utilized to model the project success.

As a result, the objective of this study is to demonstrate the application of CMs as a powerful tool for modeling project success. It is hypothesized that CMs can be effectively used to model the factors affecting success of a construction project, to reflect the interrelations between project success factors, to demonstrate the different objectives of parties involved in a project and show how the project success can be defined differently, by different parties. This technique is applied to a real construction project realized in Turkey. CMs of two consortium contractors and client organization involved in the project are constructed and the differences between the perceptions of three parties are revealed by content and structural analyses. Finally, the benefits and shortcomings of using CMs for modeling project success are discussed by referring to case study findings.

Key words: Project Success, Cognitive Map

ÖZ

PROJE BAŞARISINI MODELLEYEBİLMEK İÇİN BİLİŞSEL HARİTALAMA YÖNTEMİNİN KULLANIMI

Atasoy, Güzide
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Bir projenin başarılı olup olmadığını değerlendirebilmek için öncelikle "projeyi etkileyenler faktörler nelerdir" ve "başarı kime ve hangi kıstaslara göre değerlendirilmelidir" sorularına cevap bulmak gerekir. Bir projenin kendine has özellikleri, kendisini etkileyen çevresel faktörler ve mevcut tarafların farklılıklarından kaynaklı, her projeyi etkileyen faktörler ve bunların etkileri çeşitlilik göstermektedir. Bu faktörler birbirinden bağımsız değildir ve proje başarısını modelleyebilmek için bu faktörlerin birbirleri arasındaki ilişkileri de bir bütün olarak ele alınmalıdır. Ayrıca, bir projedeki mevcut taraflar genellikle farklı hedeflere sahiptirler ve şirket öncelikleri, tercihler ve tutumlarına göre proje başarısını ölçen performans göstergeleri değişiklik göstermektedir. Nitekim; risk, kararlar ve stratejiler gibi faktörler arasındaki ilişkileri, proje başarı kriterlerini, hedefleri ve hedeflerle faktörler arasındaki ilişkiyi gösterecek bir proje başarısı modeline ihtiyaç vardır.

Bilişsel haritalama, bir durum veya olay hakkındaki nedenler, sonuçlar ve aralarındaki ilişkiyi belirleyerek insanların bilgi ve görüşlerini yansıtan kuvvetli bir görsel araçtır. Bu nitel tekniğin matematiksel ölçülebilir özelliklerle geliştirilmesi, proje başarısını modellemekte kullanılabilmesini sağlamaktadır.

Sonuç olarak bu tezin amacı; proje başarısını modelleyebilmek için güçlü bir araç olarak önerilen bilişsel haritaların uygulanmasını göstermektir. Bir inşaat projesinin başarısını etkileyen faktörleri modellemek, proje başarı faktörleri arasındaki ilişkiyi yansıtmak ve projedeki tarafların farklı hedeflerini ve proje başarısının farklı taraflarca değişik bir şekilde tanımlandığını göstermek için bilişsel haritaların etkin olarak kullanılabileceği, bu tez kapsamında hipotez olarak ileri sürülmektedir. Bu teknik, Türkiye'de gerçekleştirilen gerçek bir inşaat projesine uygulanmıştır. Projede konsorsiyum üyesi olarak yer alan yer alan iki yüklenici firma ile birlikte işverenin bilişsel haritaları oluşturulmuş ve gerek içeriksel gerekse de yapısal analizler sonucu tarafların bakış açılarındaki farklılıklar ortaya çıkarılmıştır. Son olarak, proje başarısını modelleyebilmek için bilişsel haritalama yönteminin kullanılmasının kazanımları ve uygulamada karşılaşılan eksiklikleri, vaka çalışması bulgularına dayanarak irdelenmiştir.

Anahtar kelimeler: Proje başarısı, Bilişsel Harita

To my beloved family

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ABBREVIATIONS

ABS	Absolute
AHP	Analytical Hierarchy Process
ANOVA	Analysis of Variance
CEO	Chief Executive Officer
CM	Cognitive Map
CSFs	Critical Success Factors
EIS	Effective Information Systems
KPIs	Key Performance Indicators
ICMs	Idiographic Causal Maps
IS/IT	Information Systems/Information Technologies
MH	Man-hours
MW	Mega Watts
NPD	New Product Development
NPD	New Product Development
PE	Partial Effect
PM	Project Manager
PSC	Project Success Criteria
SD	Standard Deviation
TE	Total Effect
USD	United States Dollar

CHAPTER 1

INTRODUCTION

Construction industry is a project based industry. Every project has its uniqueness as a result of the fact that many different events and interactions occur throughout the projects with the inclusion of different parties. As a result of this uniqueness, it is difficult to define, identify and evaluate the success of a project.

Project success is related with the satisfaction gained from the project objectives. Throughout the literature, many researches have been performed to find the factors affecting the success and different satisfaction levels of the parties due to their differing objectives. All of the factors such as risks, decisions, performances of parties etc. occurring during the life time of the project have effect in the outcome; however, some factors are crucial to reach the desirable objectives of the project and these factors are called critical success factors (CSFs). It is seen that various studies have been conducted on identification of the CSFs throughout the literature and diverse factors have been identified as a result of these studies. There is not a general consensus about which factors are vital for success because every project is unique and the effects of the factors are dependent on multiple factors such as characteristics of the projects, the dynamic environment, and mostly the preferences or needs of the parties. Moreover, the identification of the factors has been performed basically by listing the most influential factors and choosing the critical ones as a result of analytical methods without considering the interrelations between the factors. However, the fact that the factors are not independent of each other, there is a need to evaluate their effects on the success of the project by regarding the interrelationships between the factors.

The information related with the literature review on project success concept, its determinants as the CSFs and the project success criteria (PSC), the presence of different perspectives held between the project participants and the interrelationships between the success factors are presented in Chapter 2.

As a result of the requirement of the identification of the different objectives of parties involved in a project, possible differences between their measurement criteria, CSFs and the interrelationships between the factors, a project success model is proposed which incorporates the utilization of the cognitive mapping technique.

A cognitive map (CM) is a strong visual tool to reflect the beliefs and knowledge of people about a situation or domain, identifying the causes, effects and the relations between them. The information revealed by CMs is more effective than a corresponding textual explanation. As a result of the capabilities of the technique, it has been used by many researchers in different areas and this information is presented in Chapter 3 via the literature review of the cognitive mapping technique.

This technique is used to reflect and compare the different perspectives of the parties involved in a project. Thus, Chapter 4 reports the research methodology of elicitation of the beliefs via the reflection of the beliefs into the maps as constructs (factors) and the links (interrelationship between the constructs) and application of the technique to a completed hydropower plant project in Turkey through interviews held with the client and the contractors.

In Chapter 5, the comparison of the maps of the client and contractors are presented by a multiple of quantitative methods proposed by different researchers with the detailed explanation of the methods.

In addition to the potential benefits and possible shortfalls of the model, the major conclusions of the study are depicted in chapter 6.

CHAPTER 2

LITERATURE REVIEW ON PROJECT SUCCESS

Definition of project success is a complicated task. The initial step is to define the measures of success and the factors affecting the success of a project. In the old days, a successful project was defined as a project which was completed on time, in budget and in conformance with the specifications. However, today, this gives a very limited scope of project success. Now, there can be seen projects which have been completed in accordance with the pre-mentioned criteria but still considered as unsuccessful, or inversely, could not satisfy the time and cost criteria but considered as successful. Clearly, the old adage of on time, on budget and (even) conformance to requirements are not, of themselves, satisfactory success criteria. The reality is that the notion of "success" and "project success" in particular, is a much more complex issue (Wideman, 1996). Various authors through the years performed researches to be able to define success, to find the factors affecting the success, to find criteria to evaluate the success by using different methods. The critical point in defining success is to set up a common goal between the parties involved in the project to satisfy needs of all of the parties such as the client, contractor, consultant, designer and the suppliers and to perceive the relationship between the factors affecting success. Check-listing the important factors is not satisfactory to reach success; the relationship between the factors should also be investigated. The literature review depicted in this research study is organized to answers the following questions:

1. What is meant by project success?
2. How can success be measured?
3. What is meant by critical success factors?

4. What are the critical success factors identified in previous researches?
5. Which methods were used to study the relationships between the CSF?

In this chapter, the literature review on the definition of project success, the criteria to measure project success, the identification of the success factors, and the need to show the interrelationship between the factors are given.

2.1. Definition of Project Success

The definition of success changes from person to person depending on a variety of factors such as the perspective of the person, the role in the project, the project characteristics and the expectations from the project. According to Pinto and Slevin (1988) "there are few topics in the field of project management that are so frequently discussed and yet so rarely agreed upon as the notion of project success."

The success has been perceived and defined differently by the researchers such as Tuman (1986), de Wit (1986), Ashley et al (1987), Baker et al (1988), Pinto and Slevin (1988), Wuellner (1990), Parfitt and Sanvido (1993), and Kerzner (1998). These definitions are presented in Table 2.1 which is adjusted from Asif (2003).

Table 2.1: Definitions of Success

The Source	**The Definition**
Tuman, 1986	Having everything turned as hoped….anticipating all projects requirements and have sufficient resources to meet needs in a timely manner
de Wit, 1986	The project is considered an overall success if the project meets the technical performance specifications and/or mission to be performed, and if there is a high level of satisfaction concerning the project outcome among: key people in the parent organization, key people in the project team and key users or the clientele of the project effort

Table 2.1: Definition of Success (continued)

Ashley et al 1987	Having results much better than expected. Results much better than expected or normally observed in terms of cost, schedule, quality, safety and participant satisfaction
Baker et al (1988)	If the project meets the technical performance specifications and/or mission to be performed, and if there is a high level of satisfaction concerning the project outcome among key people in the parent organization, key people in the client organization, key people on the project team, or the key users or the clientele of the project effort, the project is considered an overall success
Pinto and Slevin, 1988	A project is considered to be successfully implemented if it: comes in on-schedule (time criterion) comes in on-budget (monetary criterion) achieves basically all the goals originally set for it (effectiveness criterion) is accepted and used by the clients for whom the project is intended (client satisfaction criterion)
Wuellner, 1990	Successful project is one that is completed on time and within budget at a profit acceptable to the firm, produces high quality design or constructing services, limits the firm's professional liability to acceptable levels, and satisfies the client's expectations
Parfitt and Sanvido, 1993	Project success is different for each participant. However, relative to each participant, it is defined as the overall achievement of project goals and expectations. These goals and expectations relate to a variety of elements including technical, financial, educational, social, and professional issues
Kerzner, 1998	Project success is stated in terms of five factors: completed on time, completed within budget, completed at the desired level of quality, accepted by the customer, and resulted in customer allowing contractor to use customer as a reference

2.2. Project Success Criteria

It is seen that project success is related with the satisfaction gained from the project goals. In literature, the initial success measurement criteria were cost, time and quality, and they are later named as the iron triangle. The inadequacy of criteria is criticized by Pinto and Slevin (1988), Wateridge (1998) and Atkinson (1999). Parfitt and Sanvido (1993) claimed that success should be viewed from different perspectives of individuals and the goals related to a variety of elements, including technical, financial, education, social, and professional issues. Atkinson (1999) added three new dimensions to iron triangle such as the technical strength of the resultant system, the benefits to the resultant organization (direct benefits) and the benefits to a wider stakeholder community (indirect benefits) and named the new success criteria as the Square Route which has been shown schematically as Figure 2.1. Moreover, further criteria were added to the literature by various researchers. They were integrated by Chan et al (2002) and pictorially represented as Figure 2.2.

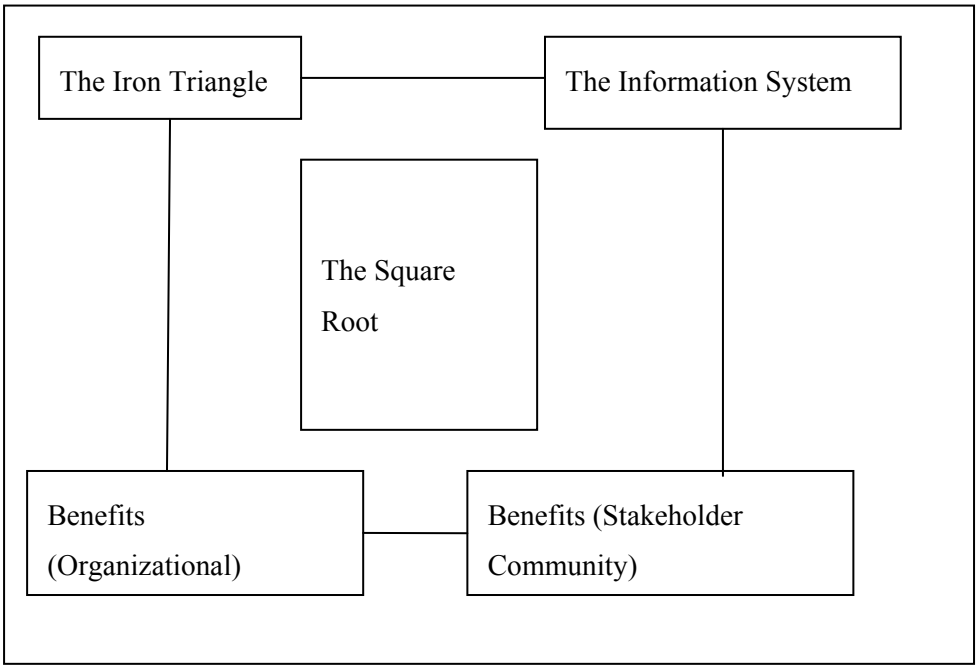


Figure 2.1: The Square Root (Atkinson, 1999)

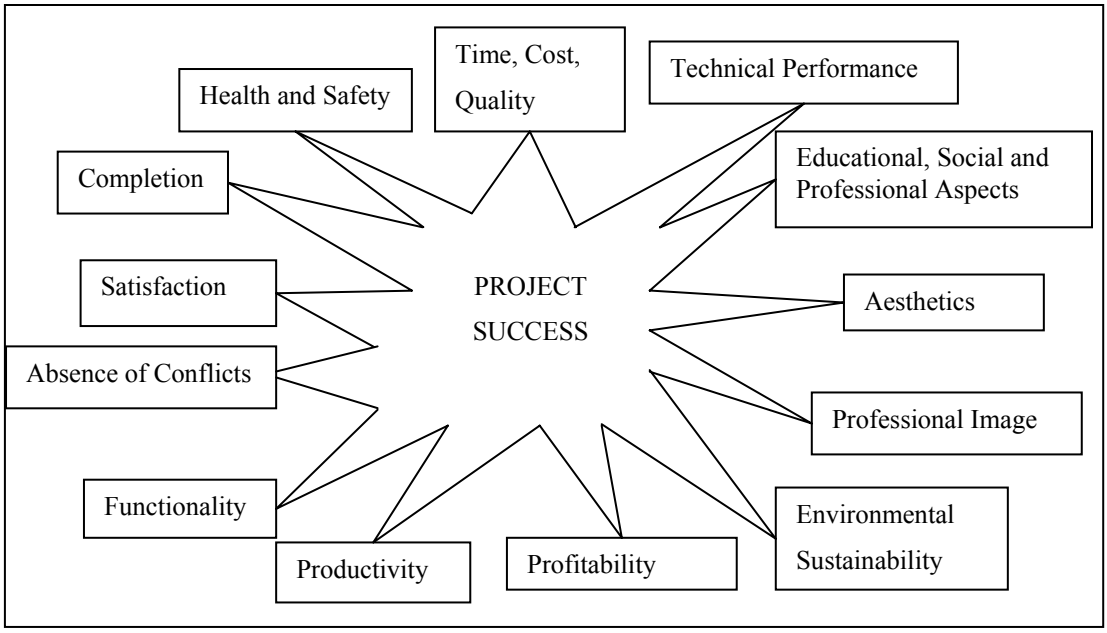


Figure 2.2: Criteria for Project Success (Chan et al 2002)

Agarwal and Rathod (2006) explored the software project success indicators as perceived by software professionals and signified cost, time and scope (comprising functionality and quality of project outcome) as three core parameters. They also mentioned that, in their study a limited number of software professionals also considered customer happiness, satisfaction and project specific priorities as important criteria in addition to the core parameters.

Key Performance Indicators (KPIs) are compilations of data measures used to assess the performance of a construction operation. (Cox et al 2003) The criteria contained in the definition of project success (PSC) can also be regarded as the key performance indicators (KPI) of a project.

One problem with the multi-dimensional project success criteria is that it is difficult for project participants to agree a success verdict (Bryde, 2003). This difference was identified by Sanvido et al (1992) and he developed a list of typical success criteria for the Owner, Consultant/Designer and Contractor.

Owner's criteria for measuring success are:

1. On schedule
2. Within budget
3. Quality
4. Function for intended use (satisfy users and customers)
5. End results as envisioned
6. Aesthetically pleasing
7. Return on investment

Consultants/Designer's criteria for measuring success are:

1. Client satisfaction
2. Quality architectural product
3. Design fee and profit goal
4. Experience gained, learned new skills
5. Met project budget and schedule
6. Minimal construction problems (disputes, liabilities)
7. Well-defined scope of work

Contractor's criteria for measuring success are:

1. Meet schedule (pre-construction, construction, design)
2. Profit
3. Under budget (savings)
4. Quality specifications met
5. No claims
6. Safety
7. Client satisfaction
8. Good communication (expectations of all parties clearly defined)

Wideman (1996) has also studied on measurement of success. Instead of categorizing as the criteria of client, designer, and contractor; he has used a time based benefit categorization as shown in Table 2.2.

Table 2.2: Measurement of Success (Wideman, 1996)

Success Category	Measurable Success Criteria
Internal Project Objectives (Pre-completion)	Meeting schedule
	Within budget
	Other resource constraints met
Benefit to Customer (Short-term)	Meeting functional performance
	Meeting technical specifications and standards
	Favorable impact on customer, customer's gain
	Fulfilling customer's needs
	Solving a customer's problem
	Customer is using product
	Customer expresses satisfaction
Direct Contribution (Medium term)	Immediate business and/or commercial success
	Immediate revenue and profits enhanced
	Larger market share generated
Future Opportunity (Long-term)	Will create new opportunities for future
	Will position customer competitively
	Will create new market
	Will assist in developing new technology
	Has, or will, add capabilities and competencies

Cox et al (2003) identified a total of 14 indicators; the quantitative indicators are cost, on-time completion, resource management, quality control-rework, $/unit, units/ MH, percent complete, earned man-hours, lost time accounting and punch list; and qualitative indicators such as safety, turnover, absenteeism, and motivation to measure the success of the projects.

Phua (2004) claimed that the determinants of project success are not homogenous across different types of firms and such heterogeneity in perspectives is often the

result of a complex interplay between various environmental, economical and structural factors affecting particular firms.

Thus, it is seen that project success measurement is studied by a great number of researchers focusing on different points such as the general measures, the measures differing according to the participants of the projects, and measures reflecting the time the benefit is gained. It is understood that every party involved in a project evaluates the success of the project based on different criteria, and this case arises from the fact that everybody has different objectives related with the project.

2.3. Critical Success Factors

KPIs are the indicators to evaluate the result of a project. Investigating the factors affecting the success of a project is as important as evaluating success. Depending on the diversity of parties involved in a project and the types of projects, CSFs are defined, identified and listed in a variety of ways throughout the literature.

Daniel (1961) was the first to introduce the concept of CSF. This concept became popular when it was later used to assist in defining the CEO's information needs that are most critical to the success of the business (Rockart 1979). Further, it was first used by Rockart in 1982 in the context of the management of projects and is defined as those factors predicting success on projects (Sanvido et al 1992). Following Rocart, many other researchers such as Ferguson and Dickinson, 1982; Boynton and Zmund, 1984; Sanvido et al 1992; Lim and Mohamed, 1999; and Ghost et al 2001 have defined CSF. Asif (2003) has collected the mentioned critical success factors definitions and presented in his study as a table, which is also shown in Table 2.3.

Table 2.3: Definitions of Critical Success Factors

The Source	The Definition
Rockart, 1982	Those few areas of activities in which favorable results are absolutely necessary for a particular manager to reach his or her goals
Ferguson and Dickinson, 1982	They are events or circumstances that require the special attention of management because of their significance to the corporation. They may be internal or external or be positive or negative in their impact. Their essential character is the presence of a need from special awareness or attention to avoid unpleasant surprises or missed opportunities or objectives. they may be identified by evaluating corporate strategy, environment, resources, and operations
Boyton and Zmund, 1984	Those few things that must go well to ensure success for a manager or organization, therefore, they represent those managerial or enterprise areas that must be given special and continual attention to bring high performance. Critical Success Factors include issues vital to an organization's current operating activities and its future success
Sanvido et al, 1992	Critical success factors are defined as those factors predicting success on projects
Lim and Mohamed, 1999	Critical success factors are those needed to produce the desired deliverables for the customer. Critical Success Factors measure end results
Ghost et al 2001	Key Success Factor is defined for our purpose as factors which are critical for excellent performance of the company, rather than just survival which is the function of Critical Success Factors

Many authors have published lists of factors, sometimes relating them to specific problem domains and types of activity, sometimes stressing their applicability to all types of projects and sometimes turning the notion on its head and referring instead to critical failure factors. (Fortune and White, 2006)

The first application of CSF in the project management area was made by Rubin and Seeling (1967), who investigated the impact of project managers' experiences and the size of the previously managed project, on project success (Zwikael and Globerson, 2006). The other early study was performed by Avots (1969) who identified the main reasons for project failure to be the wrong choice of a project manager, unplanned project termination and non-supportive top management.

Ashley et al (1987) identified 46 factors contributing to project success and grouped them under five headings such as management, organization, and communication; scope and planning; controls; environmental, economic, political, and social factors; and technical factors.

Pinto and Slevin (1988) used statistical regression analysis and identified project mission; top management support; project schedule and plans; client consultation; personnel; technical expertise; client acceptance; monitoring and feedback; communication; and troubleshooting as CSFs that are significantly related to project success.

Sanvido et al (1992) studied the CSFs of 16 construction projects. Pair-wise analysis was used and the analysis verified that facility team, contracts, experience, and optimization information were the critical success factors, and that resources, product and external elements were less influential.

Chua et al (1999) studied the effect of 67 success factors on the cost, time, and quality performance of construction projects with the usage of AHP method to determine the relative importance of factors which were grouped under four groups: project characteristics, contractual arrangements, project participants, and interactive process. They have concluded that there are different sets of factors for different objectives. Project success was not determined exclusively by the project managers, monitoring and control; additionally project characteristics and contractual arrangements have influence on project success as represented in Figure 2.3.

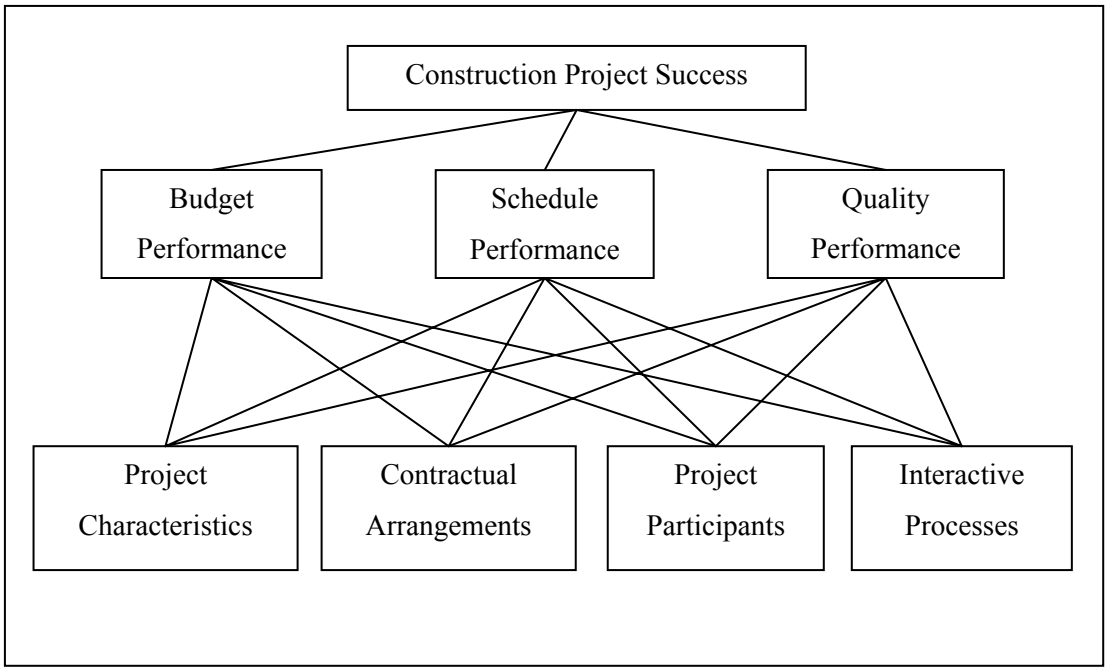


Figure 2.3: Construction Project Success by Chua et al 1999

McKim et al (2000) conducted a study to analyze the factors contributing to schedule and cost overruns in reconstruction projects and came up with unforeseen site conditions and changes in the scope of work.

Chan et al (2001) conducted a survey with 53 respondents related with 19 projects to identify success factors in design-and-build projects. As a result, six factors were identified out of 31 variables as project team commitment, the client's competencies, the contractor's competencies, risk and liability assessment, end users' needs, and constraints imposed by end users.

Andersen et al (2002) compared the Chinese and Norwegian projects success with the data collected by a questionnaire from a total of 358 projects, and concluded that the scores can not be compared directly as a result of either the scale difference (Chinese give higher scores than Norwegian) used or the better outcome of the Chinese projects. In their study, the identified groups of CSFs and factors in the groups are; Scope: project mission and goals, terms of reference; planning: planning

global level, planning detail level; organization: formal organization, informal organization; execution: activities, decisions; control: financial and technical control, internal and external communications.

Jin and Ling (2006) used multiple linear regression model to investigate the relationship-based factors that affect performance of general building projects in China.

Chan et al (2004) conducted a thorough review on literature related to CSFs in seven major management and selected the 43 articles to review. As result of the study, they have identified a total of 44 factors under the subcategories of project management actions, project procedures, project-related factors, external environment and human-related factors.

It is seen that diverse studies have been conducted on identification of the critical success factors throughout the literature and diverse factors have been identified as a result of these studies. The table which is formed by the review of 13 articles showing which factors are recognized as critical for project success is presented in Table 2.4.

Table 2.4: Critical Success Factors (Frequencies as found from literature)

Identified Factors	**Literature Source**													
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
realistic obligations/clear objectives		+	+		+		+	+	+			+		+
top management support		+	+		+	+	+		+			+	+	
PM commitment, involvement and competency	+				+	+	+	+	+				+	
communication through the project			+		+			+	+		+		+	+
schedule and plans			+			+			+	+		+	+	+
technical/managerial skills of the project team	+		+	+								+	+	+
project management	+	+			+		+						+	+
monitoring and feedback system	+		+					+	+			+	+	

Table 2.4: Critical Success Factors (continued)

Identified Factors	Literature Source													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
organizational structure					+				+	+		+	+	
finance		+					+	+			+			
client involvement			+			+	+						+	
risk identification and allocation								+		+	+			
technologically advanced materials/methods											+		+	+
economic risk								+			+		+	
political risk		+									+		+	
design quality											+	+		
clear scope and work definition	+			+										
equipment/computing resources						+								+
technical experience of contractor				+										+
fair contractual terms for all parties								+			+			
firm's track record											+			+
client satisfaction			+											+
performance of supplier/contractor/consultant		+					+							
good site safety conditions											+		+	
type of project													+	+
appropriate project procurement systems											+		+	
site inspections								+						
co-operation between project firms											+			
co-operation between colleagues of own firm											+			
common goal										+				
contract strategy												+		
adequacy of plans and specifications								+						
firm's knowledge of the host country														+
mature scope change control process.										+				

1-Ashley et al (1987) 2-Morris and Hough (1987) 3-Pinto and Slevin (1988)
4-Sanvido et al (1992) 5- Couillard (1995) 6-Belassi and Tukel (1996)
7-Jang and Lee (1998) 8-Chua et al (1999)9-Andersen et al (2002)
10-Cooke-Davis (2002) 11-Phua (2004) 12-Torp et al (2004) 13-Chan et al (2004)
14-Ling et al (2006)

A great number of researches have been made on the concept of success and with the usage of various methods and perceptions, on different definitions of PSC and CSFs.

In spite of these well-known research results and despite column-miles of words that have been written about project management, despite decades of individual and collective experience of managing projects, despite the rapid growth in membership of project management professional bodies and despite a dramatic increase in the amount of project working in industry, project results continue to disappoint stakeholders (Cooke-Davies, 2002).

Lim and Mohamed (1999) mentioned that project success is normally thought of as the achievement of some pre-determined project goals which commonly include multiple parameters such as time, cost, performance quality and safety; however the users and public do not necessarily have similar goals regarding the project. Combining the views presented though out the literature, it is inevitable to agree with Westerveld (2003) who stated that it is impossible to generate a universal checklist of project success criteria suitable for all projects. Depending on the characteristics of the projects, the dynamic environment, and mostly the preferences or needs of the parties, the criteria differ. Thus, the factors affecting the project success and arising from the environmental or project specific conditions should be viewed from the different perspectives of the client, contractor, designer, public, and so on.

Cox et al (2003) performed a study to investigate the differences among the different levels of management in their set of perceived KPIs. The results of their study indicated that a statistically significant difference does exist between executive management perceptions and project management perceptions of the on-time completion and quality control/rework KPIs; while no significant difference was found on the perceptions of the total cost, safety, $/unit and units per man-hour.

Lim and Mohamed (1999) performed a study to classify the perspectives of project success into two categories: the macro and micro viewpoints. The macro viewpoint of project success is related with the achievement of the original project concept while the micro viewpoint of project success deals with project achievements in

smaller component levels. As a result of the study it is concluded that the users and stakeholders are usually the ones looking at project success from the macro viewpoint which contains sets of completion and satisfaction criteria, while the contractor concerns about the micro viewpoint which contains only sets of completion criteria.

Bryde and Robinson (2005) made a study to compare the emphasis placed on PSC between client and contractor organizations, by using ANOVA test method. Their analysis gave these results: satisfying the customer needs and meeting the technical specifications gained the same emphasis, on the other hand minimizing project cost, minimizing project duration and satisfying the needs of the stakeholders (other than customers) showed differences in the sense that contractors put more emphasis on the first two, while putting less emphasis on the third as success criteria.

One more study identifying the need for the investigation of the success criteria perceived by different parties is presented by Turner (2004) as one of the four necessary conditions for project success which states that: The success criteria should be agreed with the stakeholders before the start of the project, and repeatedly at configuration review points throughout the project.

It can be seen that there does not appear to be a hackneyed opinion between the researchers regarding the factors affecting the project success. In addition to this lack of uncommon list of factors, it can be seen that most studies focused on identifying the organizational, management or technical factors leading to success. However, the relationship between the factors did not gain the value it deserves in the investigation of CSFs, while Fortune and White (2006) pointed out criticism of the CSF approach emerging from the literature as the inter-relationships between factors are at least as important as the individual factors but the CSF approach does not provide a mechanism for taking account of these inter-relationships. Nandhakumar (1996) points out “a better understanding of the relationship between key success factors and the EIS (effective information systems) development is required if success

factors are to be of any guidance to the practitioners to develop effective information systems" (Fortune and White 2006).

Fortune and White (2006) further developed a formal system model which realizes the need to show the interrelationships between the factors in spite of independently identifying and listing the factors. This model is a collection of factors represented schematically with the links between the factors showing the relations between the factors. Moreover, they propose to draw the model for the comparison of projects. However, instead of a system model a different tool can be proposed which can also provide the formation of interrelationships between the factors. This technique is cognitive mapping and it also provides the comparison of different projects or different perspectives of participants and more advantages over system model by allowing the user to assign strengths to the links between the factors. The details of this technique are presented throughout the thesis.

In recent times, the flow of research publications identifying new sets of factors has slowed but reference to and use of the concept has not diminished (Fortune and White 2006). According to Zwikael and Globerson (2006) one reason of the existence of failed projects in spite of the identified factors in literature is that CSFs are rarely specific enough for project managers to act on. Thus, instead of general lists, project specific studies can be helpful for the managers to see the project specific factors and their relationships, and the final effects of these factors on the success of the project. What needs to be done is to investigate critical factors and their relationships based on held projects to reflect more specific factor related with the organizations and the effects and relations of the factors specific to projects. This would provide to have a database for the organizations to increase their organizational learning. The impact of experience possessed by project key personnel toward project outcomes has been widely recognized (Jaselskis and Ashley 1991; Sanvido et al 1992). Thus, this can be made through the usage of expert opinions about the success of the project. Chua et al (1999) claimed that CSFs can also be identified based on expert opinions. As a result, the need for the

identification of the factor to yield the different perspectives of the parties and the interrelationships between the factors by taking the expert opinions can be provided with the usage of cognitive mapping technique both in general terms or project specific basis.

In this part of the thesis, basic definitions regarding the project success concept and the factors affecting the success of a project are discussed. Moreover, the need to further investigate the relationship between the factors is presented. The next chapter gives information related with the cognitive mapping technique and based on these definitions, identified factors, and technique the project success maps of a real project are constructed according to different perspectives of parties and compared in the forthcoming chapters.

CHAPTER 3

LITERATURE REVIEW ON COGNITIVE MAPS

3.1. Causal Maps

Causal maps have been widely employed to represent subjective knowledge about a phenomenon, that is, a discourse about perceived causes and effects and about the perceived links between those causes and effects (for details see Eden, 1992). Causal maps permit a rich representation of ideas, through the modeling of complex chains of argument, and are suitable for several types of analysis (Montibeller and Belton 2006). Indeed, causal maps are visual digraphs and directed networks where each node represents a concept and an interconnecting link between two nodes represents causality/influence.

A causal map represents the beliefs of subjects in a specific domain and can be used for decision making and problem solving within the context of organizational intervention (Eden, 1992). Nadkarni and Shenoy (2004) have emphasized that causal maps are effective decision tools since they represent domain knowledge more descriptively than other models such as regression or structural equations.

3.2. Cognitive Maps

Fiol and Huff (1992) suggest that people make sense of their experiences by developing map like structures within their own mind. Techniques that can reveal these mental maps are cognitive and causal mapping. When someone produces a

cognitive map on paper or computer, they produce a representation of their knowledge and experience (Billsberry et al 2005).

The taxonomy of causal maps is not well defined, but maps about objective knowledge tend to be referred to as influence diagrams, causal maps, or means–ends networks; while maps representing subjective knowledge are usually called idiographic causal maps (ICMs), cognitive maps, or means–ends chains (Montibeller et al 2007).

3.3. The areas Cognitive Maps are used

Cognitive map (CM) term was first introduces by Tolman (1948) as a basis for cognitive psychology research, and developed to describe an individual's internal mental representation of the concepts and relations among concepts that the individual uses to understand their environment.

CM was utilized by Axelrod (1976) for political analysis and decision making. It has been used widely by researchers in a variety of different contexts such as management and administrative sciences (Eden, 1992; Eden et al, 1992; Langfield-Smith and Wirth, 1992; Clarke and Mackaness, 2001; Ross and Hall, 1980; and Diffenbach, 1993), game theory (Klein and Cooper, 1982), information analysis (Montezemi and Conrath, 1986), popular political developments (Taber, 1991), analyzing political decisions (Hart, 1977), electrical circuits analysis (Styblinski and Meyer, 1988), decision analysis (Zhang et al 1989), a distributed decision process model in the internet domain (Zhang et al 1994), the process of way-finding (Chen and Stanney, 1999), IS/IT project risk management (Al-Shehab et al, 2005), business process redesign (Kwahk and Kim, 1999), new product development (Carbonara and Scozzi, 2006), knowledge management (Noh et al, 2000), online community voluntary behavior (Kang et al, 2007), Bosphorus crossing problem (Ulengin et al, 2001), design of electronic commerce web sites (Lee and Lee, 2003), modeling the

strategy building process (Carlsson and Fuller, 1996), and modeling IT projects success (Rodriguez-Repiso et al, 2007).

Some detailed works related with cognitive maps are as follows;

Hart (1977) drew the cognitive maps of three Latin American foreign policy elites and compared them in terms of the following characteristics: (1) the frequency of utility, goal, policy, and peripheral variables; (2) the degree of path-balance; (3) the degree to which policy choices are consistent with the maps; (4) the frequency of cycles; and (5) the density and variable frequency of the maps.

Klein and Cooper (1982) used the cognitive mapping technique to examine the behavior of seven military officers who played two scenarios in a research wargame. They concluded that the differences that have been observed fall into distinct classes related to the size and complexity of the CMs, their detailed interpretation, the players' confidence and anticipation of the future.

Nadkarni and Shenoy (2004) described a systematic procedure for constructing Bayesian Networks from knowledge domain of experts using the causal mapping approach depending on the capability of causal maps to capture knowledge of experts, to represent domain knowledge descriptively and to be comprehensive and less time consuming when compared to other techniques. The Bayesian Causal Map technique is also used by Sahin et al (2006) to estimate and analyze inflation in Turkey as a result of the suitability of the method in modeling uncertainty and supporting expert judgment by collecting the past data.

Hong and Han (2004) integrated CMs with neural networks to improve the performance of neural networks in the prediction of interest rates, where cognitive maps were utilized to retrieve event information from news on the web, managing causality and relation of the qualitative information.

Hodgkinson et al (2004) conducted a study to investigate the extent to which freehand maps differ in terms of structure and content from maps elicited by means of pair-wise evaluations. Freehand maps require the participants to represent their beliefs visually, on the other hand in pair-wise evaluation, participants are presented with a set of variables and required to undertake a series of evaluative judgments concerning causality in pair-wise fashion. In their study, they have provided the participants with a given number of variables. They concluded that the maps elicited via pair-wise method were found to be denser/more complex than those drawn freehand but this does not necessarily imply that the latter maps are qualitatively distinct from the former.

Al-Shehab et al (2005) conducted two experiments; one with a group of master-level students and a second with practitioners from a government organization to study on IS/IT project risk management using causal maps.

Al-Shehab et al (2006) proposed a core model based on cognitive and causal maps to capture disparate perceptions of project risk and providing a common basis for its analysis, prediction and mitigation.

Carbonara and Scozzi (2006) used CMs in their study to investigate the problems arising during New Product Development (NPD), understanding the perspectives different actors involved in NPD have and to describe, analyze and compare four NPD processes.

Kang et al (2007) conducted a study using CMs to describe the inference process for the investigation of online community voluntary behavior by an online survey applied to 632 community members.

In the construction management literature, there are only a limited number of studies where the cognitive mapping technique is used. The influence diagramming method which is a special form of cognitive mapping have been used by Ashley and Bonner

(1987) for political risk assessment; by Eden et al (2000) to study disruptions and delays in projects; by Poh and Tah (2006) for cost-time integration and by Dikmen et al (2007) for risk modeling of international construction projects. Other than these, causal mapping technique has been utilized by Williams et al (1997) to explore risks in projects; by Williams (2002) to model complex projects; by Maytorena et al (2004) to explore the process of risk identification in projects; and finally Edkins et al (2007) used cognitive maps to understand rigorously the attributes of issues falling under the term "management of project".

The latest study is performed by Edkins et al (2007) who conducted four enquires related with the specific issues of; the management of design, the conversion of building structure for alternative use, the modern use of heritage buildings, and the challenges of a modern procurement practice of a total of 11 different projects, to understand thoroughly the attributes of issues falling under the term "management of project". In the study a cognitive mapping software is utilized combined with a qualitative data analysis software to explore the limits and structure of individuals' cognitive models, with the objective of connecting and/or combining multiple perspectives from those involved in each of the construction projects studied to allow a meta-truth to emerge. As a result of the study, it is stated that the method revealed the highly contingent, complex and iterative nature of the processes, the key areas of similarity between projects, a project's decisive course of action, and the networked pivotal activities. The advantages and challenges of the methodology are presented in a detailed manner, whilst the resulting key processes were not taken into the scope of the paper.

The multiple usage areas of CMs are coming from the fact that they are strong and simple visuals tool to transform the beliefs of the people into simple maps to be used to identify the root causes of some outcomes, the causal influences of factors, and identify and compare the similarities and differences between different participants or between the beliefs' change over time of same participant.

3.4. Computer tools

Computer programs that have been developed specifically to support causal mapping are, “Decision Explorer” (Eden et al 1992), “Distrat/askmap suite of programs” (Goldberg, 1996), “CMAP2” (Laukkanen, 1994), and “Cognizer” (Clarkson and Hodgkinson, 2005). Clarkson and Hodgkinson (2005) presented a table comparing the features of the software programs which is presented in Figure 3.1. The tools have advantages and disadvantages over each other, but after investigation it is seen that the most appropriate tool is Cognizer for our study. Because it is seen that its characteristics of supporting direct map construction, providing the assignment of weights to the links formed between the constructs, supporting concurrent visualization, owning detailed analytical features, and providing the comparison of the maps are all found in Cognizer. That’s why it is found reasonable to utilize Cognizer in our study instead of other software programs providing the formation of causal maps.

3.5. Cognizer

In the cognitive mapping literature, a variety of terms are used interchangeably. It is important to clarify which terms are used in this study and what is called to them on other studies. To define the nodes/ideas/elements, the term construct is used. To define the causal/influential interrelationships between the constructs, the term link is used instead of arc or belief.

There are different map elicitation methods in the literature including preparing a pool of constructs for the participants to choose the factors they find important and make pair-wise comparisons to identify the interrelationships between the factors (Markóczy and Goldberg, 1995), and performing interviews with the participants in a storytelling fashion to identify the factors important to them. The main approach for data collection consists of the administration of semi-structured interviews (Eden, 1988). Cognizer is a tool which is applicable to both of the elicitation procedures.

Key Features of Currently Available Causal Mapping Software					
Name and Source of Package	What is the main intended application?	Does the software support direct elicitation and map construction?	Does it allow links incorporated within the map to be formally weighted?	Does it support concurrent visualization?	What are the main internal analytical featues of the software?
CMAP2 (see Laukkanen 1998, p.189)	Small-scale idiographic studies	No	No	No	Key numerical outputs from the program include measures of the distances between the maps of individual participants or clusters of participants
Cognizer (www.mandrake-technology.com)	Large-scale cross-sectional longitudinal studies	Yes; participants may (a) draw a weighted digraph directly on screen, (b) select a subset of constructs ans compare each individual set in a pairwise fashion, or (c) pairwise compare completely a completely specified set of constructs	Yes	Yes	Many basic analytical functions are incorporated, including a number of map content measures (eg., direct and indirect indegree and outdegree values) and structural measures (eg., link-to-node ratio and map density); distance ratios (reflecting the degree of overall dissimilarity between pairs of causal maps) can be computed to investigate patterns of similarity and difference among sugroups of participants.
Decision Explorer (www.banxia.com)	Small-scale idiographic studies	Yes; participants are able to draw a weighed digraph directly on screen	No	Yes	This software enables the graphical representation of maps as well as the calculation of a variety of quantitative indices of a structural nature; the menu option performs cluster analysis, based in the link similarities between constructs or a variety of slicingmechanisms to, forexample, create hierarchical clusters or those with feedback loops
Distrat/askmap suite of programs(www.goldmark.org/jeff/programs/distrat/software/drdoclet.ps.gz)	Supports selected features of the Markóczy-Goldberg (1995) approach	No	No	No	These programs perform several of the tasks associated with the Markóczy-Goldber approach

Figure3.1: Mapping software (Clarkson and Hodgkinson, 2005)

Apart from the easiness and usability in elicitation, it is a comprehensive tool enabling the quantitative analysis and comparison of the maps. Quantitative analysis not only would provide a more concise way of comparing the maps of different individuals, or of tracking changes in the beliefs of one individual over time, they could also provide a more objective basis for making qualitative assessments (Langfield-Smith and Wirth, 1992). In this way qualitative analysis can be enhanced by reducing the biases of researcher.

Cognitive maps can be analyzed by focusing on two dimensions: the content and the structure of each map (Langfield-Smith and Wirth 1992). Content analysis is performed quantitative with the outcomes of the reachability matrix, and indegree/outdegree values. Other than these, the distance formula (introduced by Langfield-Smith and Wirth, 1992 and developed by Markóczy and Goldberg, 1995) which mainly calculates the differences between the maps on a construct-to-construct and link-to-link basis and divides the sum by the greatest possible difference taking into account the number of unique and common constructs between the maps can be calculated by the software. The detailed explanations and definitions of the indices are presented in Chapter 5.

The structural indices found in Cognizer are number of constructs, number of constructs selected, number of links, total link strength, mean link strength, SD (standard deviation), link strength, total ABS (absolute) link strength, mean ABS link strength, SD ABS link strength, link density, link strength density, link ABS strength density, and map density. More detailed explanation of the analysis and comparison values are also presented in Chapter 5.

The detailed properties and the guideline of using Cognizer will not be presented in the scope of the study (for detailed information about the program see Clarkson and Hodgkinson, 2005). However, to show the simplicity in using Cognizer, the steps followed can be summarized as follows;

The data related with the participants and the researchers are introduced to the program. Later, all of the constructs identified by the participants are entered to Cognizer. When the constructs are introduced, the construct set to be used in this project is formed with the inclusion of all of the constructs. Following the introduction, the constructs to be used in the maps of participants are selected by checking the constructs from a list of constructs. After the selection of the constructs, there are two ways to assign the strengths of the links. Either the strengths can be assigned from the pair-wise listing or the links between the constructs can be drawn on the map. The scale of the first choice is 6, as Likert Scale of 1-5 has been used in this study; the second way is preferred to be used. By drawing the links, the strengths are assigned 1 as default and this is the other reason of the utilization of this choice; because as will be explained in the methodology section, after the elicitation of the map, the links strengths are requested from the participants. Thus, initially assigned fixed value was appropriate for the participants to scale the links by seeing whole of the map with relations instead of the pair-wise listing.

Thus, it is obvious that Cognitive Mapping is a strong and simple visual tool to transform the beliefs of the project participants into simple maps. Different factors and how they are interrelated for specific projects can be understood and the comparison of the maps can be neatly done. The comparison of the maps does not only help to evaluate the perspectives of different parties but also the change of a person's perception over time. Thus, this is an appropriate technique to reflect the beliefs of project participants related with the success of a project as a result of its power to show the interrelationship between the factors included, the differences between the maps constructed, and its capability to be used saved and used as a learning tool.

CHAPTER 4

METHODOLOGY

The literature has been reviewed related with the project success studies. It is seen that very detailed and diverse studies has been made to define project success, to find and group the factors affecting success, and to try to understand the different perspectives of different parties involved in a project. However, it is seen that most of these CSF identification methodologies are restricted with listing the factors and assigning relative importance; disregarding the inter relationship between the factors. The factors are not independent of each other and their effects should be considered as a whole. Moving from this point, a tool to show the combined effects of CSFs was searched and CMs were found applicable for this study. CMs are the tools used to reflect the ideas of people in a cause and effect frame as described in the previous chapter.

Moreover, success is a subjective issue and each party involved in a project evaluates the success with differing criteria and differing drivers. Thus; it is found very important to take the expert opinions of the vital parties in a project such as the client and the contractor and draw the cognitive map of their understanding of the success of a realized project. Throughout the literature it is also seen that the importance of investigating the relationship between success factors and criteria is mentioned, however studies aimed at investigating the relations are very limited. In general, the success factors are listed, without defining the success measurement basis on which these factors are valued or the factors resulting in specific type of criteria (as schedule or budget performance) are listed.

Another finding of the literature survey is the case that the identification of CSFs have been tried to be made on the general basis. In other words, most of the studies focused on the identification of CSFs which can be applicable to all type of projects, and some others trying to select a target group as a specific type of project, a specific type of project delivery system, or all types of projects held in a country by other international contractors. However, the existence of vulnerability requires to be focused on project basis analysis. Vulnerability science helps to understand those circumstances that put people and places at risk and those conditions that reduce the ability of people and places to respond to environmental threats (Cutter 2003). Zhang (2007) explained and schematically represented the vulnerability of a project as follows: A system's vulnerability represents the extent or the capacity of a system to respond to or cope with a risk event. It categorizes the different types of vulnerability that a project system can exhibit in two dimensions as exposure to a hazard and capacity to resist the hazard impact. The schematic representation is presented as Figure 4.1. Vulnerability can be internally created and changed by organizational, social and economic factors (decisions and behaviors) which usually are not dependent on hazard events in time and space. Thus, organizations can increase their capacity to cope with the risks by high commitment, adequate capability and sufficient information (Zhang, 2007).

Thus, what is asserted here is that, success or failure in a project is also associated with the vulnerability capacity of organizations under unexpected hazardous situations. The effect of same factors would not yield the same results in all types of projects. Thus, the mapping of cognitions of different projects containing both the project and environmental properties should be investigated and recorded to form a learning mechanism for the future projects.

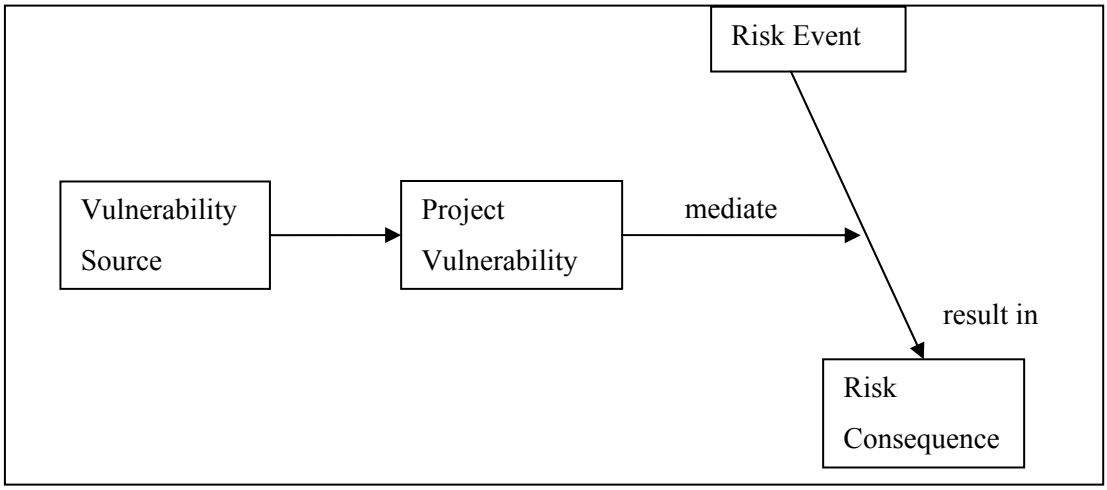


Figure 4.1: Vulnerability affecting project system in risk process (Zhang; 2007)

As a conclusion; with this study, both the relations within the CSF and between the CSFs and PSC valid for a project are investigated and the differences in the perspectives of parties involved in a project are compared.

4.1. Case Study: Project Characteristics

To be able to draw the CMs of the different parties involved in a project, to show the factors affecting the success of the project, to show the relations (causes and effects) of the factors, and to compare the perspectives of the parties, a hydropower plant project located in the northeastern Turkey has been used as a case study project. The construction of the plant has been completed but some disputes and court cases continue. For the confidentiality purposes the name of the project, and the parties involved are kept confidential.

The constructed dam has a total reservoir storage capacity of nearly 75 million m^3 and installed capacity of nearly 120 MW. Being a Turnkey project, the construction was started in September 1999 and ended in April 2005, two months earlier than the planned program. This project has the characteristic of being the first execution of a dam facing in Turkey.

The client is a governmental organization. The project was tendered in May 1999 and awarded to a consortium to nearly 250 Million USD. The consortium is composed of six companies; two are responsible from design, two from electro-mechanic works and two from construction works. For both of the design and construction works, one of the companies are local and the other is foreign, for electro-mechanic works both of the contractors are foreign firms.

The project type is lump sum plus reservations. It means there is an agreed amount of contract as the contractor is required to achieve the project at the negotiated contract value; but in case there are extra works, the cost compensation will be provided. This contract type was applied for the first time for both the client and the contractors. In this type of contracts, the owner knows the actual cost of the project before it begins if the project is well estimated, contractual documents accurate and project clearly defined. However, for this project, there have been problems as a result of the vagueness in the contract in defining the unit prices which will be applied in the case of additional works.

The finance of the project was provided by foreign credit as a result of an agreement between the countries. Although the finance was provided from a foreign agency, the project was acted as dependent to the budget arrangements of the governmental organization as a result of the applied budget law in Turkey. Indeed, the governmental organization arranges the budgets it will assign to all of the projects being held and as the client was this organization for this project, the project's progress payment amount allocation was also arranged as if the payment was made by the governmental organization. Thus, this situation created some problem in the timely payment of the progress payments.

The general characteristics of the project are as mentioned. As our aim is mainly to investigate the construction works, from now on the construction related part of the project will be focused.

Two contractors were responsible from the construction works. One company is a foreign company who has completed just one project in Turkey which was a Build-Operate-Transfer type of a project for which they had no relation with the client. In other words, it can be said that it is the first time they work with a governmental institution in Turkey. The other partner is a local Turkish company who has completed lots of works with the client.

For our study, interviews have been held with different parties of this project to elicit the cognitive maps of the parties regarding the success of the project as has been explained in the introduction of the chapter. The steps followed in eliciting the cognitive maps will be briefly presented in a step by step manner and the details of the study will be presented following the procedure.

4.2. Map eliciting procedure

Markóczy and Goldberg (1995) have developed a systematic approach for the elicitation and comparison of causal maps. The first three steps of the procedure are related with the elicitation of the maps and the other two related with the comparison of the maps. The mentioned distance ratio and its application will be explained in the following chapter.

1. Develop a pool of constructs by conducting and analyzing interviews with managers and a review of relevant literature. This is done prior to the study so that each subject selects constructs from the same pool.
2. Have each subject select a fixed number of constructs by identifying items from a constant pool of constructs.
3. Construct the causal map of each individual subject by having her/him assess the influence of each of her/his selected constructs on her/his other selected constructs.
4. Calculate distance ratios between causal maps using a generalized version of Langfield-Smith and Wirth's (1992) formula.

5. Perform a variety of statistical tests on the distance ratios to identify what characteristics account for similarities in thinking

From the methodology it is seen that the first step is the identification a pool of constructs to be presented to the interviewee in selecting the factors affecting the outcome. However, there are different views and studies in the literature which are supporter of giving the interviewee flexibility in selecting the constructs to be used in their maps. The details of the construct identification used in this study with the ideas from literature will be explained in the methodology section.

Other than individual interviews, there is also a technique of map elicitation namely collective mapping. In these types of elicitation, the interviewees are brought together and requested to decide on the constructs of the map together. Both of the methods have advantages over each other. The Individual interviews allow the elicitation of deeper individualistic knowledge at the cost of creative group dynamics (Eden and Ackermann 1998).

4.2.1. Identification of Critical Success Factors

Various studies held in the literature examined and multiple critical success factors identified by different authors have been investigated. It is seen that according to the characteristics of a project such as the size and the type, and differing views of the experts, success factors differ. There is not a general checklist of success factors which is applicable to all kinds of the projects. Thus, depending on the characteristics of our case study, the most important ones according to the researcher which are applicable to our project have been identified and grouped under subcategories and a data gathering chart has been formed. This chart is used in as a reference for the researcher during the interviews to remind the interviewee some aspects of the project to see whether he thinks the factors have an effect on their project's success or not.

4.2.2. Performing the interviews

Scavarda et al (2006) declared that the only two methodologies currently in practice for capturing cognitive data for a causal map are brainstorming and interviews. The brainstorming of the concepts to be mapped provides the formation of a common language however; it may fail to identify some important factors which can be explored as a result of interviews. The main approach for data collection consists of the administration of semi-structured interviews (Eden, 1988).

For the formation of the cognitive maps of the parties involved in the project, face-to-face meetings with the participants were preferred to be made, and during the interviews, the storytelling technique was preferred to be utilized. According to Billsberry et al (2005) the research technique of storytelling has a very long tradition across many academic fields and it has many forms and manifestations.

Initially the interviewees were requested to talk about the project in a story telling fashion. The main requested point was "what happened during the project which has an effect on the outcome". In other words, when they evaluate the project, what are the important points to mention about the success of the project? Markóczy and Goldberg (1995) developed a common pool of constructs prior to the elicitation of the cause maps in their study. Individuals were required to select a personalized list of constructs to be mapped from this common pool. However, in our study, the mentioned constructs were not shown to the interviewees because one important aspect of the study is to reflect the own ideas of different parties. In other words, the interviewee was given the flexibility to select their constructs.

Although interviews tend to be intrusive and involve researcher influence, they allow for a better understanding of the domain of inquiry through the use of appropriate probes (Nelson et al, 2000).

After their finishing the story, they were reminded the success factors as previously mentioned. This action should not be seen as influencing the participants, instead it

should be seen as helpful in terms of the content of the maps. Having talked about the whole project, the interviewee may skip some important factors which need to be mentioned about.

4.2.3. Constructing the maps

The most important point is the elicitation of the maps from what has been narrated by the interviewees since listening to the interviewee and looking at the notes about the mentioned factors may not directly reflect the ideas of the participant. Eden (1992) said that the outcome of a cognitive mapping technique is not the same as the internally represented mental mode but rather a reconstruction of subjective beliefs that have been revealed to the researcher. In this stage, what is drawn is the interpretation of the researcher and the researcher should be very neat in transforming the ideas of the participants to the maps and should not include his/her own beliefs to the maps of the participants.

The construction of the maps is made with the utilization of the software, named as Cognizer. How the constructs were defined to the software and how the relationships were formed will not be explained, instead the constructs defined and the formed maps will be presented.

Following the individual face-to-face meetings with the participants, the researcher have identified the factors mentioned in the story telling fashion and then, defined the terms to the software. Neatly evaluating what is told by the participants, the constructs (factors) were placed on the map and "which constructs exert causal relationships on another" is questioned depending on the views of the interviewees. Reflecting all of the relationships between the factors ended the draft of the maps.

4.2.4. Validation and Quantification

Following drawing the maps, the interviewees were requested to investigate the drawn maps to check if the defined constructs and the relations between the

constructs are reflected as they believe. Huff and Fletcher (1990) advocated that the interviewee should be provided with the opportunity to validate their completed maps in cases in which indirect elicitation procedures have been used to construct the maps from interview transcripts or other textual documents. Thus, the interviewee was given the opportunity to edit their maps if necessary by adding or removing concepts or relations between the concepts.

After validation of the map, the participant was asked to consider whether the causal influence of the drawn constructs on the other constructs is positive (the effect is to yield increase) or negative (the effect is to yield decrease). Moreover, he was asked to consider the strength of the relations and to quantify the relationships according to their importance on a Likert Scale of 1 to 5. “5” stands for a strong importance and “1” for rather insignificant (slightly) importance.

When the interviewees are satisfied with the formed map in terms of the constructs, and the existence, sign and strength of the relation, the map construction ceases.

4.2.5. Interpreting

Cognitive Mapping technique is used to identify and reflect the subjective beliefs of the participants to make these perceptions accessible for analysis and comparison.

As a result of the interviewees with all of the parties and the construction of individual maps, the final step is the interpretation of the drawn maps. This interpretation is held with the analysis and comparison of the maps in terms of both some mathematical formulas and verbal expressions.

4.3. Case Study

The application of the aforementioned step by step methodology will be presented in this section. The properties of the project were given in Section 4.1.

4.3.1. Identification of Critical Success Factors

The literature is reviewed and the success related factors identified for this study is listed in Figure 4.2.

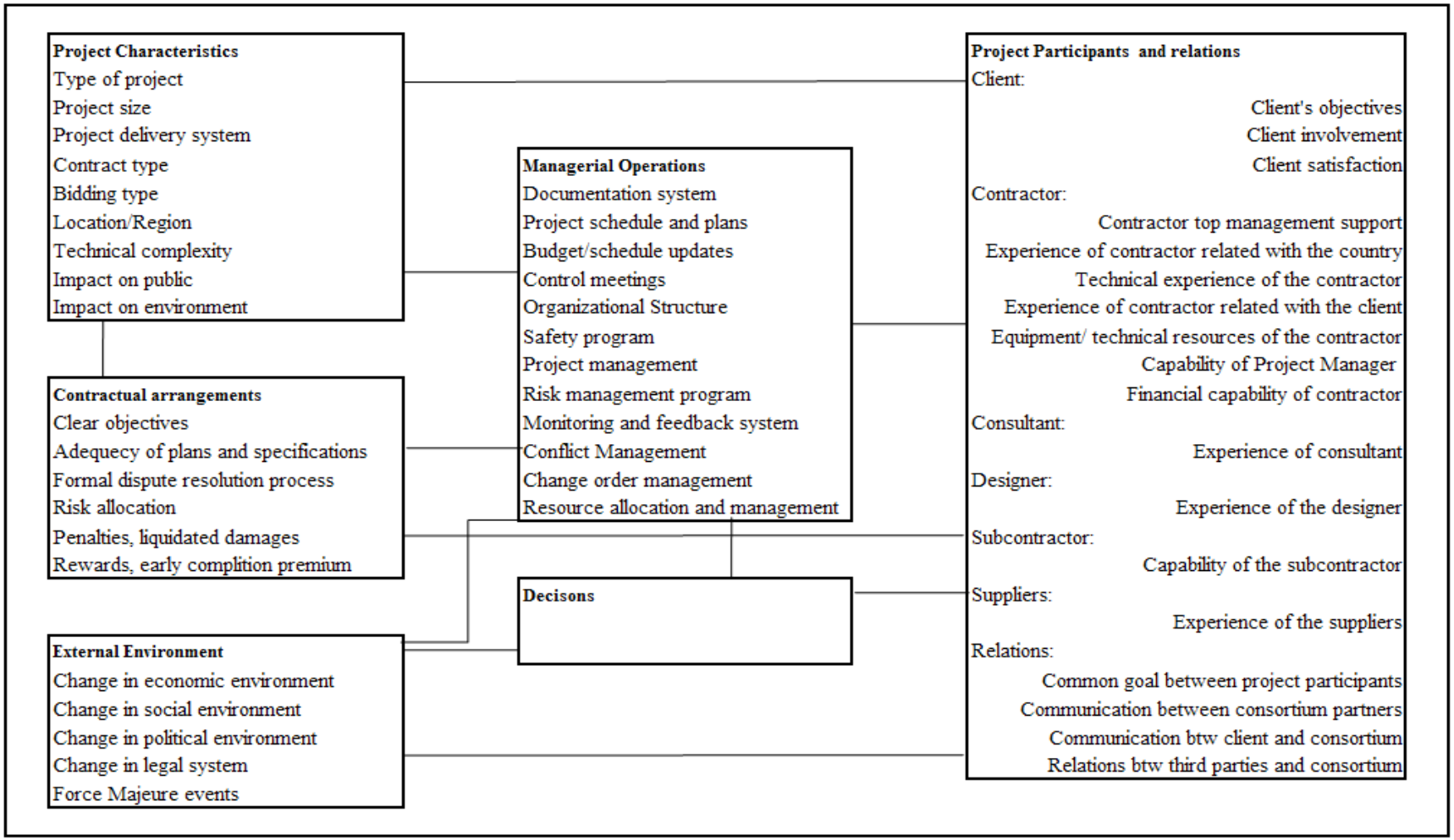


Figure 4.2: Identified critical success factors chart

4.3.2. Performing the interviews

The consortium was formed from six companies to finalize the project and put the plant in operational stage. There were two contractors responsible from the construction works of the project. As the researcher is trying to make contributions to the construction sector, the interviews were made with the construction works contractors and the client. To prevent from confusion, the contractors are coded. The foreign firm is mentioned as the contractor 1 and the local firm as the contractor 2.

The initial meeting was performed with the contractor 1 for nearly two hours, the later with contractor 2 for an hour and finally with the client for nearly one and a half hour. The parties were informed about the confidential aims of keeping the name of the project and parties confidential, thus they can freely talk about the negative aspects.

As explained in the methodology section, initially the participants were requested to talk about the project in a story telling fashion about the important events, decisions, relations or factors affecting the success of the project. When they finished the story, they were reminded if any, skipped success factors from the identified CSFs chart and the interviewees ended.

4.3.3. Constructing the maps

Following the individual face-to-face meetings with the participants, the factors mentioned by the participants were identified and defined to the software. All of the concepts identified by three interviewees are presented in Table 4.1 with the abbreviations used in the maps. The reason for using abbreviation is that, the software used has a limited rectangle size for the constructs. The individually identified factors by the participants can be checked from the maps of the each interviewee.

Table 4.1: The constructs used

Full name of the construct	**Abbreviation of the construct**
Acceleration	Acceleration
Additional work	Additional work
Benefit to the public	Benefit to the public
Budget law	Budget law
Bureaucratic delays	Bureaucratic delays
Change in foreign exchange rate	Change_foreign exchg_rate
Change in scope	Change in scope
Claims	Claims
Client relations	Client relations
Communication between parties	Communication btw. parties
Considering the Welfare of the locals	Consider_Welfare_ locals
Cost	Cost
Cost overrun	Cost overrun
Delay	Delay
Delay in construction of access road	Delay_const_access_road
Delay in land acquisitions	Delay in land acquisitions
Delay in progress payments	Delay in progress payments
Dispute between client and contractor	Dispute client-contractor
Economic instability in Turkey	Economic instability
Equipment and machinery resources	Equip_machinery resour.
Experience in country	Experience in country
Experience of contractor with client	Experience with client
Financial resources of contractor	Financial resour_contractor
Force Majeure (Land slide)	Force Majeure (Land slide)
Formal correspondence language is Turkish	Formal correspond_Turkish
Good procurement strategy	Good procurement strategy
Good risk management	Good risk management
High quality materials	High quality materials
High quality personnel	High quality personnel
Increase workload in Turkey	Inc_workload in Turkey

Table 4.1: The constructs used (continued)

Full name of the construct	Abbreviation of the construct
Life cycle cost	Life cycle cost
Location/Region	Location/Region
Negative attitude of client towards contractor	(-)attitude_client-to-contr.
Negative public reaction	Negative public reaction
No bill of quantities	No bill of quantities
No consensus on payment amount	No payment_amnt_consensus
No control by client	No control by client
No quantities consensus	No quantities consensus
Payment type: lump-sum plus reservations	Payment:lumpsum+reserv.
Poor accessibility of site	Poor accessibility of site
Poor international relations	Poor international relations
Poor motivation at site	Poor motivation at site
Poor performance of client	Poor performance of client
Poor performance of consortium leader	Poor perform_consortium leader
Poor public relations	Poor public relations
Profitability	Profitability
Project duration	Project duration
Project management	Project management
Qualified subcontractors	Qualified subcontractors
Quality	Quality
Quality of design	Quality of design
Reputation in international markets	Reputation_internt_markets
Safety	Safety
Security problem	Security problem
Technical experience/capabilities	Technical exper./capab.
Unclear risk allocation about Force Majeure events	Unclear-risk-alloc-FMajeure
Unexpected geological conditions	Unexpected geological cond.
Vagueness in contract conditions	Vague_contract_conditions
Wrong escalation formula	Wrong escalation formula

It can be seen from the map that the factors identified are not in one-to-one compliance with the pre-identified success factors as a result of the literature survey. The reason arises from the fact that the identified critical factors chart was formed depending on the literature so the identified factors were named as general factors which would be valid for all types of the project. However, this is a case study and there are multiple factors which may not be listed in the pre-list but important for the success of this project.

As previously mentioned, none of the interviewee was leaded. Thus, every factor identified by the interviewees differs, and of course there are some common constructs. For the comparison of the maps, it is important to see whether the interviewees used the same constructs or not. Thus arrangements had to be made related with four of the identified constructs. First one is "experience of contractor related with the client. One of the contractor was experienced whilst the other not. Instead of creating two different constructs as experienced and inexperienced; one construct was created and named as experience of contractor. In each of the maps, the meaning given to the construct has changed. In other words; in one map it stands for experience and in the other as inexperience. The same condition is also valid for the "experience of contractor related with country", "project management", "communication between parties", and "client relations" concepts. All of the other constructs carry the same meaning for all of the maps.

The first interview is held with the technical office manager of contractor 1. First of all, the manager was asked to identify the project as successful or not and on what criteria did he base his conclusion.

He said that their company sees the project as successful, based on the following criteria and objectives: quality, on-time delivery, reputation in international markets, and increased workload in Turkey. Profitability was an objective that did not carry utmost importance. Long term profitability and increasing workload in the Turkish market were more important than immediate profitability.

Later, he was asked to talk about the project. The interview was continued for two hours and narrated the project talking mainly about the basic operations held, the contractual vagueness, and the relation with the client.

In summary, this was the first time the contractor was realizing a project with the client thus, did not know how to develop good relations with the client and the local people, unfavorable conditions that could arise from contractual vagueness or poor risk allocation and the bureaucratic difficulties. Their unfamiliarity combined with some unexpected situations such as delay in land acquisition, force majeure, additional works, negative attitude and local reaction to company and economical instability in Turkey caused problems for the company. However, with the utilization of their own resources and focusing on claims they tried to minimize the negative effects of problems to realize the project successfully.

After the interview, the researcher drew the cognitive map of the project success model based on the information provided by the manager. The initial map of contractor 1 is presented in Figure 4.3.

It is seen that the strength of the causal relations between the constructs are assigned 1 as default of the software, which will be changed by the participant in the following step of the elicitation.

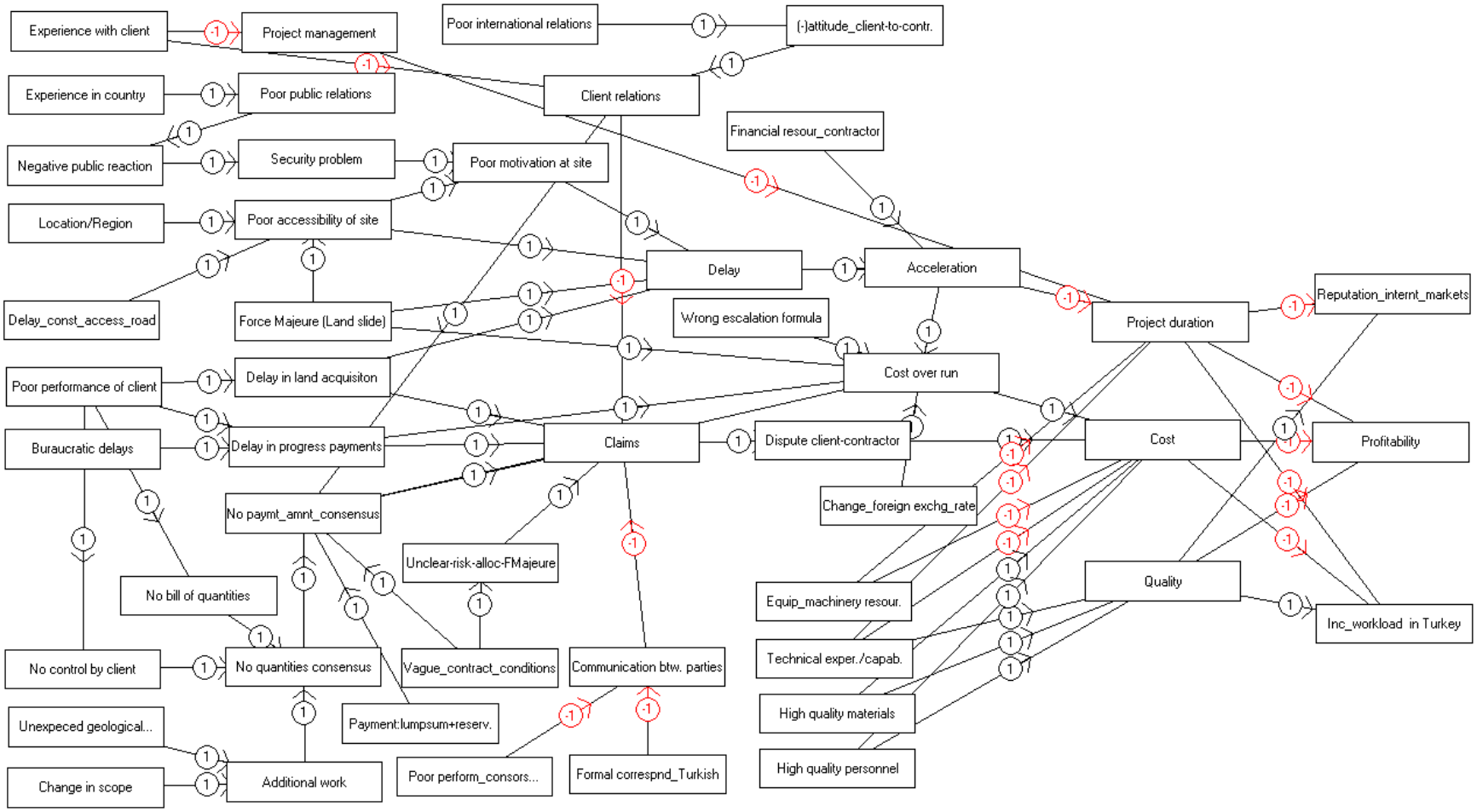


Figure 4.3: Cognitive map of contractor 1

The second interview was made with the project manager of contractor 2. The same steps were also followed for this interview. First of all, the interviewee was asked to denote whether the project is considered as successful of not. He said that the project was very successful. He based his conclusion on the fact that they have completed the project on time by making profit, and by strengthening their status in the construction industry in Turkey. After defining the performance indicators, he talked about the project for an hour.

In summary, this Turkish company has conducted several works with the client before and knows how to get along with the client and how to manage projects according to the requirements related with the contract and the country conditions. Thus; by maintaining good relations with the client and managing the project effectively, they managed to cope with the unexpected situations such as the delay in land acquisition, and force majeure events etc.

Following the interview, the cognitive map of the contractor was drawn. The map is presented in Figure 4.4. The strengths of the links are assigned 1 (default) which are further revised according to respondent's comments.

In this map one point should be reminded that there is a causal influence of client relations on claims. The logic behind this relation is that good relations with client positively affected the outcomes of the claims. Thus it should not be interpreted as the causal effect increased the number of the claims.

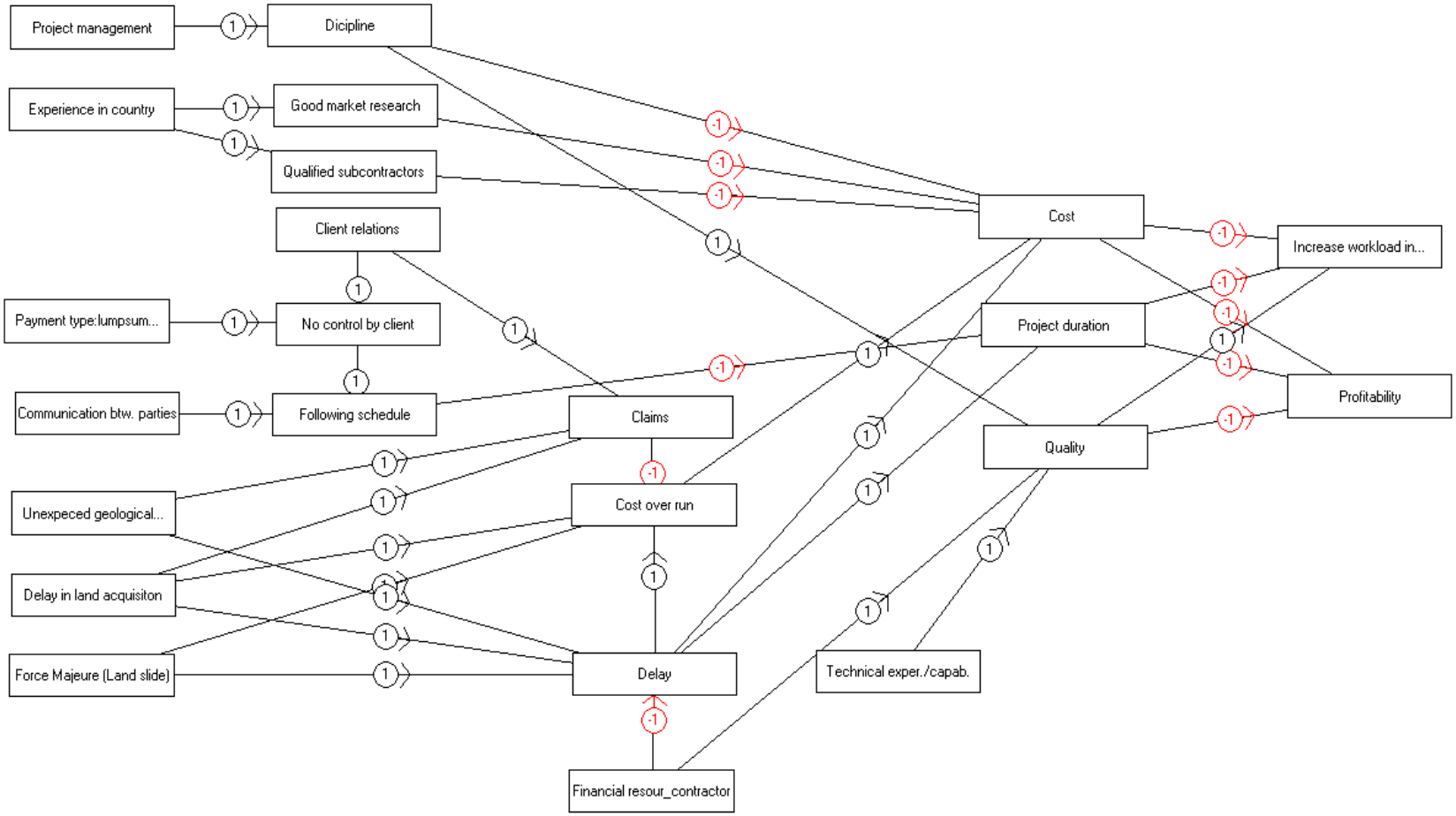


Figure 4.4: Cognitive map of contractor 2

The final interview was made with the client in one and a half hour. The client did not tend to give specific relational concepts related with the parties. In general he talked about the procedures held in the project and whether they satisfied their needs or not. Client also regards the project as a successful one and put the evaluation criteria as the “life cycle costs” and “benefit to public”. “Life cycle costs” include the repair and maintenance costs throughout the operation period of the facility. Thus, the main idea is to minimize the life cycle costs. The other criterion is the “benefit to the public”. This benefit is achieved through the increase in employment possibility and the energy policy. He identified that the project was not completed within the contract value as a result of the economical instability, unexpected geological conditions and land acquisitions. The general picture of the project related with the reasons and consequences of the factors occurred during the realization of the project is drawn.

The map of the client is presented in Figure 4.5. The same situation applied to the previous maps is also applicable here, which is that the relations are assigned 1 as default and the map is sent to the interviewee to check the relations.

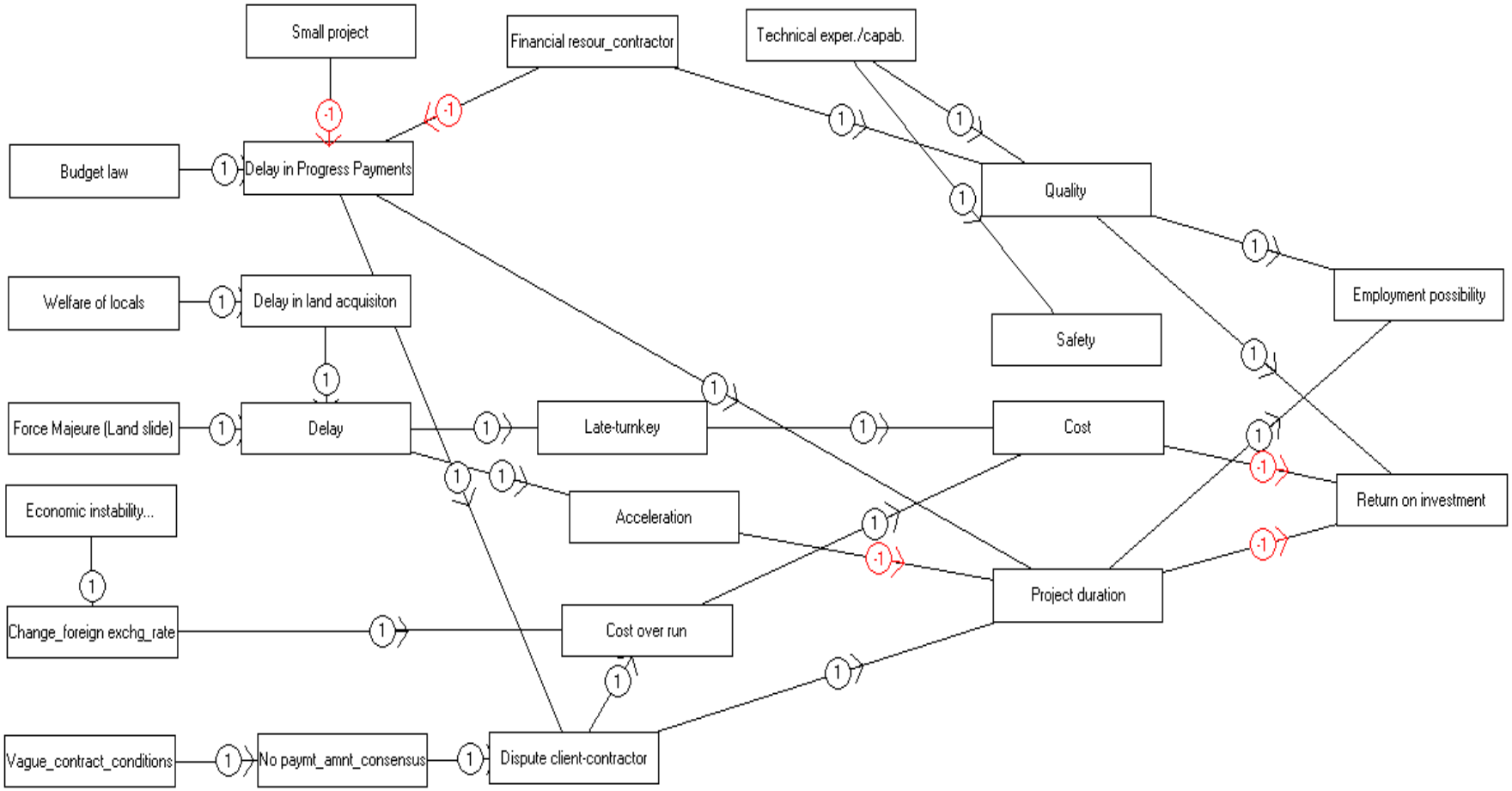


Figure 4.5: Cognitive map of client

4.3.4. Validation and Quantification

When three of the maps were drawn, they were shown to the participants. The participants were requested to investigate the maps and check if the maps formed reveal their subjective understanding of the project, if there is missing data or the antecedents and consequences of the factors are reflected correctly.

After validation of each map, the participants were asked to consider whether the causal influence of the drawn constructs on the other constructs are positive (the effect is to yield increase) or negative (the effect is to yield decrease). Moreover, they were asked to consider the strength of the relations and to quantify the relationships on a Likert Scale of 1 to 5 where "5" stands for strong importance and "1" for rather insignificant (slightly) importance.

When the interviewees were satisfied with the constructed maps in terms of the constructs, and the existence, sign and strength of the relation, the map elicitation ceased and the validated maps of the participants are presented in Figure 4.6 (the final map of contractor 1), Figure 4.7 (the final map of contractor 2), and Figure 4.8 (the final map of client).

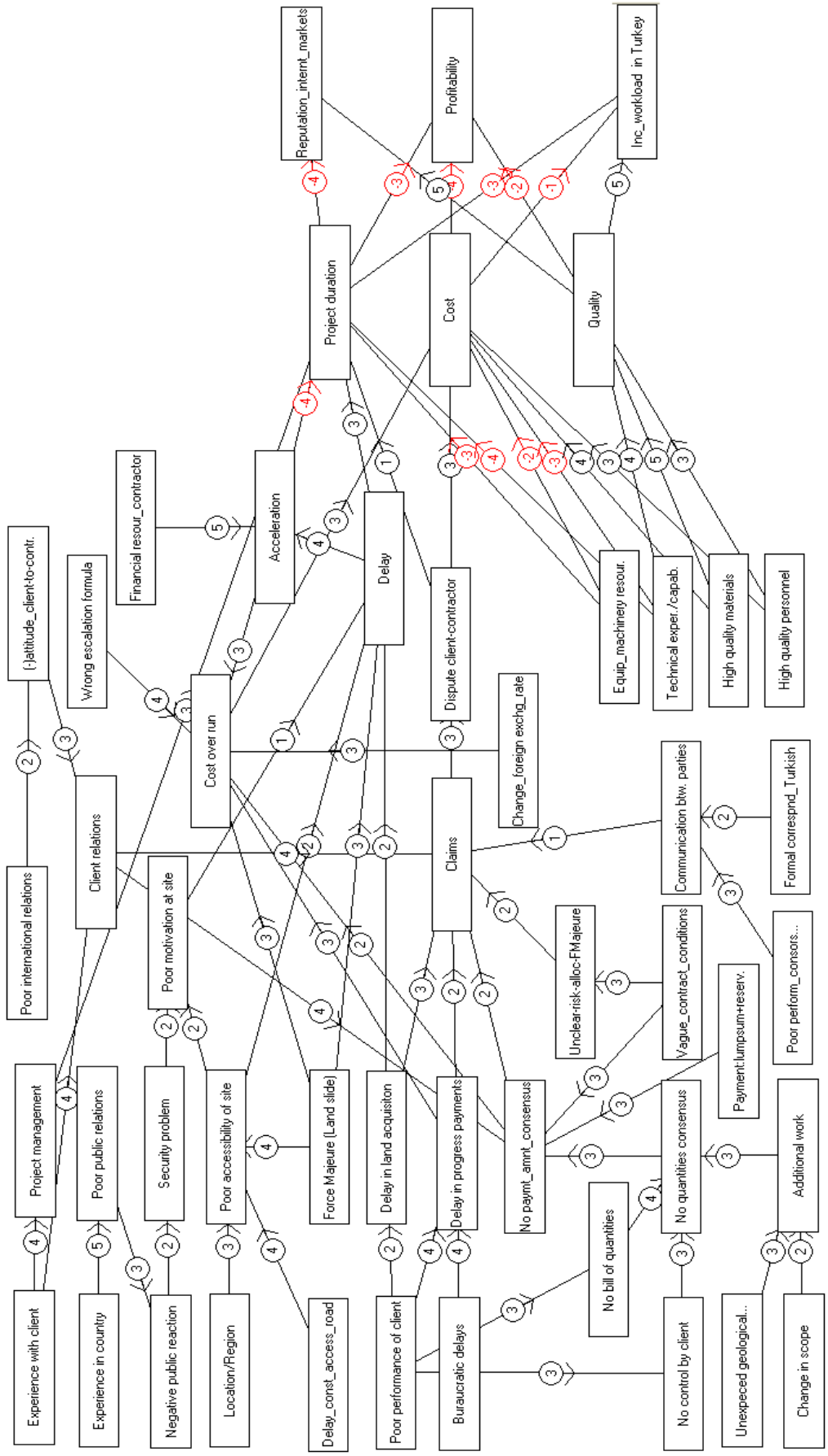


Figure 4.6: The final cognitive map of contractor 1

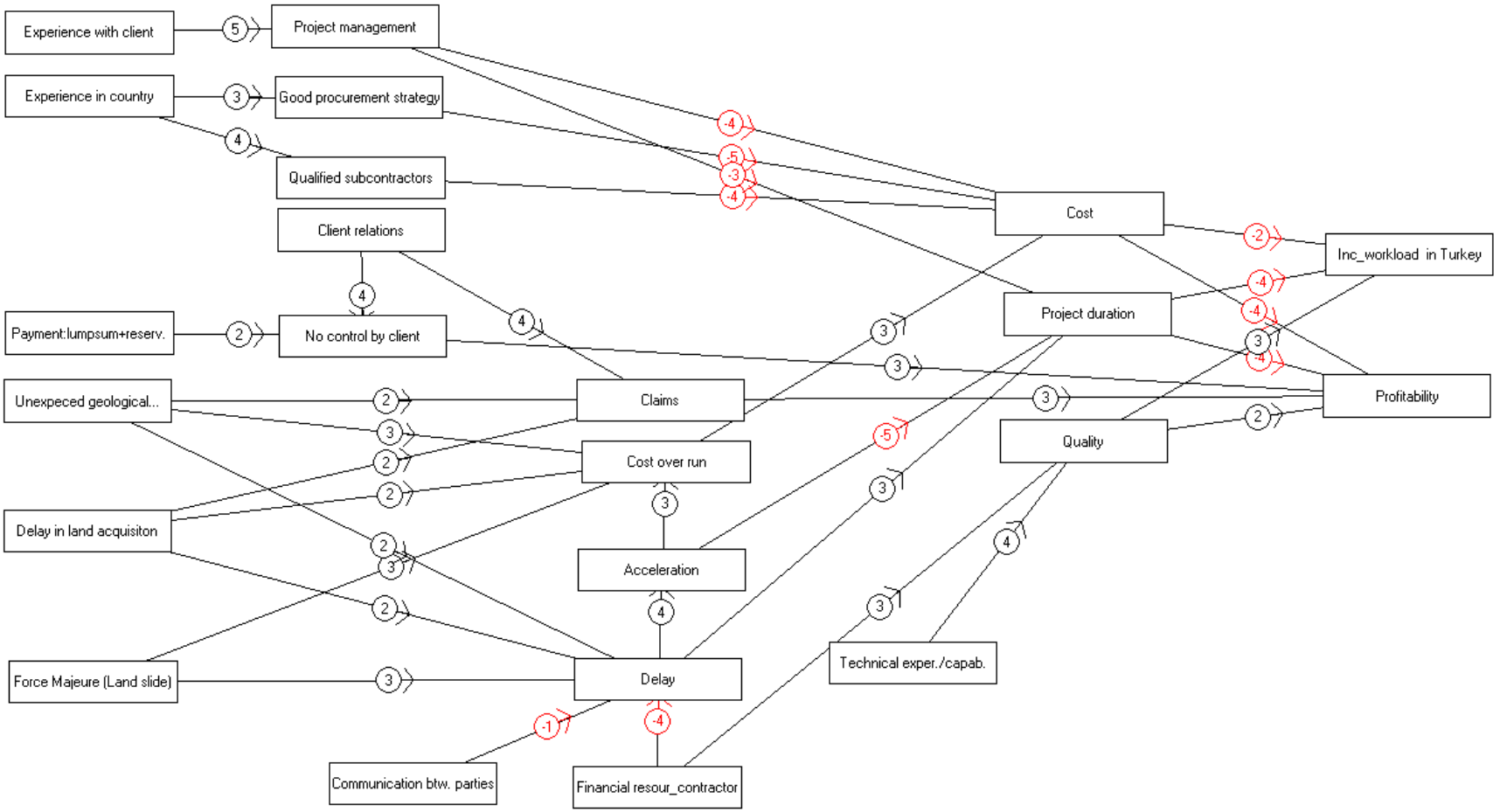


Figure 4.7: The final cognitive map of contractor 2

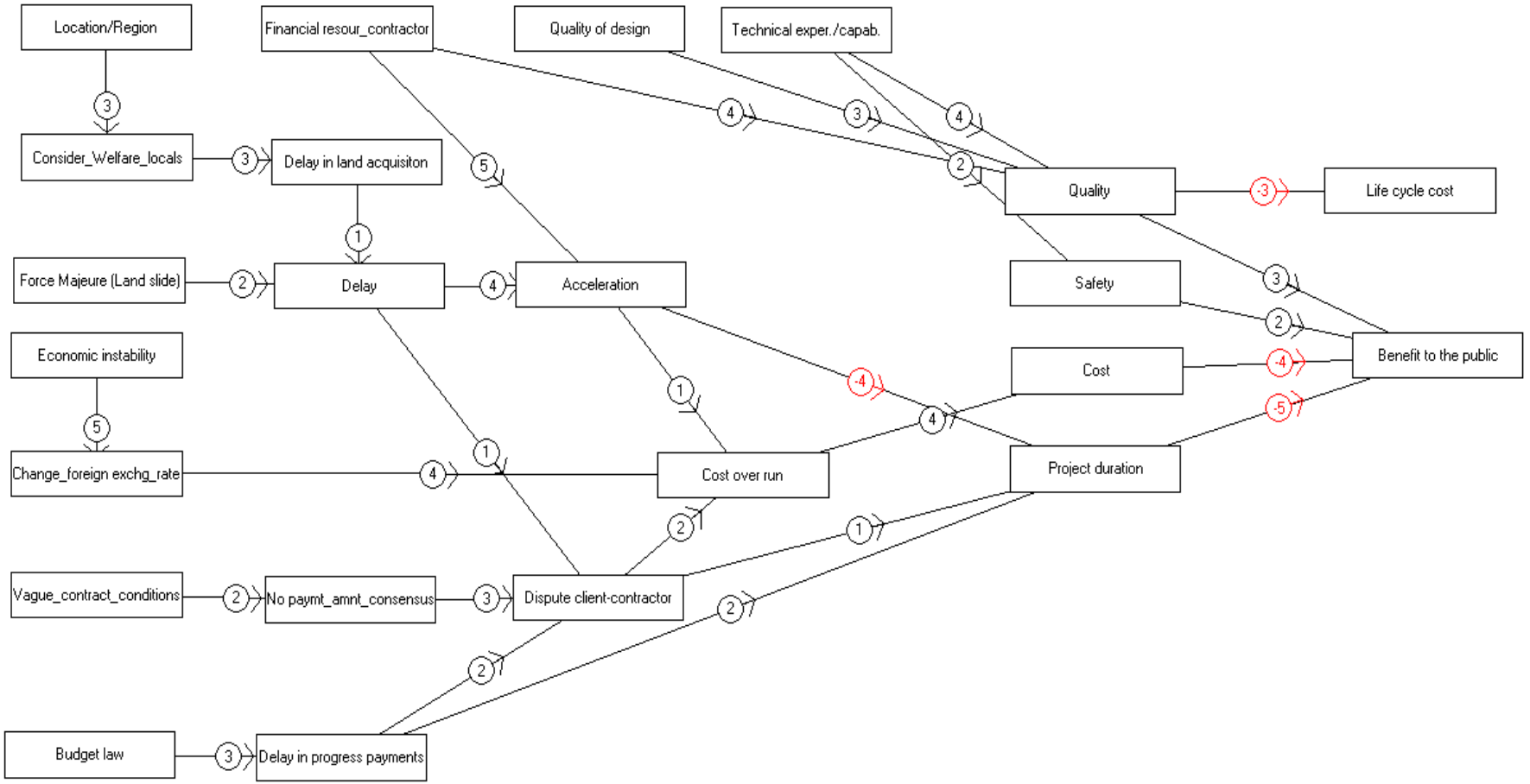


Figure 4.8: The final cognitive map of client

4.3.5. Interpreting

As a result of the interviews with all of the parties and construction of individual maps, the final step is the interpretation of the drawn maps. This interpretation is done with the analysis and comparison of the maps in terms of both some mathematical formulas and verbal expressions. Detailed results and interpretations are presented in the next chapter.

CHAPTER 5

FINDINGS AND DISCUSSION

The main aim of the study is to demonstrate the facts that success (both the criteria to measure the success and the factors affecting the success) is a relative issue for the parties involved in a project and there are interrelationships between the factors which can not be captured by identification of project success factors independently. The issue of different perspectives has been emphasized in the literature; however the interrelationship between the factors has not been investigated much. Thus, with the usage of the cognitive maps, the aim is to show the differences between the perspectives of the participants related with the

1. Project success criteria/ performance measures
2. Project success factors/ performance drivers
3. Interrelationship between the success factors
4. The relationship between the success factors and the criteria

The analysis and comparison of the cognitive maps have been studied by a number of researchers (e.g. Markóczy and Goldberg (1995), Langfield-Smith and Wirth (1992), Ford and Hegarty (1984), Klein and Cooper (1982) and etc.) and various methods have been proposed for both quantitative and qualitative analysis and comparison of the maps.

Current techniques used to analyze causal maps provide a qualitative interpretation of the variables representing a decision problem by focusing on the structure of a causal map (Eden et al, 1979; Ross and Hall, 1980). Causal maps can be analyzed

quantitatively using different analytical tools. Quantitative analysis provides an objective basis for assessments of causal maps so that subjective biases in qualitative analysis could be reduced (Wijesuriya et al, 2003). The quantitative analysis is also valid for the CMs.

To be able to compare the maps, first of all, the analysis of the maps should be done based on the parameters which give information about the existence of the constructs and the direction and strength of the causal relationships between the constructs used in a CM. When these parameters are defined, the comparison of the maps can be based on these values.

In this chapter, first of all, the techniques proposed for the analysis and comparison of the maps and then; the findings and discussions related with the case study in an order of analysis of each individual map and comparison of the maps will be presented.

5.1. The Analysis and Comparison Techniques

Cognitive maps can be analyzed by focusing on two dimensions: the content and the structure of each map (Langfield-Smith and Wirth 1992). Content difference is associated with differences in the constructs (events, nodes, concepts) that individuals perceive as relevant to a domain, and differences in the way that these constructs are related to one another (Axelrod, 1976; Langfield-Smith and Wirth, 1992; Markóczy and Goldberg, 1995). Structural differences reflect varying degrees of complexity of the map structure (Langfield-Smith and Wirth 1992).

The content and structure measures are generally quantitative interpretation of the maps depending on the number or path of the concepts and links in between these concepts used in the maps.

5.1.1. Content Differences

Content measures reflect the extent to which individuals vary in terms of the concepts and the interrelations between the concepts incorporated within their cognitive maps.
When comparing the cognitive maps of two individuals, three types of difference can be identified (Langfield-Smith and Wirth, 1992):

1. Existence or non-existence of elements (constructs): This difference takes place when a construct is regarded as important and included in the map of one of the individual whilst the other individual does not mention about the construct.
2. Existence and non-existence of beliefs (links): A causal relationship between two constructs may exist for an individual whereas; these constructs can be regarded as independent by other individual. Thus, this difference is not independent of the first one, because for the existence of the identical links, both of the constructs should be included in the maps of the both of the individuals.
3. Identical beliefs held with differing strengths: Two individual may believe in the existence of a causal relationship between two constructs but the strength of the relationship would be identified differently. Thus this type of difference takes place when a link between two constructs is weighted differently by different individuals.

Langfield-Smith and Wirth (1992) indicates that the basis for developing content measures is the recognition that, visually, a cognitive map is simply a network of nodes (elements, constructs) and connectors (links, causal relationships), with the lines connecting the elements indicating causal relationships between the elements. Thus, a cognitive map can be represented as an adjacency matrix. An adjacency matrix is an n x n matrix, where n is the total number of constructs in a CM. The elements used in the map are listed along the horizontal and vertical axes of an adjacency matrix. Cells at the intersection of each column and row contain a number

indicating the existence, direction and strength of the causal relationship between two elements. For example, Figure 5.l contains a cognitive map and Figure 5.2 the corresponding adjacency matrix as snap shot taken from Cognizer; the software used. From Figure 5.1 it is seen that construct 1 has a causal influence on construct 2 with the weight assigned as 5 (strong) while construct 2 affects construct 3 with a weight of 3 (moderately strong). The contents of the cells in Figure 5.2 show the same values at the intersection of the corresponding rows and columns. For example, when the cell at the intersection of construct 1 at the row and construct 2 at the column is looked, the value assigned to the cell is 5. A zero in a cell signifies that there is no causal relationship between the two constructs. The cells at the intersection of the same element being at the row and column will usually contain a 0, unless that element 'affects itself'.

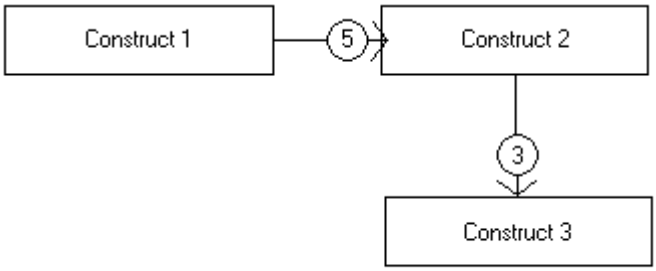
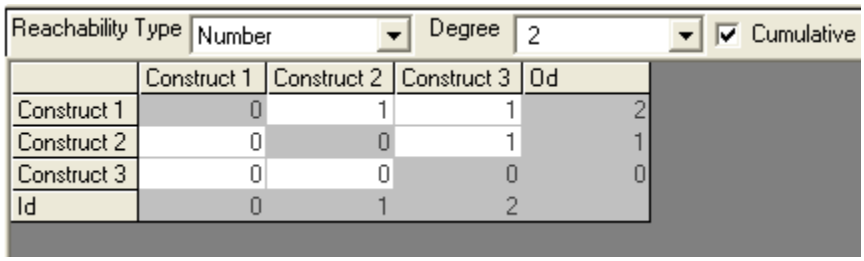


Figure 5.1: Demonstrative digraph of cognitive map

	Construct 1	Construct 2	Construct 3	Od
Construct 1	0	5	0	1
Construct 2	0	0	3	1
Construct 3	0	0	0	0
Id	0	1	1	

Figure 5.2: Demonstrative adjacency matrix

Ford and Hegarty (1984) analyzed indirect causal effects by representing each cognitive map as a 'reachability matrix'. A reachability matrix allows the determination of the cumulative direct and indirect effect of one construct on all other constructs within a map. It was argued that the reachability matrix provided a better basis for analysis than the adjacency matrix because of the inclusion of indirect relationships (Langfield-Smith and Wirth 1992). Cognizer provides different options of calculating the reachability matrix. It can count either the number or the weight of direct and indirect links to constructs not only for the first degree, but also to the 'n-1'th degree, n being the number of constructs. The number answers the question of "from how many different paths a construct influences another" and the weight answers "what is the total effect of a construct on another".



	Construct 1	Construct 2	Construct 3	Od
Construct 1	0	1	1	2
Construct 2	0	0	1	1
Construct 3	0	0	0	0
Id	0	1	2	

Figure 5.3: Demonstrative reachability matrix

In Figure 5.3; a reachability matrix can be seen. This matrix belongs to the map in Figure 5.1. Here the number of the links to the second degree was chosen. From the matrix it can be seen that, along with the direct relations of construct 1 on construct 2 and construct 2 on construct 3; the second degree relation of construct 1 on construct 3 is shown as the value 1 indicating that there is only one path from construct 1 to construct 3.

One of the techniques for the analysis and comparison of cognitive maps is the number of the indegree and outdegree values. The indegree value indicates the number of incoming links to a given construct and the outdegree value indicates the

number of links from a given variable. In other words, the indegree indicates the extent to which the construct is influenced from other constructs, and outdegree indicates the extent to which the construct exerts causal influences in other constructs. Generally, the greater number of "indegrees into" and "outdegrees from" a construct, the more important (or salient) that construct is considered to be (Markóczy and Goldberg, 1995; Clarkson and Hodgkinson, 2005).

The indegree and outdegree values are also calculated by the software not only to the degree one, but also to the degree (n-1). In Figure 5.3 the values calculated for indegree and outdegree can be seen. As the analysis was set to be to the degree two on the cumulative basis, the outdegree of construct 1 is seen as two, which means that it affects both construct 2 and 3. If, the analysis was made to the degree 1, the outdegree value would be 1 as in that case construct 1 only affects construct 2 directly.

Beside the number of the outdegree and indegree values, the weights of these influences can also be calculated by Cognizer. It means that for indegree; both the number of how many causal effects are exerted to a construct and what is total of the weight (the strength) of these influences can be measured, same is valid for the outdegree. The difference of this measure from what is found out from reachability matrix is that the reachability matrix shows the pair-wise relation of the constructs, whilst the outdegree and indegree values investigates the constructs one by one. For example, from reachability matrix, the effect of each construct on "profitability" is seen one by one, and with the indegree/outdegree values the total of the causal influences made to/by profitability is seen.

Montibeller and Belton (2006) proposed the measurement of partial effect (PE) and total effect (TE) of a construct on another construct, potency and shortest path. In Figure 4.4 it is seen that construct 1 influences construct 4 through two paths. First one is 1→2→4 and the second is 1→3→4.

1. Partial effect (PE) of a path: this index is obtained by multiplying the signs along the path. For example, in Figure 4.4, between constructs 1 and 4 there are one positive and one negative path.

2. Total effect (TE) of the initial concept on the last concept: this index is positive if all paths between those two concepts have a positive partial effect; it is negative if all paths have a negative partial effect; and it is undetermined otherwise. For example, in Figure 4.4 construct 1 has an undetermined effect on construct 4. This situation is also referred to as a dilemma (Eden et al, 1992). However, if the causal influence between constructs 1 and 3 has been negative, then the total effect of construct 1 on construct 4 would have been negative.

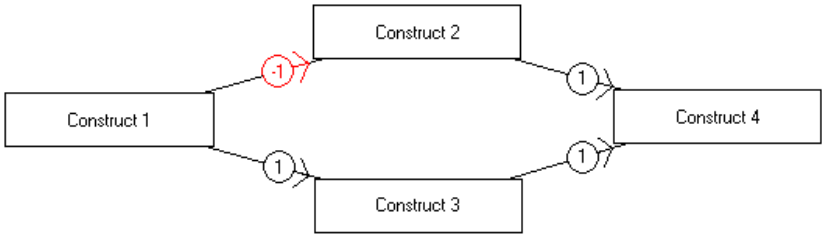


Figure 5.4: Demonstrative cognitive map digraph 2

The partial and total effect indexes can be utilized by taking into account the weights (strengths) of the links.

Quantitative assessment of strengths: The partial effects are calculated by multiplying the strengths along a path. Total effects are calculated by adding up the partial effects. For example, in Figure 4.2 the partial effect of construct 1 on construct 6 is given by PE (1 →3 →5 →6) = 3*(-2)*5 = (-30). In a similar way: PE (1 →3 → 5→7) =3*(-2)*2= (-12); PE (1 →3 →4 →7) = 3*3*2=18; PE (2 →4 →7) =4*2=8. The total effects for each option are given by: TE (1 →6) = (-30) TE (1

→7) = (-12) +18=6; and TE (2 →7) = 8. Thus in this example, construct 2 is more influential than construct 1 on construct 7.

What is revealed from the calculation of the reachability matrix taking into account all of the degrees of direct and indirect effects is nothing but the total effect of a construct on another.

Potency: The potency of an option is determined by the number of goals it influences (Eden et al, 1992). For example in Figure 4.5, construct 1 is more potent than construct 2 because construct 1 influences both construct 6 and 7 whilst construct 2 influences only construct 7. The rationale here is explained by Montibeller and Belton (2006) as the constructs that have impact on the achievement of more goals are more potent.

Shortest path: In this case, the option with the shortest path to the goals is considered to be the most influential one (Hall, 2002). For example, in Figure 5.5 construct 2 is more influential than construct 1, as it has a shorter path (2 →4 →7 compared to 1 →3 →5 →6, 1 →3 →4 →7, or 1 →3 →5 →7). The underlying principle here is explained by Montibeller and Belton (2006) as the shortest path represents the simplest argument in favor of an option.

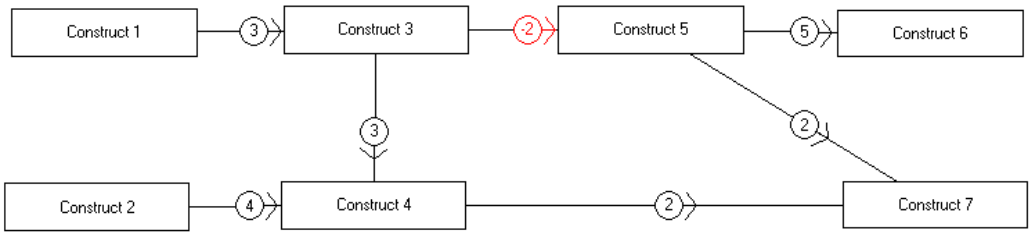


Figure 5.5: Demonstrative cognitive map digraph 3

At this point, a discussion can be made as a result of defining both the total effect and the shortest path concepts. Here forms an argument to interpret the meanings

these measures imply. It can be thought that as these numbers defining the total direct and indirect effects are the multiplication of the individual link strengths throughout the path to the goal, the greatest number implies the greatest effect on the goal. Although this logic is valid, it has a bottleneck. If the influence of the constructs which goes through the same number of multiplication of the strengths of the links along the path to the goal were to be compared, the greatest number would be regarded as the most influential effect without any doubt. However, map is formed of constructs which have different number of constructs along the path. This case would result in identifying the longest path with the greatest strength of the links as the most important factor but in this point the idea that is the simplest argument in the favor of the achievement of the goal is the shortest path, which can be regarded as the most influential one is contradicted.

Thus; in this study three different investigations of the paths are made. First of all, the shortest path for the identification of the simplest argument is presented. Secondly, the greatest cumulative effect (of all of the degrees) is calculated to identify the initiator factor which causes most of the critical decisions or gave birth to the occurrence of the other factors. Lastly, the degree based comparisons of the factors are made. In other words, the constructs which go through the same length of path are compared to identify the relatively more influential one.

Langfield-Smith and Wirth (1992) proposed a number of formulae to measure the distance between the CMs and selected the measure known as Distance Formula 12 as the best representative of the (dis)similarity between the maps. The details of the formula can be found in the study of Langfield-Smith and Wirth (1992). The formula mainly calculates the differences between the maps on a construct-to-construct and link-to-link basis and divides the sum by the greatest possible difference taking into account the number of unique and common constructs between the maps. Scores range between zero and one, with larger numbers reflecting greater dissimilarity.
Markóczy and Goldberg (1995) presented a parameterized version of the distance formula 12 of Langfield-Smith and Wirth (1992). Distance Formula 12, revised in

such a way as to take account of a number of variations in mapping procedures adopted by researchers over the years, including whether only the strength of causal relations is considered or polarity judgments are also incorporated, whether the variables within the perceived causal system are permitted to self-influence, and the number of strength values incorporated within the mapping system (Clarkson and Hodgkinson 2005).

Cognizer makes the calculation of the distance measure by using the formulas of both Langfield-Smith and Wirth (1992) and Markóczy and Goldberg (1995). In respect of the latter, a variety of parameters can be set by the user, with the appropriate settings being dependent on the exact form of elicitation procedure adopted. The software provides the possibility of assigning values to the coefficients which provides the applications of the variations proposed by Markóczy and Goldberg (1995). These coefficients are:

Self loops (alpha) value: The decision of taking into account the existence of direct self influence is reflected by assigning value to alpha. If the values for concepts directly influencing themselves are preferred to be compared, then the alpha value is set to 0 if not 1.

Maximum absolute strength (beta) value: This is the maximum strength assigned to the links between the concepts. For example, it is 5 in our study. This must be an integer value greater than 0. The default value is 3.

Nodes mismatch (gamma) value: The meaning of gamma is explained by Markóczy and Goldberg (1995) in its role in drawing an inference about individuals' beliefs based on both the absence of a node (if the node is not in the map then it is not believed to be in any causal relations) and based on the absence of an arc (if an arc does not exist between two nodes then there is not believed to be any causal relation). The first assumption is valid if the participants are free to select all constructs they find relevant. The latter is safe if the map was elicited by comparing

each pair of nodes in the map. Thus in the first case meaning is assigned to the fact that a participant chooses or not a construct assigning gamma as 2, and in the second case meaning is assigned to the existence of the common links regardless of the existence or absence of the constructs, assigning 0 to gamma. Gamma = 1 denotes an intermediate position whereby such differences imply material differences in cognition that need to be taken into account.

Polarity change (delta) value: Delta being 0 indicates that the difference between an arc with strength 3 and with strength 1 is the same as the difference between +1 and -1. Thus this is the additional weight given to a polarity and it must be an integer value greater or equal to 0.

Influence relations (epsilon) value: Epsilon is the number of possible polarities. For the maps in our study two possible polarities are assigned as negative and positive. Thus epsilon is 2.

With the parameters [Alpha] = 1, [Beta] = 3, [Gamma] = 1, [Delta] = 0, and [Epsilon] = 2, this formula (more or less) reduces to Langfield-Smith and Wirth's formula.

5.1.2. Structural Differences

Structural difference measures seek to capture differences and similarities in the complexity of the cognitive maps.
The structural indicators used in this study are calculated by Cognizer are as follows:

1. Number of Constructs –Total number of constructs within the map
2. Number of Links –Total number of links between the constructs within the map
3. Total Link Strength –The sum of all link strengths within the map
4. Mean Link Strength –The arithmetic mean of all link strengths within the map

5. SD Link Strength –The standard deviation of all link strengths within the map (note this is undefined if there is less than two links, a value of 0 is assigned)
6. Total ABS Link Strength –The sum of absolute values for all link strengths within the map
7. Mean ABS Link Strength –The arithmetic mean of absolute values for all link strengths within the map
8. SD ABS Link Strength – The standard deviation of absolute values for all link strengths within the map
9. Link Density –The number of links divided by the number of constructs
10. Link Strength Density –The sum of all link strengths divided by the number of constructs
11. Link ABS Strength Density –The sum of absolute values for all link strengths divided by the number of constructs
12. Map Density - The number of links divided by the theoretical number of maximum links between constructs (number of constructs * number of constructs –1)

5.2. Analysis of the Maps

The content and structural analyses of each map are presented separately. The sequence of the map presentation is as client, contractor 1 and contractor 2.

5.2.1. Map of the client

The map will be investigated in two parts, first the content and then structural analysis.

5.2.1.1. Content Analysis

The two goals of the client with the realization of the project are minimization of the life cycle costs and the provision of benefits to the public. Minimization of the life

cycle costs means reducing the repair costs throughout the operation period. Thus from the map is seen that measuring index is the quality. The other goal; benefit to the public is measured by safety, cost, quality and project duration.

The first goal is affected from only 3 factors which are the technical experience/capabilities, financial resources of the contractor, and quality of design; on the other hand unlike the limited number of factors affecting life cycle costs, all of the factors have an effect on the latter criteria.

When the reachability matrix is issue of concern, the greatest affect on "life cycle costs" is made by financial resources of the contractor with link strength of 12. It is followed by technical and quality of design by link strength of 9.

The benefit to the public is affected by all of the factors both negatively and positively. The longest path is formed of 8 constructs, thus when the cumulative of all of the degrees of direct and indirect effect made on this goal is calculated by the reachability matrix to the degree 7, it is seen that the constructs with the greatest negative influence are: vagueness in contract clauses (strength of -222), economic instability in Turkey (strength of -320) and budget law (strength of -252) and the ones with the positive influence are: technical experience/capabilities (strength of +16) and financial resources of the contractor (strength of 32).

The simplest argument in the favor of the success of the project, in other words the shortest path is identified as the quality of design, financial resources of the contractor and technical capability/experience of the contractor affecting both "life cycle costs" and " benefit to the public" through safety or quality.

The degree based investigation of the influences has also been made. In other words, the factors having the highest influence on the goals on the basis same degree have been searched. The resulted constructs with weights are as presented in Table 5.1.

Table 5.1: Degree based critical factors of map of client

Degree	Most influential constructs on "Life Cycle Cost"	Most influential constructs on "Benefit to public"
1	Quality (-3)	Project duration (-5) Cost (-4)
2	Financial resour_contractor (-12) Technical exp/capability (-12)	Acceleration (20) Cost overrun (-16)
3	--	Change in foreign exchange rate (-64) Financial resources of contractor (100)
4	--	Force majeure (150) Economical instability in Turkey (-320)
5	--	Force majeure (-192) Vagueness in contract clauses (-192) Budget law (-192) Considering the welfare of public(225)
6	--	Location/Region (675) Considering the welfare of public(-288)
7	--	Location/Region (-864)

From the table it is seen that when the degree changes, the effects of some factors change their polarity. The reason is caused from the fact that these factors (location/region, considering the welfare of locals and force majeure) have effect on the goal through cost and project duration. If they had same length of path, the combined effect would reflect to the result. However; as they have different lengths, their effects can be seen separately. Indeed; the positive effect occurs when the path through project duration is considered and negative effect occurs when the path through cost is considered. Although these factors having shortening effect on project duration does not sound correct, the fact that these factors caused the contractors to take the decision of "acceleration" of the project with the usage of their own resources should not be forgotten. When the numeric values presented summed up, the resulting effect of these factors are negative.

The other fact revealed from the table is the minimum number of factors affecting the life cycle cost, which has been explained.

Potency: it is seen that, the quality of design, financial resources of the contractor and technical capability/experience of the contractor are the three factors which are more potent in the achievement of the project goals because only they affect both the "life cycle cost" and "benefit to the public".

The indegree and outdegree calculations have been performed in four different patterns.

1. The number of the first degree direct causal effects as indegree and outdegree separately
2. The number of the total of the direct and indirect causal effects as indegree and outdegree separately
3. The weight of the total of the direct and indirect causal effects as indegree and outdegree separately
4. The number of the first degree direct causal effects as the summation of the indegree and outdegree

1. The maximum number of outdegrees is 2 and directed from quality, technical experience/capability of the contractor, acceleration, financial resources of the contractor, dispute, delay, and delay in land acquisition.

   The maximum number of indegrees is 4 and it is to the goal "benefit to the public" and cost overrun, quality, project duration and dispute are following it with a number of three.
2. Outdegree: When the total of the direct and indirect influences are counted the highest number is 9 from location/region and considering welfare of the locals is following it with a number of 8.

   Indegree: The project goal "benefit to the public" has a number of 21 indegrees and it is followed by cost with a number of 15 indegrees.

3. Outdegree: Economic instability in Turkey with a weight of "-215" is the highest outdegree followed by budget law with a weight of "-171". These are the negative ones, the positive ones are financial resources of the contractor with a weight of "34" and technical experience/capability of contractor with a weight of "10".

   Indegree: Benefit to the public with a weight of "-1385" is the highest indegree followed by project duration with a weight of "-238". The positive ones are cost with a weight of 652 and cost overrun with a weight of 162.
4. The highest total of the indegree and outdegree values are provided by dispute (5) and quality (5).

When all of the results obtained from the cumulative effect reachability matrix, shortest path, degree based reachability matrix, potency, and indegree/outdegree values, it is seen that the measurement methods have differences in the identification of the most influential factors such as taking into account the effects at the same degree of indirect relations or cumulative effect, looking at the influences made to/from a construct as construct based (pair-wise relations) or as a total. The summarized result is presented as follows:

1. The factors affecting the benefit to the public are more than the factors for the minimization of life cycle costs.
2. As a cumulative, direct and indirect indegree value of the benefit to the public is negative indicating as a total the factors were not in the favor of the achievement of this goal; for life cycle costs the cumulative indegree value is again negative indicating that the constructs were as a total in the favor of the minimization of the life cycle costs.
3. Client's evaluation of the project as successful can be explained in three ways. The client might value the "minimization of the life cycle costs" more than "benefit to the public" or although the benefit to the public is negatively affected from the factors, the client might be evaluating the success of the project as a comparison to the other projects and this project's benefits might

be higher or although these effects are negative as a cumulative, the benefit to the public might still stay in acceptable limits.

4. The critical factors for the achievement of "minimum life cycle costs" are the technical experience/capability; financial resources of the contractor and the quality of the design.
5. The critical factors in achieving "benefit to the public" are technical experience/capability; financial resources of the contractor, economic instability in Turkey, location/region, force majeure (land slide), budget law, vagueness in contract clauses, considering the welfare of the locals and technical experience/capability.
6. Technical experience/capability and financial resources of the contractor are the factors which provided the project to be completed in time, over quality and safely. Economic instability caused cost overrun. Location/region, force majeure (land slide), budget law and vagueness in contract clauses resulted in the disputes and cost overrun for the client. Other than the negative effects, location/region and force majeure forced the contactor to accelerate which provided the timely completion of the project.
7. The quality and cost are comparatively more influenced from the factors than the other PSC of project duration and safety.
8. The negative factors are from diverse groups such as the environmental factors, contractual arrangements and project characteristics. While, the positive factors are from the group of project participants and relations.

As a conclusion the content analysis of the client identified these factors as the most influential ones in the evaluation of the success of the project from the point of view of the client.

5.2.1.2. Structural Analysis

Cognizer calculated the structural values of the map and these are presented in Table 5.2. The interpretation of these values will be made during the comparison of the maps.

Table 5.2: Structural values of the map of the client

Number of constructs	23
Number of links	28
Total link strength	50
Mean link strength	1.79
SD link strength	2.67
Total ABS link strength	82
Mean ABS link strength	2.93
SD ABS link strength	1.25
Link density	1.22
Link strength density	2.17
Link ABS strength density	3.57
Map density	0.06

5.2.2. Map of the contractor 1

The analysis of the map is made in two parts as content and structural analysis.

5.2.2.1. Content Analysis

There are three project goals of the company as profitability, increased workload in Turkey and reputation in international market. The first two goals are affected from all of the factors whilst for the last one the constructs influencing cost are excluded.

The reachability matrix reveals the following influences made on the three project goals by the cumulative of the direct and indirect relations of the constructs as the highest positive and negative values:

Profitability: Poor performance of client (strength of -8376), experience in country (strength of -6300), poor international relations (strength of -3816), unexpected geological conditions (strength of -3078), experience with client (strength of -2580), technical exp/capabilities (strength of 16), equipment and machinery resources (strength of 17).

Reputation: Poor performance of client (strength of -1472), poor international relations (strength of -864), unexpected geological conditions (strength of -648), experience with client (strength of -624), experience in country (strength of 3120), force majeure (strength of 988), delay in land acquisition (strength of 832).

Increase work load: Poor performance of client (strength of -2922), poor international relations (strength of -1440), unexpected geological conditions (strength of -1134), experience with client (strength of -996), experience in country (strength of 180), force majeure (strength of 48), delay in land acquisition (strength of 48).

It is seen that poor performance of client, experience in country, poor international relations, unexpected geological conditions, and experience with client are the common factors affecting all of the project objectives. Generally their effects are negative because as a result of the unfamiliarity of the contractor about the characteristics of the client and the county, unexpected geological conditions and client's attitude unexpected situations occurred which hindered the success of the project. However, the increased work load in Turkey is seen to be positively affected from experience in country, force majeure, and delay in land acquisition. This can be explained by the fact that as a result of these situations, the contractor accelerated the

project using its own financial resources thus completed the project in time, and increasing its reputation.

The explanation made in the methodology chapter shall be reminded here. The constructs “experience in country”, “project management”, “client relations”, and “communication between parties” bear negative meaning for this map. In other words these constructs represent the inexperience of the contractor related with the country and the client, bad client relations and bad communication between the parties. Thus, while the relationships between the constructs are followed these negative meanings should not be forgotten.

There are 23 shortest paths. These are the different combinations of the factors equipment and machinery resources, technical capability/experience, high quality materials and high quality personnel with project duration, cost and quality to reach reputation in international markets, profitability and increased workload in Turkey. If the strengths are taken into account most effective one is “high quality materials” affecting reputation and increased workload.

It is seen that as a result of the reachability matrix, generally the factors negatively affecting the success of the project has been identified. However, the shortest path, in other words the simplest argument identifies the resources and experience of the contractor as the most influential factors.

The degree based influences made on the project objectives are presented in Table 5.3.

Table 5.3: Degree based critical success factors of the map of contractor 1

Degree	Most influential construct on Profitability	Most influential construct on Reputation in International Markets	Most influential construct on Increased workload in Turkey
1	Cost (-4)	Project Duration (-4) Quality (5)	Project Duration (-3) Quality (5)
2	High quality materials (-26) Equipment and machinery (17)	Technical experience/capability (36) Project management (-12)	Technical experience/capability (35) Project management (-9)
3	Financial resources of contractor (60) Force majeure (-63)	Experience related with client (-48) Financial resources of contractor (80)	Financial resources of contractor (60) Force majeure (-36)
4	Client relations (-276) Force Majeure (72)	Poor accessibility of site (104) Delay in construction of access road (-96)	Client relations (-96) Poor accessibility of site (78)
5	Experience related with client (-1104) Delay in construction of access road (312)	Experience related with client (-192) Delay in construction of access road (416) Force Majeure (416)	Experience related with client (-384) Delay in construction of access road (312)
6	Poor performance of client (-2088) Negative public reaction (192)	Experience related with client (-576) Delay in construction of access road (512) Force Majeure (512)	Poor international relations (-576) Experience related with client (-576) Negative public reaction (192)
7	Poor performance of client (-5760) Poor public relations (576)	Poor performance of client (-1512) Poor public relations (768)	Poor performance of client (-2268) Poor public relations (576)
8	Poor public relations (-1728) Experience related with country (2880)	Experience related with country (3840)	Poor public relations (-432) Experience related with country (2880)
9	Experience related with country (-8640)	--	Experience related with country (-2160)

From the Table 5.3, it is understood that the most influential factors on the success of the project are mostly associated with the client (the experience related with the client, client relations, and poor performance of the client), followed by the unfamiliarity to the country, project management, force majeure, inaccessibility to the site, and the resources of the contractor.

Wang and Huang (2006) claimed that project owners play the most important role in determining project success, and it is seen that this claim is also valid for the perspective of the contractor 1.

Potency: The potency can not be calculated for this map because as explained all of the factors have an effect on both of the project goals except the 20 constructs which do not affect the reputation in international markets.

The indegree and outdegree calculations also for this map have been performed in four different patterns.

1. The number of the first degree direct causal effects
2. The number of the total of the direct and indirect causal effects
3. The weight of the total of the direct and indirect causal effects
4. The number of the first degree direct causal effects as the summation of the indegree and outdegree

1. The maximum number of outdegrees is 4, directed from poor performance of the client and followed by a degree of 3 by force majeure, technical experience/capabilities, quality, and project duration.
   The maximum number of indegrees is 6 and it is to cost overrun, cost, claim and project duration.
2. Outdegree: poor performance of client (16), experience in country (12), poor international relations (11), experience with client (11), unexpected geological conditions (11), poor public relations (11), change in scope (11)

Indegree: increased workload in Turkey (46), profitability (46), reputation (42), cost (42), project duration (38), cost overrun (31)

3. Outdegree: poor performance of client (strength of -9722), poor international relations (strength of -4744), unexpected geological conditions (strength of -3741), experience with client (strength of -3268), technical experience (strength of 85), equipment and machinery resources (strength of 34), high quality materials (strength of 29), financial resources of the contractor (strength of 20)

   Total indegree: the greatest positive values are cost (strength of 10883), cost overrun (strength of 2107), dispute (strength of 1518) and the greatest negative values are profitability (strength of -42731), increase workload in Turkey (strength of -9988).
4. The highest total of the indegree and outdegree values are provided by project duration (9), cost (7), and claims (7).

From the analysis of the indegree and outdegree values it is noticed that the same factors identified from the reachability matrix are also spotted here with only extra highlighting of the claims and disputes.

As a result of the above investigations, the following summaries can be formed based on the map of contractor 1.

1. All of the factors have an effect on both the profitability and the increased workload in Turkey whilst the reputation in international markets are not influenced by the constructs which have an effect only on cost except from quality and project duration.
2. The cumulative direct and indirect causal influences on the project objectives are negative for profitability and increased workload in Turkey whilst they are positive for reputation in international markets.
3. Contractor 1 told that they perceive the project as being successful. Their primary objective was to strengthen their reputation. This fact is supported by

the act of the contractor 1 as the materials used in the construction are above the quality requirement in the contract and they provided this with their own resources. Their map indicates that the factors proceeded in a way to increase their reputation thus providing the project as successful.

4. Although the most valued project objective is reputation, profitability is identified as the most critical as a result of the indegree/outdegree calculations. This is related with the fact that most of the factors affected cost and profitability, causing the contractor to lose money but its importance for the contractor is smaller than reputation. Because they had enough resource to complete the project in time and over quality to strengthen their reputation. The bottleneck of the cognitive mapping technique is that comparative importance (strength) to the concepts can not be assigned.
5. The critical factors in achieving "profitability" are poor performance of client, experience in country, experience with client, poor public relations, unexpected geological conditions, equipment and machinery resources, financial resources of the client, and client relations.
6. The critical factor to achieve "reputation in international markets" are poor performance of client, experience related with client, experience related with country, force majeure, poor international relations, unexpected geological conditions, poor accessibility of site, financial resources of contractor, and technical experience/capability.
7. The critical factors to achieve "increase work load in Turkey" are poor performance of client, poor international relations, experience related with client, experience in country, poor public relations, force majeure, delay in land acquisition, unexpected geological conditions, technical experience/capability, and project management.
8. The project duration and quality are comparatively more influenced from the factors than the other success criterion of cost.
9. The negative factors are mainly from the environmental factors (unexpected situations preventing the contractor to access to site) and project participants and relations (the client side and the unfamiliarity of the contractor). While, the

positive factors are from the group of project participants and relations (the resources of the contractor).

5.2.2.2. Structural Analysis

The structural properties of the map of the constructor 1 are presented in Table 5.4. Again, the interpretation of the structural characteristics will be made in the comparison of the maps section.

Table 5.4: Structural values of the map of the contractor 2

Number of constructs	49
Number of links	71
Total link strength	151
Mean link strength	2.13
SD link strength	2.42
Total ABS link strength	217
Mean ABS link strength	3.06
SD ABS link strength	0.98
Link density	1.45
Link strength density	3.08
Link ABS strength density	4.43
Map density	0.03

5.2.3. Map of the contractor 2

The analysis of the map is done in two parts as content and structural analyses.

5.2.3.1. Content Analysis

The project goals of this contractor are the increased workload in Turkey and profitability. Both of the project goals are affected from all of the factors through the measurement criteria of cost, quality and project duration.

The longest path is formed of six constructs and when the reachability matrix is constructed, the maximum direct and indirect influences of the factors on the two project goals are calculated. When increased work load in Turkey is evaluated it is seen that the greatest effects are made by experience of the contractor related with client (strength of 180), the experience of contractor in country (strength of 62), and financial resources of the contractor (strength of 25). The negative maximum effects are provided by force majeure (strength of -30), unexpected geological conditions (strength of -26), and delay in land acquisition (strength of -20).

In the same way, the cumulative maximum positive and negative effects on profitability are provided by financial resources of the contractor (strength of 310), experience of contractor related with the client (strength of 140), experience in country (strength of 124), Force Majeure (strength of -264), unexpected geological conditions (strength of -182), and delay in land acquisition (strength of -170).

Although the strengths of the relations differ, it is seen that the critical factors for both of the project objectives are identical.

There are six shortest paths of the map. The first four are identified as the financial resources of the contractor and technical capability/experience of the contractor affecting both “increased workload in Turkey” and “profitability” through quality; third is payment type being lump-sum plus reservations affecting profitability through no control by client and fourth is unexpected geological conditions affecting profitability through claims.

For the same length of path (same number of constructs in each degree) the question of what are the most critical factors is answered by Table 5.5.

Table 5.5: Degree based critical factors of the map of contractor 2

Degree	Most influential construct on Profitability	Most influential construct on Increased workload in Turkey
1	Claims (3) Project duration (-4) Cost (-4)	Quality (3) Project Duration (-4)
2	Cost overrun (-12) Delay (-12) Project management (28)	Delay (-20) Acceleration (20) Project management (20)
3	Experience related with client (140) Force majeure (-72)	Experience related with client (100) Force majeure (-54)
4	Force majeure (240) Financial resources_contractor(-320)	Force majeure (240) Financial resources_ contractor (-320)
5	Force majeure (-432) Financial resources_contractor (576)	Force majeure (-216) Financial resources_ contractor (288)

Force majeure and financial resources of the contractor have positive and negative effects in consecutive steps. The reason arises from the fact that in the first step the effect of the construct on the decision of acceleration and thus, shortening the project duration is considered however in the following step the effect of construct on cost overrun is reflected.

The combined results of the reachability matrices divulge that the most critical factors in the achievement of both of the goals are experience of the contractor related with client, the experience of contractor in country, financial resources of the contractor, force majeure, unexpected geological conditions, delay in land acquisition and project management. The difference between the objectives is that

for profitability cost and quality, for increased workload in Turkey quality and project duration are more critical than the remaining criteria.

Potency: The potency can not be calculated for this map because as explained all of the factors have an effect on both of the project goals. Thus none of the constructs is more potent than the others.

The indegree and outdegree calculations also for this map have been performed in four different patterns.

1. The number of the first degree direct causal effects
2. The number of the total of the direct and indirect causal effects
3. The weight of the total of the direct and indirect causal effects
4. The number of the first degree direct causal effects as the summation of the indegree and outdegree

1. The maximum number of outdegrees is 3 and directed from both the unexpected geological conditions and the delay in the land acquisition.
   The maximum number of indegrees is 5 and it is to the goal “profitability” and to delay. Cost overrun and cost are following them with a number of 4.
2. Outdegree: When the total of the direct and indirect influences are counted the highest values are financial resources of the contractor (8), delay in land acquisition (8), unexpected geological conditions (8), communication between parties (7) and force majeure (7).
   Indegree: The project goal “profitability” has a number of 21 indegrees and it is followed by the goal “increased workload in Turkey (17), cost (13) and project duration (9).
3. Outdegree: the highest positive weights are directed from experience of contractor with client (strength of 210), financial resources of the contractor (strength of 194) and experience of contractor in country (strength of 162). The highest negative ones are force majeure (strength of -174), unexpected

geological conditions (strength of -122), and delay in land acquisition (strength of -108).

Indegree: the only negative indegree is to project duration (strength of -74); the positive ones are increased workload in Turkey (strength of 154), cost (strength of 80), cost overrun (strength of 47), profitability (strength of 32) and acceleration (strength of 12).

4. The highest total of the indegree and outdegree values are provided by delay (7) and cost (6). Followed by cost overrun (5), profitability (5) and project duration (5).

The results of the indegree/outdegree values are in a supportive manner of the results of the reachability matrices. The additional remarks are the dominance of the project duration and cost over quality and the fact that as a total the two project objectives are positively affected (holding a cumulative positive indegree weight) from the constructs.

As a result of the above investigations, the following summaries can be formed based on the map of contractor 2.

1. All of the factors have an effect on both the profitability and the increased workload in Turkey.
2. The cumulative direct and indirect causal influences on both of the project objectives are positive.
3. Contractor 2 told that they perceive the project as being successful and from the positive values of the cumulative indegrees of the objectives it is observed that map also supports the conclusion.
4. The critical factors in achieving “profitability” are experience of the contractor related with client, the experience of contractor in country, financial resources of the contractor, force majeure, unexpected geological conditions, delay in land acquisition and project management.

5. The critical factor to achieve "increased workload in Turkey" are also experience of the contractor related with client, the experience of contractor in country, financial resources of the contractor, force majeure, unexpected geological conditions, delay in land acquisition and project management.
6. Over quality; cost and duration seem to be the more influenced from the factors.
7. The critical factors of the map can be categorized as environmental factors, managerial operations, and project participants and relations.

5.2.3.2. Structural Analysis

The structural analysis revealed these values in Table 5.6 and the interpretation of the values will be performed in the comparison of the maps section.

Table 5.6: Structural values of the map of contractor 2

Number of constructs	23
Number of links	35
Total link strength	32
Mean link strength	0.91
SD link strength	3.27
Total ABS link strength	112
Mean ABS link strength	3.20
SD ABS link strength	0.99
Link density	1.52
Link strength density	1.39
Link ABS strength density	4.87
Map density	0.07

5.3. Comparison of the maps

Until now, the cognitive map analysis and comparison techniques have been presented with the analysis of the maps. In this section the comparison of the maps will be performed in two parts. First of all, the content based comparison and after structure based comparisons will be made.

5.3.1. Comparison based Content Analysis

In a project, there are multiple parties each with differing duties, characteristics and objectives. These differences can be seen from the project investigated. The client aimed to provide benefit to the public and minimize the life cycle costs of the project, whereas the contractors focused on profitability and increased workload in the country, with an addition to the foreign contractor as providing international reputation.

The success measurement criteria have been a topic of investigation for a variety of researchers in the literature. First of the golden triangle of cost, quality and duration has been proposed and later, different criteria added to the triangle representing the differing needs and perspectives of the parties involved in the project. Here it is seen that the golden triangle of cost, quality, and duration is applicable to our study in terms of the maps of the contractors, whereas the client added “safety” to the triangle.

If a project is recognized as successful, it means that the parties involved in the project are satisfied in achieving their objectives. However, as a result of the existence of many parties and unique nature of the projects, all parties may not be fully satisfied. Our project is perceived as successful by all of the parties, while the maps reveal that their degree of satisfaction varies. When the cumulative effects of the constructs on the project objectives as indegree are evaluated it is found that for client one of the objectives is negatively and the other is positively affected, for

contractor 1 one of the three objectives is positively, the other two are negatively affected and finally for the second contractor both of the objectives are positively affected. When the satisfaction of first contractor is questioned the numerical values reveal that the objective achievement is one per three which would mean a small amount of satisfaction. However this wrong conclusion is caused from the insufficiency of the program in assigning values to the objectives. In other words, the fact that the contractor cared more about the positive objective than the others can not be reflected in the program.

When the mostly influenced measures in the maps are spotted it is seen that the marked measures are quality and cost for the client, duration and quality for contractor 1 and duration and cost for contractor 2. These measures also reveal what the parties are mainly concerned about.

The success factors identified as critical by the participants are not identical. It is seen that the number of constructs common in the maps are more for contractors with each other than for contractors with client. In other words, the contractors have more common objectives, measures or factors affecting success than any of them has with the client.

The numerical comparison of the defined strengths of the links can not be made as a result of the difference in the scoring habits of the participants. In other words, one participant may show a tendency of assigning higher values to a causal relation between two constructs opposed to the lower scaling attitude of another participant for the same link. Thus the identified strengths of the links as a result of the reachability matrices and the indegree/outdegree calculations are made based on the constructs which were identified as more critical than the others.

All of the parties concur on the importance of the financial resources and the technical experience/capability of the contractors in bringing the success. Moreover, the effect of the force majeure is also highlighted by each of the party.

In case of an external event, the effect can not be the same for the parties involved in the project depending on the vulnerability of the parties. This situation can be demonstrated with the economical instability occurred in Turkey during the construction period of the project. The effect of this economical situation resulted in great change and fluctuations in the foreign exchange rates as the progress payments were made based on foreign currency. However, its effects were relative to the parties. For client this factor is one of the most critical ones and for the foreign contractor had a negative impact on the project but the other contractor did not even mention about the factor. Thus it is seen that the same factor created different outcomes for different parties and the reasons include many agent from procurement strategy to escalation formula used in the contract.

Both of the contractors identified the relation with the client, and experience related with the country and client as critical for the success of the project. However, the content of the factors differ for the contractors. For example; the local contractor had a great experience with the client as a result of the previous projects and they knew how to communicate and get along with them and the required steps for the management of the project. These all are remarkable aspects in achieving success. However, the foreign contractor was very unfamiliar with the bureaucracy, the characteristics of the country and client, what shall be done to have good relations, progress payment system and probable unfavorable contract clauses. All of these factors resulted in cost overruns, delays and disputes which to some degree hampers the project performance. Thus the same concepts created inverse effects for different parties.

The risk allocation scheme according to the contract was not in the favor of the contractors. Thus the unmentioned effects of the unexpected geological conditions by client were found very critical for the contractors.

Other than these qualitative comparisons of the content, the quantitative comparison based on the distance ratio is made between the maps.

The content of the formula and the meanings of the variables were explained in section 5.1.1. Depending on the meaning the gamma variable has, three comparisons were performed by assigning 0, 1 and 2 values to the gamma variable. The other four variables were set fixed as follows;

Alpha = 0 (as there is no loop)
Beta = 5 (the maximum strength assigned is 5)
Delta = 1 (to take into account the polarity changes)
Epsilon = 2 (there are two polarities positive and negative)

1. Gamma = 0

Gamma being zero indicates that while the comparison of the maps are made on the basis of the existence and strength of the common constructs and links and the unique constructs, the existence of a link between two constructs is identified by looking at the existence of this links between the common constructs in the maps instead of looking at the existence of the constructs. As explained by Markóczy and Goldberg (1995) zero value is generally given if the map is elicited by the pair-wise comparisons of the constructs. Although the participants were given the flexibility in the selection of the constructs in this study, the comparisons were performed and the comparison matrix is presented in Table 5.7.

Here; 0 stands for similarity and 1 for complete dissimilarity. It is seen that the numbers are too close to 0 as a result of the fact that the identified common constructs mostly have the same links in between for all of the maps. In other words, the logical sequence and causal relations of the common constructs mostly exist in all of the maps. The similarity of the maps relative to each other reveals that the most similar maps are contractor 1 and 2 while the most dissimilar ones are client and contractor 2.

Table 5.7: The comparison of maps (gamma =0)

	Contractor 1	Client	Contractor 2
Contractor 1	0.000000	0.014915	0.014430
Client	0.014915	0.000000	0.021818
Contractor 2	0.014430	0.021818	0.000000

2. **Gamma = 1**

This is an intermediate value between zero and two which can not reflect the substantial differences between the logic of the gamma value. The results are shown in Table 5.8. The relative comparison of the maps results in a supportive manner of the gamma equal to zero value, in other words; the most similar maps are contractor 1 and 2 while the most dissimilar ones are client and contractor 2.

Table 5.8: The comparison of maps (gamma =1)

	Contractor 1	Client	Contractor 2
Contractor 1	0.000000	0.020252	0.017539
Client	0.020252	0.000000	0.033708
Contractor 2	0.017539	0.033708	0.000000

3. **Gamma = 2**

Gamma value is assigned two in the case that the meaning is given to the existence or absence of common constructs instead of the status of the links. Markóczy and Goldberg (1995) claimed that if the participants are free to select all constructs they find relevant, the value of 2 shall be assigned to gamma. The resultant matrix is shown in Table 5.9. Here, it is seen that the (dis)similarity values are more realistic.

The case that the different scores assigned to links may be resulting from the different scoring (scaling) habit of the participants has been mentioned in the study which case also was claimed by Wang and Huang (2006) in their study to compare the Chinese and Norwegian supervising engineers' project performance perceptions. Assigning 2 to gamma may also overcome this difference. From the matrix, it is observed that the most similar maps are contractor 1 and 2 while most different ones are contractor 1 and client.

Table 5.9: The comparison of maps (gamma =2)

	Contractor 1	Client	Contractor 2
Contractor 1	0.000000	0.470004	0.307001
Client	0.470004	0.000000	0.450460
Contractor 2	0.307001	0.450460	0.000000

As a result, it is seen that no matter which gamma value is assigned, the most similar and dissimilar maps do not change. This is mainly caused form the fact that the objectives and success measurement criteria of contractors are more alike in between and different from the client's. Moreover, the critical factors identified are more parallel in the maps of the contractors. Ashley et al (1987) mentioned the importance of sharing the common project goals in the success of projects and the differences in our maps leads us to the same conclusion.

The most similar maps being the contractors is logical since the similar project objectives and the importance of relation with the client are mentioned in only their maps. The case that the client and the contractor 1 have the most dissimilar maps instead of contractor 2 and client represents that contractor 1 has far more uncommon constructs with the client; that can also be interpreted as their state of success was affected from more constructs.

This case is consistent with our initial expectation because as contractor 1 had no experience with the client and their relations were poor, their interpretation of success and the existence of factors affecting success are different than the clients'.

5.3.2. Comparison based on Structural Analysis

The structural indices obtained from the analysis of each of the maps are integrated into the same table as shown in Table 5.10. The comparisons of the maps based on the similarities and differences in the structural values will be presented in this section.

Table 5.10: Structural values of the maps

	Client	Contractor 2	Contractor 1
Number of constructs	23	23	49
Number of links	28	35	71
Total link strength	50	32	151
Mean link strength	1.79	0.91	2.13
SD link strength	2.67	3.27	2.42
Total ABS link strength	82	112	217
Mean ABS link strength	2.93	3.20	3.06
SD ABS link strength	1.25	0.99	0.98
Link density	1.22	1.52	1.45
Link strength density	2.17	1.39	3.08
Link ABS strength density	3.57	4.87	4.43
Map density	0.06	0.07	0.03

While the client and the contractor 2 has used 23 concepts in their maps, contractor 1 used 49 concepts, indicating that this contractor has been affected by more factors

such as site security, progress payment systems, and lack of consensus on payment amount.

Total and total absolute link strengths gains meaning when divided by the number of the links. The values of mean and SD link strength and mean and total ABS link strength will be evaluated together. The absolute mean strength values show that the scaling habits (disregarding the polarity of the links) do not seem to be too different and client using smallest strengths assignment whilst absolute standard deviation shows that disregarding the polarity of the links, client has the greatest range. The comparison of absolute mean strength and mean strength show that the number of negative links are greater than the number of positive links in each of the maps. The greatest difference is seen in contractor 2's map indicating that the greatest number of negative links is used in this map. Also, the standard deviation of link strength indicates that the range of the negative and positive values assigned to the links is wider for contractor 2. But when all of the polarities are considered it is seen that the greatest values are assigned by contractor 1 being more consistent in the assignment. This fact combined with the differences in the size of the maps (contractor 1 having longer paths than the others) caused us not to compare the reachability matrix causal relationship weights and indegree and outdegree weights for the maps, instead compare the constructs identified as most critical factors in each of the map as explained.

The number of the negative links being more than positive does not mean that the project's success was generally affected negatively. Because there are concepts such as cost and project duration and the fact that they are negatively affected may be in the favor of the success of the project.

Number of links does not mean much without combining it with number of constructs in the map. Two important values are provided with their division. First one is the link density and the other map density which give information about the complexity of the maps.

Link Density

A simple analysis of complexity is the ratio of links to nodes in the map. Simply put, the higher the ratio of links to nodes, the more complex the map (Eden et al 1992).

In our map the link density values are as follows;

1.22 for client,
1.45 for contractor 1,
1.52 for contractor 2.

Eden and Ackermann (1992) reported typical ratios of 1.15 - 1.20 for maps elicited from interviews. However, there are several studies reporting higher ratios. For example, the link densities Hart (1977) come up with are 1, 1.27 and 1.38 for three different maps. Moreover, the link densities in the 14 maps of Klein and Cooper (1982) range in-between 1.2 to 1.7. Thus our average link density of 1.4 is consistent with other studies.

Having the greatest number of link density, contractor 2 seems to have the most complex map of all. Their map has fewer concepts than contractor 1 meaning that fewer factors affected the success status of their project. In fact, before the conduction of the structural analysis, the researcher's expectation was that the contractor 1 would have the most complex map because at the first sight, as this map has much more concepts than the others, what was thought is that more concepts yield a more complex map. However, as the unique concepts to this map are generally connected with other concepts with fewer links, the density of the map is smaller than contractor 2.

Map Density

Map density is obtained by dividing the number of links by the maximum possible number of links. Hart (1977) claimed that the density of a cognitive map is simply a measure of its degree of interconnection.
In our maps the map density values are

0.06 for client
0.03 for contractor 1
0.07 for contractor 2

Hart (1977) worked on three maps and found the map densities as 0.024, 0.035 and 0.042. In the study of Klein and Cooper (1982) the map densities of 14 maps lie between 0.056 and 0.214 and they concluded that the smaller the map, the larger the density. Thus it is seen that, the density of our maps lie between the densities found in the literature. The contractor 1's map with the smallest density is the largest map. The other two maps have the same size (same number of constructs) and contractor 2 having the largest map density reveals that the degree of interconnection is greater than client.

The results of the analysis and comparisons of the maps of client and contractors are presented in Table 5.11 and Table 5.12 as a summary of the findings. The first of the indices is identified as a result of the calculation of the cumulative indegree value of the objectives. The second of the indices is the view of the party obtained by asking the participant whether the project was successful or not according to them during the interview. The third of the indices is the most critical factors identified by parties with their effects and finally the fourth of the indices reflects the criteria which are subject to highest causal influence from the factors.

Table 5.11: Summary of findings of the analysis of the CMs

Indices	Client	Contractor 1	Contractor 2
1-The objectives and the cumulative causal effects on them	Benefit to the public (-) Minimization of life cycle costs (+)	Profitability (-) Increase workload in Turkey (-) Reputation (+)	Increase workload in Turkey (-) Profitability (+)
2-The success of the project	Successful	Successful	Successful
3-The vulnerability of the project (the hazards and the capacity of the organization to resist the hazards with their combined effects on all of the objectives of the project)	Budget Law (-) Economic Instability in Turkey (-) Financial Resources (+) Force Majeure (-) Location/Region (-) Quality of Design (+) Technical Experience (+) Vagueness in Contract (-)	Client Relations(-) Delay in land acquisition (-) Experience in Country (-) Experience with Client (-) Financial Resources (+) Force Majeure (-) Poor Accessibility of Site (-) Poor International Relations (-) Poor Performance of Client (-) Poor Public Relations (-) Project Management (-) Technical Experience (+) Unexpected Geological Cond. (-)	Delay in Land Acquisition (-) Experience in Country (+) Experience with Client (+) Financial Resources (+) Force Majeure (-) Project Management (+) Unexpected Geological Cond. (-)
4-Mostly influenced PSC	Cost and Quality	Duration and Quality	Cost and Duration

Table 5.12: Summary of the findings of the comparison of the CMs

Indices	**Identified Conclusion**
Most similar Maps	Contractor 1 and Contractor 2
Most Different Maps	Contractor 1 and Client
Most Complex Map	Contractor 2
Largest Map Smallest Density	Contractor 1
Smallest Scaling Habit*	Client
Greatest Scaling Habit**	Contractor 1
* and **: The mean of the strengths assigned to the links between the concepts	

CHAPTER 6

CONCLUSION

Projects are temporary endeavors which are unique in nature as a result of the different characteristics of the projects, different events and interactions occurring during the project, and the different parties involved in the projects. Thus, a general list for the identification of the critical success factors or static objectives of the participants can not be made. Each party has its own goals in realizing the project which causes the parties to be satisfied to different degrees in achieving their objectives when combined with the differing effects of the critical factors, these factors not being independent of each other. Thus; the aim of this study is to show that there are interrelationships between the critical factors in a project and the mental beliefs of different parties involved in a project differs from each other both in terms of the factors and the objectives. A project success model is proposed for this purpose and the application of the cognitive mapping technique which is a strong visual tool for the representation of the perspectives of the peoples in a cause and effect relations is presented on a case study. As a result of the elicitation of the maps of the client and two contractors responsible from the construction works of the project, the exploration of the different beliefs of the parties is carried out by the content and structural analysis of the maps.

It is seen that the parties reflected their particular conditions to the map according to their perceptions and there are differences between these perceptions from a variety of points such as the identified critical factors, project objectives and the interrelationships between them, as expected. Although each party found the project as successful, the objectives of the parties are different than each other as well as the

differences in the degree of satisfaction of these parties. Although there are similar factors identified by each of the participants, different factors unique to particular maps are identified as well as the different strengths of the common links. These are all caused by the different vulnerability levels of the parties.

Case study findings reinforce the idea that checklisting the critical success factors and defining project success in terms of cost, time and quality only gives a very limited scope for modeling project success. CMs are powerful tools to simulate the relations between success factors, project vulnerability and objectives.

The benefits provided as a result of the usage of cognitive mapping in modeling project success can be discussed under two categories such as the benefits provided by the application of case study and the potential areas of application.

The benefits provided by case study application:

- An easy to understand way of visualization of the project and factors affecting its success is constructed.
- Subjective views and opinions are transformed to CMs and finally quantitatively analyzed.
- The interrelationships between the critical factors are identified as well as the root causes of the events.
- The critical factors having the greatest effect on the whole project as well as the ones for different project objectives are identified.

The potential areas of application:

- The different objectives of the parties and the criteria they value to measure the attainment of the project goals can be identified. This can be utilized in the pre-project phase by the formation of the common objectives through sharing the expectations and the assumed factors related with the project with all parties

included to gain greater satisfaction from the project and this would also enhance the communication between the parties.

- The comparison of the maps formed pre and post project would give information about the reality of the expectations and the performance of the firm in reaching their goals.
- In the post project phase, the parties can compare the differing effects of the factors to each of the parties to question the vulnerability of their organization or resources because most crucial interactions, factors and processes of the project with differing effects are identified by using CMs.
- The cognitive maps can be used to document the experience that was gained during the project to transform the experience into knowledge as a database and this procedure can also be seen as organizational learning.
- Causal maps can be integrated with neural networks to keep track of the projects to support the decision making process in the future projects.

Other than the benefits there are some shortfalls of the technique:

- Cognitive Maps can not be utilized as objective tools because they reflect the subjective beliefs of the participants.
- The elicitation of the maps is performed by the researchers and the maps formed can reflect the researchers' biases.
- The elicitation of the maps is time consuming
- The relative importance of the constructs, the objectives specifically, can not be reflected.

As a conclusion, complexity of modeling project success stems from:

- Interrelated factors of project vulnerability
- Interrelated events, risks, decisions, strategies etc. that can hardly be expressed as individual critical success factors

- Difference views on the performance measures
- Different perceptions of parties regarding even the same or similar situations
- Different priorities attached to performance measures
- Hardly quantifiable factors.

Cognitive maps provide a solution for modeling project success given the above given complexities. They can be used to simulate the project environment and considered as an effective visualization and knowledge sharing tool that can increase awareness of all parties involved in a project about potential sources of failure and success.

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