EFFECTIVENESS OF PROJECT MANAGERS IN TURKISH CONSTRUCTION INDUSTRY

by

Ömer Faruk Akgemik

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EFFECTIVENESS OF PROJECT MANAGERS IN TURKISH CONSTRUCTION INDUSTRY

APPROVED BY:

Assoc. Prof. Beliz Özorhon Orakçal .....
(Thesis Supervisor)

Assist. Prof. Semra Çomu Yapıcı .....

Prof. Gül Polat Tatar .....

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ABSTRACT

EFFECTIVENESS OF PROJECT MANAGERS IN TURKISH CONSTRUCTION INDUSTRY

Construction industry becomes more dynamic day by day. Changes in technology, construction methods, and project budgets cause more dynamic construction industry. Project participants especially project managers are obliged to deal with all these constantly changing components. In this dynamic construction industry, project managers can be a main source of competitive advantage for construction companies. project managers are like orchestra chiefs, coordinate constantly changing components of the construction industry to reach project goals. For completion of assignments in predetermined time, project managers provide effective project with coordination of project team members. Efficiency of project can be improved with examination of project success and critical success factors. Performance of project managers on a construction project is mutually associated project success. In addition, effectiveness of project managers is itself one of critical success factors in the construction industry. The main target of this study is to determine effects of two important issues, the first one is effectiveness of project managers in the Turkish construction industry, and the second one is proportional effects of critical success factors on project success of the Turkish construction industry. In order to achieve the target of this research, a comprehensive literature review was conducted to determine the most convenient components that have effect on effectiveness of project managers and project success. Then, correlation between those components were identified and the proposed model was tested based on data collected from Turkish construction companies. Structural equation modeling was used for testing the validity of the proposed model. Finally, effectiveness of project managers and proportional effects of critical success factors on project success of the Turkish construction industry is discussed by referring to structural equation modeling analysis findings.

ÖZET

TÜRK İNŞAAT SEKTÖRÜNDE PROJE MÜDÜRLERİNİN ETKİSİ

Teknolojik ilerlemeler, inşai yöntemlerindeki değişiklikler ve proje bütçelerindeki değişim daha dinamik inşaat sektörü oluşmasına sebep olmaktadır. Projelere dahil olan her bir parti, özellikle proje müdürleri, sürekli değişen bu dinamik etkenlerle başa çıkmak zorunda kalmaktadır. Dinamik inşaat sektöründe proje müdürleri inşaat firmalarına rekabet avantajı sağlayan bir kaynak olabilir. Proje müdürleri aynı orkestra şefleri gibi projenin amaçlarına ulaşmak için projeye etkisi olan her bir bileşeni çok iyi şekilde koordine etmeleri gerekmektedir. Proje müdürleri projenin belirlenmiş zamanda bitmesi için projenin verimli şekilde yönetilmesini ve proje takımlarının koordinasyonunu sağlamaktadır. Proje başarısı ve kritik başarı faktörleri detaylı incelenerek proje verimliliği artırılması sağlanmaktadır. Proje müdürlerinin performansı proje başarısı üzerinde etkin rol oynaktadığından ötürü proje müdürlerinin etkinliği inşaatta sektöründeki kritik başarı faktörlerinden biridir. Bu çalışmanın iki ana amacı bulunmaktadır, birincisi; Türk inşaat sektöründeki proje müdürlerinin etkinliğinin etkisi, ikincisi ise; kritik başarı faktörlerinin Türk inşaat sektöründe başarıya etkisini araştırmaktır. Çalışmanın amaçlarına ulaşması için proje müdürlerinin etkinliğinde ve proje başarısında etkisi olan girdileri belirlememek adına detaylı kaynak taraması yapılmıştır. Bu girdiler arasındaki ilişki tanımlanmış ve önerilen model Türk inşaat firmalarından edinilen verilerle test edilmiştir. Önerilen modelin geçerliliğini kontrol etmek için Yapısal Eşitlilik Modeli kullanılmıştır. Bu çalışmanın bulgularından yola çıkarak proje müdürlerinin ve kritik başarı faktörlerinin Türk inşaat sektöründeki proje başarısına etkisi irdelenmiştir.

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LIST OF ACRONYMS / ABBREVIATIONS

AGFI	Adjusted Goodness of Fit Index
AMOS	Analysis of Moment Structures
ANOVA	Analysis of Variance
ARKIV	Architectural Archive of Turkey
ATCEA	Association of Turkish Consulting Engineers and Architects
BIM	Building Information Modeling
CFA	Confirmatory Factor Analysis
CFI	Comparative Fit Index
CSFs	Critical Success Factors
df	Degree of Freedom
EVA	Earned Value Analysis
GFI	Goodness of Fit Index
GLM	General Linear Model
GLS	Generalized Least Squares
HSSE	Health, Safety, Security and Environment
IFI	Incremental Fit Index
KPIs	Key Performance Indicators
LSD	Least Significant Difference Test
ML	Maximum Likelihood
NFI	Normed Fit Index
NNFI	Non-normed Fit Index
PMs	Project Managers
RMSEA	Root Mean Square Error of Approximation
SEM	Structural Equation Modelling
TCA	Turkish Contractors Association
TCEA	Turkish Construction Employers Association
TEACI	Association of Construction Industries
TLI	Tucker-Lewis Index
TSLS	Two-Stage Least-Squares

ULS	Unweighted Least-Squares
USD	United Stated Dollar
WLS	Weighted Least-Squares

1. INTRODUCTION

Outline of the study is drawn below sections by summarizing background of the research, indicating determination of problem, stating the problem, referring related studies, establishing the aims and objectives of the research, outlining research method, discussing the scope and limitations, and finally presenting the organization of the study.

1.1. Background of the Research

Today's world is dynamic, changes are happening constantly. Changes in technology, project duration, and project budgets cause more dynamic industries, including construction industry. Construction project participants especially project managers are obliged to deal with all these constantly changing components to reach the project success. All the constant changes make efficiency in project vital for project success. Efficiency of project activities can be improved with examination of project success. Project success is main objective of every construction projects. Although it is crucial for all projects, there is no consensus on its definition. It has different definitions for different people. It is an intangible feeling changes according to people's perspective of success (Parfitt and Sanvido, 1993). According to one perspective, project success is achieved if the project complies with the technical performance specifications 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 client of the project, (Wit, 1986). According to another perspective, 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 (Wuellner, 1990). Understanding from project success can change from person to person, from project to project, and even from time to time. There are two components of project success which are project success criteria and project success factors, (Morris and Hough, 1987; Wateridge, 1998; Turner, 1999; Jugdev and Muller, 2005). Project success criteria have been an inseparable part of project management theory, since the early times of project management theory. In project management literature, project success has been majorly discussed. Project success criteria can be defined as principles or standards can be considered as base of

accomplishment of goals. Navarre and Schaan (1990) stated that measurement of success can be achieved by project performance, cost and duration. Various researchers identified project success as time, cost and quality (Pinto and Slevin, 1987; Belassi and Tukel, 1996; Hatush and Skitmore, 1997; Walker, 1995, 1996; Meredith and Mantel, 2000; Barclay and Osei-Bryson, 2010). These basic project success criteria are named as “iron triangle” by Atkinson (1999). Success criteria and success factors should not be confused. Success factors can affect directly or indirectly to the success of the project or business. On the other hand, success criteria are outcomes of a project which are needed to consider the project a success. Success factors are defined as "success factors are those inputs to the management system that lead directly or indirectly to the success of the project or business" (Cooke and Davies, 2002). Understanding effectiveness of PMs in the Turkish construction industry has become compelling topic since there is small number of studies focuses on it.

1.2. Problem Determination

PMs can be a main source of competitive advantage for construction companies, in today’s dynamic construction industry. PMs are like orchestra chiefs, coordinate constantly changing components of the construction industry to reach project goals. PMs enable more effective project and project team with coordination of project team members to make sure completion of assignments in predetermined time (Gido and Clements, 2003).

The effectiveness of PMs in a construction project is mutually associated project success. In addition, the effectiveness of PMs is itself one of critical success factors in the construction industry. An extensive measurement system for effectiveness of PMs is needed for Turkish construction industry so that parties in the Turkish construction industry understand effects of PMs in the projects.

1.3. Problem Statement

Major part of conducted studies related to project success and critical success factors focus on different types of industries other than construction industry. The ones focus on construction industry take into account only specific countries.

There is a shortage of research on project success and critical success factors of Turkish construction industry. Limited number of research on Turkish construction industry makes it difficult to understand strengths and weaknesses of the industry. Therefore, a comprehensive research on effectiveness of PMs in the Turkish construction industry is needed to understand effects of PMs in the projects and strengths and weaknesses of the industry. This research is based on comprehensive look at on effectiveness of PMs in the Turkish construction industry.

1.4. Related Studies

A main difficulty in evaluating effectiveness of project managers on projects is caused by confusion associated with the definition of project success, definition of effectiveness of project managers and measurement of project success and effectiveness of project managers.

The evaluation of project success and effectiveness of project managers requires a well-organized, systematic, and comprehensive approach. There are studies which investigate project success (Freeman and Beale, 1992; Austeng et al. 2004; Sanvido, Parfitt et al. 1992; Lim and Mohamed, 1999) but there is no complete consensus on definition of project success. It has different definitions for different people. It is an intangible feeling changes according to people's perspective of success (Parfitt and Sanvido, 1993). Understanding from project success can change from person to person, from project to project, and even from time to time.

Additionally, there are studies which investigate effectiveness of project managers (Mustapha Naoum, 1997; Muller and Turner, 2007; Crawford and Lynn, 2000; Clarke and Angela, 1999). There should not be confusion about success criteria and success factors. Outcomes of a project which are needed to consider the project a success are called as success criteria whereas success factors are factor affecting the success of the project directly or indirectly.

Measurement of effectiveness of PMs in the Turkish construction industry has become compelling topic since there is small number of studies focus on it. Combining project

success and effectiveness of project managers and analyzing for Turkish construction industry provides clear view about understanding strengths and weaknesses of the industry.

1.5. Aim and Objectives of the Research

There is lack of research about effects of project managers on project success. This is a contradiction to management literature since effective management is a critical success factor on projects according to management literature. The main objectives of this research are to measure effectiveness of PMs and proportional effects of critical success factors on project success of Turkish construction industry. In order to achieve the target of this research, correlation between components which have effect on effectiveness of PMs and project success will be identified, relationships between them will be validated with the proposed model. The model will be tested based on data collected from Turkish construction companies. Structural equation modeling (SEM) will be used for testing validity of the proposed model. The research will provide clear view about understanding strengths and weaknesses of effectiveness of PMs and proportional effects of critical success factors on project success of Turkish construction industry.

1.6. Research Method

A questionnaire is delivered to engineers and architects who are working in the Turkish construction companies assuming that they have enough knowledge about success of the project and effectiveness of project managers on project success.

Questions of the questionnaire are about general information of the company and the project, critical success factors and success criteria. Questions related to critical success factors are separated three main sections which are project managers' skills and qualities, project characteristics and company specific factors. Questions are designed to analyze effectiveness of company specific factors, project characteristics, project managers' skills and qualities on project success. Structural equation modeling (SEM) is used to test validity of suggested measures for effectiveness of PMs, to test proposed hypotheses among determinants and analyze the influences of them on effectiveness of PMs.

1.7. Scope and Limitations

Limitations of the research are mainly based on data collection process. Firstly, since questionnaire survey is administered to only engineers and architects who are working in the Turkish construction companies not shareholders of the companies, data of the research may not cover shareholders' perspective on effectiveness of PMs in the Turkish construction companies. Secondly, since data collected from engineers and architects who are working in the Turkish construction companies, the data and findings of the research reflect Turkish construction companies. They may not be applicable to construction companies from other countries. Further analysis is needed to understand shareholders' perspective on effectiveness of PMs in the Turkish construction companies and other countries' construction industry. However, conducting such a survey was not included within the scope of this study.

1.8. Organization of Study

The study is composed of five chapter. In the first chapter, information regarding background of the research, problem determination, problem statement, related studies, aims and objectives of research, research method, scope and limitation, and organization of study are discussed. In the second chapter, literature review on definition of project success, project success criteria and critical success factors (CFSs) are discussed. In the third chapter, research methodology is discussed together with presentation of administrated questionnaire survey. In the fourth chapter, analysis results are presented according to findings from proposed model analyzed by AMOS (Analysis of Moment Structures) software. SEM is used to test validity of suggested measures. In the fifth chapter, summary and discussion based on data analysis results are provided. In the sixth chapter, conclusion of the research is presented with major findings of the research, contributions to literature, limitation of the research, recommendation for future studies. In Appendix section of this study, descriptive statistics and correlation matrices are provided.

2. PROJECT SUCCESS

Today's world is dynamic, changes are happening constantly. Changes in technology, project duration, and project budgets cause more dynamic industries, including construction industry. Construction project participants especially project managers are obliged to deal with all these constantly changing components to reach the project success. All the constant changes make efficiency in project vital for project success. Efficiency of project activities can be improved with examination of project success. Project success is main objective of every construction projects. However, the concept of project success has been a vaguely defined topic with lack of consensus since it has different definitions for different people (Liu and Walker, 1998). Although project success is crucial concept for all projects and many definitions exist, there is no consensus on its definition (Jha and Iyer, 2006). It is a frequently discussed concept by various studies through years to be able to define project success. It is an intangible feeling which changes according to people's perspective of success (Parfitt and Sanvido, 1993). Project success is a subjective concept that depends on the perspective of the individual who is assessing that success (Carvalho, 2014). Understanding from project success can change from person to person, from project to project, and even from time to time. It is a complicated task to define project success properly. The concept of "success" and "project success" is a complicated issue (Wideman, 1996). There are two components of project success which are project success criteria and project success factors (Morris and Hough, 1987; Wateridge, 1998; Turner, 1999; Jugdev and Muller, 2005).

Project success is an important concern of in the area of project management and literature. There are major reasons of the concern which are how success can be decided, namely success criteria, and factors affecting success of projects, namely success factors. Literature review of this research covers followings:

- Definition of Project Success.
- Project success criteria.
- Critical success factors (CSFs).

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.” According to Liu et al. (1999), it can have different meanings for different people because of varying perceptions, and results in disagreements about project success. It is remarked that the perception of project success or failure and the expectation on the outcome of the project will be different for everyone (Lim et al, 1999).

The success has been perceived and defined differently by the researchers (Tuman, 1986; Wit, 1986; Ashley et al. 1987; Baker et al. 1988; Pinto and Slevin, 1988; Wuellner, 1990; Parfitt and Sanvido, 1993; Kerzner, 1998). It is remarked by Wit (1986) that a project is considered an overall success if technical performance specification, high level of satisfaction regarding the project’s outcome among clients of the project, key people in the organization and the project team is achieved. Having expected results or having results better than expected in terms of schedule, safety, cost, quality and participant satisfaction referred as project success (Ashley, 1987). If the project meets the technical performance specifications and if there is a high level of satisfaction concerning the project outcome, the project is considered an overall success (Baker et al. 1988). Pinto and Slevin (1988) indicated that a project is considered to be successfully implemented if it is on schedule (time criterion), is on budget (monetary criterion), achieves the goals originally set goals (effectiveness criterion), is accepted and used by the clients for whom the project is intended (client satisfaction criterion). When certain expectations for a participant are met, whether engineer, planner, owner, operator, or contractor, there is project success. Technical, professional, educational, financial, social aspects can be considered among the expectations (Sanvido et al. 1992). 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 (Kerzner, 1998). Chua et al. (1999) came up with a hierarchical model for construction project success.

2.2. Project Success Criteria

Project success criteria have been an inseparable part of project management theory, since the early times of project management theory. In project management literature, project success criteria have been majorly discussed. Project success criteria can be defined as principles or standards that can be considered as base of accomplishment of goals. Definitions of project success criteria deal primarily with the criteria by which project success is judged.

Navarre and Schaan (1990) stated that measurement of success can be achieved by project performance, cost and duration. Various researchers identified project success as time, cost and quality (Pinto and Slevin, 1987; Belassi and Tukel, 1996; Hatush and Skitmore, 1997; Walker, 1995, 1996; Meredith and Mantel, 2000; Barclay and Osei-Bryson, 2010). These basic project success criteria are named as "iron triangle" by Atkinson (1999). The inadequacy of iron triangle is expressed by various researchers (Pinto and Slevin, 1988; Wateridge, 1998; Atkinson, 1999). These basic project success criteria are still considered the standard for measuring project success (Papke-Shields et al. 2010). New dimensions to iron triangle are added by Atkinson (1999) and called as the Square Route criteria. It is a combination of the iron triangle, organizational benefits (efficiency, effectiveness, profits and strategic goals) shareholder benefits (satisfied users, social and environmental impact and personal development) and the information system (maintainability, reliability, and information quality). Parfitt and Sanvido (1993) stated different perspectives of individuals and the goals related to a variety of elements should be taken into account when measuring success. In addition to iron triangle criteria, Kometa et al. (1995) mentions that project success measures should include safety. If project is completed on time, on budget, on expected quality, proper to required specifications, and satisfying expectations, it can be considered as successful, (Songer and Molenaar, 1997). Several criteria to evaluate a project listed by Sidwell, (1983) which are cost, time, function, aesthetics, clients' satisfaction, quality and team members relation. Pinto and Slevin (1988) agreed with criteria suggested by Sidwell (1983) and emphasize on customer satisfaction for project evaluation. Seven main criteria used to measure project success identified by Freeman and Beale (1992) which are managerial and organizational implications, technical performance, business

performance, efficiency of execution, manufacturers ability and personal growth. Shenhar et al. (1997) mentioned that two components of project success are important to understand in order to measure success, which may include product success or project management success or both. Product success is concerned with the projects external effectiveness whereas project management success is concerned as projects internal effectiveness and measured in terms of cost, time and quality. Various definitions of project success are suggested by other researchers (Atasoy, 2007), these are as follows:

- Having everything turned as hoped…. anticipating all projects requirements and have sufficient resources to meet needs in a timely manner (Tuman, 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 (Wit, 1986).
- Having results much better than expected. Results much better than expected or normally observed in terms of cost, schedule, quality, safety and participant satisfaction (Ashley et al. 1987).
- 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 co-partner 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 (Baker et al. 1988).
- A project is 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), (Pinto and Slevin, 1988).
- 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 (Wuellner, 1990).

- 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 (Parfitt and Sanvido, 1993).
- For project success determination, Kumaraswamy and Thorpe (1996) considered a variety of criteria; meeting budget, schedule, quality of workmanship, client and project manager's satisfaction, transfer of technology, friendliness of environment, health and safety.
- Project success is stated in terms of five factors which are 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 (Kerzner, 1998).
- Collins and Baccarini (2004) analyzed different industries in terms of success criteria. The difference among industries in terms of success criteria was little. In addition, they found that decrease in cost and duration is more important for contractors in the construction industry than clients who are put more emphasis to shareholders` satisfaction. Study of Bryde and Robinson (2005) showed similar results to study of Collins and Baccarini (2004) by indicating there is different emphasis on success criteria between construction industry clients and contractors.

Westerveld (2003) analysis showed that there is a relation between project types, success criteria, and critical success factors. Studies on project success should not only focus on project efficiency and the fulfilment of project goals, but it should also consider project effectiveness (Deák, 2006; Szabó and Gaál, 2006).

Project success criteria cited by various researchers generally include time, cost, quality, health and safety, satisfaction of users and project participants. These are explained below paragraphs.

Time as success criteria means duration for project completion. Hatush and Skitmore, (1997) mentions from time as it is scheduled date to make sure constructed building can be

set at the scheduled date. Chan (1997) and Naoum (1994) suggest that speed of construction, construction time, and time variation can be classified under time criterion.

Cost or budget as success criteria means money spent for completion of project with required specification (Bubashait and Almohawis, 1994). If it is under or equal to estimated budget of the project, the project can be counted as successful one in terms of cost project success criteria. Cost does not include only sum of contract amount, it includes every cost incurs until completion of project which can be cost of design changes, variation orders, legal payments, and any other cost.

Health and safety as success criteria means completion of project with taking precautions to prevent major accidents and injuries (Bubshait and Almohawis, 1994). Safety as success criteria mentioned by various researchers (Sanvido et al. 1992; Parfitt and Sanvido, 1993; Kometa et al. 1995).

Quality as success criteria is somewhat more subjective than others. It can be defined as providing product or services with required features to meet specifications and satisfy requiring party (Parfitt and Sanvido, 1993; Songer et al. 1996; and Wateridge, 1995). Definition of technical performance is extended to quality and scope by Freeman and Beale (1992). Therefore, technical specification can be classified under quality criterion as per their study.

Users are the ones who can actually test final products. Their satisfaction is crucial for projects. Consideration of users` satisfaction is linked to success, (Liu and Walker, 1998). In addition, Torbica and Stroh (2001) provided that project can be accepted as successful if users are satisfied.

Addition to users` satisfaction, participants' satisfaction is cited as one of important success criteria (Sanvido et al. 1992; Parfitt and Sanvido, 1993; Cheung et al. 2000). Every party in project can be classified as project participants, which includes client, project team members, contractors and subcontractors. Satisfaction of every party is also related success.

Project success criteria and critical success factors (CSFs) are different from each other. Success criteria are the measures which success or failure of a project will be judged based on whereas success factors are inputs of the project that lead directly or indirectly to the success of the project (Cooke and Davies, 2002). In construction projects, seven critical success factors and six project success criteria are identified (Ashley, 1986; Wit, 1988). These critical success factors are planning effort in design, planning effort in construction, project manager technical capabilities, project manager goal commitment, project team motivation, scope and work definition and control systems. The six project success criteria are schedule performance, functionality, budget performance, client satisfaction, contractor satisfaction and project manager/team satisfaction.

Project success criteria is widely studied concept among researchers in which researchers look at project success criteria from different perspectives and come up with different conclusions. In the questionnaire of this research, included Project success criteria is as follows:

- Time performance
- Quality performance
- Cost performance
- HSSE performance
- End-user and customer satisfaction from end-product
- Satisfaction of project team members and co-partners

2.3. Critical Success Factors

Success criteria and success factors should not be confused. Success criteria and success factors are different from each other. Success factors are the factors that affect the success of the project or business directly or indirectly. On the other hand, success criteria are outcomes of a project which are needed to be achieved to consider the project a success. Success factors can be defined as the factors are those inputs to the management system which lead directly or indirectly to the success of the project or business (Cooke and Davies, 2002).

Various definitions of critical success factors are suggested by other researchers (Atasoy, 2007), these are as follows;

- Those few areas of activities in which favorable results are absolutely necessary for a particular manager to reach his or her goals (Rockart, 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 (Ferguson and Dickinson, 1982).
- 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 (Boynton and Zmund, 1984).
- Critical success factors are defined as those factors predicting success on projects (Sanvido et al. 1992).
- Critical success factors are those needed to produce the desired deliverables for the customer. Critical success factors measure end results (Lim and Mohamed, 1999).
- 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 (Ghost et al. 2001).
- Milosevic and Patanakul (2005) defined the critical success factors as characteristics, conditions, or variables that can have a significant effect on project success.
- Critical success factors require constant attention to guarantee a strong possibility of project success. If these factors are not taken seriously, it could cause the failure of a project (Kandelousi et al, 2011).

Identification of success factors are useful to analyze the reasons for project success and failure. Many theoretical and empirical studies have been completed on project success factors are studied theoretically and empirically by many researchers since 1960s. Daniel

(1961) was the first to introduce the concept of CSFs. A study about the impact of a project managers experience on the project's success and failure conducted by them and they reached conclusion that previously managed projects' sizes have more affect than project manager's previous experience. The studies on success factors provided invaluable knowledge on factors which are crucial for project success.

Ruben and Seeling (1967) suggested that technical performance as a measure of success project manager's experience has minimal impact but the size of previously managed project does affect the project manager's performance.

Hayfield (1969) proposed two sets of success factors and named them micro and macro factors. The micro factors consist of clear and simple project organization and project policies, efficient management controls, selection of key personnel, and trustworthy management information systems. The macro factors consist of crystal clear definition of the project, project environment, selection of project team members and efficient project execution.

Avots (1969) identified wrong unsupportive top management, choice of project managers and unplanned project termination are the main reasons for the failure of a project.

Sayles and Chandler (1971) proposed critical success factors in terms of project managers` perspective which are project manager`s competence, monitoring and feedback, control systems and responsibilities, scheduling, and continuous involvement in the project.

Baker et al. (1974) conducted one of the most extensive and authoritative research on success factors using a sample of 650 completed aerospace, construction and other projects with data provided mainly by project managers. Their work has been cited and used in the majority of subsequent research papers concerning project success.

Critical success factors according to Martin (1976) are clear goals, selection of project organizational philosophy, selection of project team, general management support, planning reviews and information mechanism and organize and delegate authority.

Cleland and King (1983) proposed success factors as operational concept, top management support, financial support, logistic requirements, facility support, market intelligence, project schedule, executive development and training, manpower and organization, acquisition, information and communication channels, and project review.

Cleland and King (1983) suggested following critical success factors project summary, operational concept, top management support, financial support, logistic requirements, project schedule, manpower and organization, information and communication channel.

Proposed success factors by Baker et al. (1983) are clear goals, commitment of project team, project team capability, planning and control techniques, and absence of bureaucracy. Critical success factors as project objectives, top management support, urgency of project, project control, communication and problem handling are mentioned in articles of Pinto and Slevin (1987) and Morris and Hough (1987).

Might and Fischer (1985) proposed level of authority delegated to the project manager, organizational structure and project size as success factors.

Hughes (1986) emphasize on improper managerial principles as success factors and listed those improper principles as rewarding the wrong actions, improper focus of the management system and lack of communication of goals.

Pinto and Slevin (1987) suggested clear project objectives, top management support, project planning, communication with client, human relations, technical tasks, client acceptance, project control, communication and problem handling.

Morris and Hough (1987) proposed nine success factors of a project which are clear technical uncertainty innovation, community involvement, project objectives, politics, finance, legal agreement, schedule duration urgency, contracting and solving of problems.

Ashley (1986), Wit (1988), and Anton (1988) proposed success factors which are very similar to each other although they are different studies. These factors are planning effort in

design and construction, project manager's goal commitment, project team motivation, project manager technical capabilities, scope and work definition and control systems.

Sanvido et al. (1992) proposed four critical success factors for building construction projects. These factors are team spirit without conflicts, a well-organized and cohesive facility team, experience in various aspects of similar projects and reliable optimization information from related parties during planning and design phases.

Tukel and Rom (1995) and Pinto and Kharbanda (1995) both emphasized on top management support, client consultation, and preliminary estimates. According to literature, CSFs can be divided to 5 main categories which are project participants related factors, project related factors, project management factors, project procedures, and external factors.

Walid and Oya, (1996) proposed factors related to the project, the project manager and the team members, the organization, and the external environment.

Belassi and Tukel (1996) suggested to divide success factors into four main groups. These groups consist of factors related to project, project managers, external environment and organization.

Fortune and White (2006) proposed a list of twenty-seven critical factors, where the most cited was top management support, cited by 39 references (62%) (Berssaneti and Carvalho; 2015). Top management support is mainly related to project success (Kandelousi et al. 2011; Rauniar and Rawski, 2012).

Problem solving, clear objectives, the feasibility, detailed project planning and control, the management of human resources, effective and committed leadership, the handling of relationships and good communication with stakeholders as key factors of success (Waeffler and Pfister, 2008; Rofner, 2009). Project team management, communication and leadership style of project manager, leadership style are project success factors in the industries of manufacturing, building, industry and infrastructure (Yang et al. 2011).

Pinto and Slevin (1998) identified ten critical success factors. These are project mission, project schedules, client consultation, technical tasks, client acceptance, monitoring and feedback, communication, trouble-shooting, management support, personnel. Hartman and Ashrafi, 2002, proposed a similar list of ten success factors for information systems projects. These factors are presented in table below which is adjusted from Belout and Gauvreau (2003).

Table 2.1. Pinto and Slevin's ten critical success factors.

Success Factors	**Explanation**
Project mission	Initial clarity of objectives and general directions
Project schedule	A detailed specification of the individual action steps required for project implementation
Client consultation	Communication and consultation listening to all parties involved
Technical tasks	Availability of the required technology and expertise to accomplish the specific technical action steps
Client acceptance	The act of "selling" the final projects to their ultimate intended users
Monitoring and feedback	Timely provision of comprehensive control information at each stage in the implementation process
Communication	The provision of an appropriate network and necessary data to all key actors
Troubleshooting	Ability to handle unexpected crises and deviations from plan
Management support	Willingness of top management to provide the necessary resources and authority/power for project success
Personnel	Recruitment, selection and training of the necessary personnel for the team

3. RESEARCH METHODOLOGY

Literature has been reviewed regarding project success and project manager's effect on project success. It is realized that various success factors and success criteria exist, and they differ according to researchers. It is vital to combine success factors and success criteria according to literature review. Main objective of the research is to understand effectiveness of project managers in the Turkish construction industry.

3.1. Project Success Measurement Framework

A questionnaire survey was conducted to examine the relationship between project manager's skills and qualities, project characteristics, company specific factors and project success. Questionnaire survey is prepared based on literature review. Every research read in related concept is noted on few points in terms of effectiveness of project managers, project characteristics and company specific factors in the construction industry. Those points were taken to summary tables, Table 3.1, Table 3.2, Table 3.3, and Table 3.4, and marked in which article they are mentioning and how many times in total. The summary tables showed that some of the points are mentioned in articles more than others which show they are more effective on effectiveness of project managers, project characteristics and company specific factors in the construction industry. Those factors are included in the questionnaire survey. Also, similar meaning items in the table are combined since if they are included as separate items could confuse responders' mind. The detail of the process will be discussed in following chapters.

After finalizing questionnaire survey according to literature review, a pilot study was carried out to make sure the clarity and relevance of the questionnaire. The questionnaire was sent to few engineers and architects who have work experience in the Turkish construction companies to find out questions are clear enough for responders. According to their feedback, revisions are done on expression of questions with simple and easily understandable words. Finally, the questionnaire survey forms were sent to various Turkish construction companies. The respondents were asked to evaluate the project success based

on listed variables using a 1–5 point Likert scale [(1) very low, (2) low, (3) medium, (4) high, and (5) very high]. Survey forms only delivered to engineers and architects who have completed at least one project in one of Turkish construction companies assuming that they have enough knowledge about success of the project and effectiveness of project managers on project success, since the objective of research is to examine Turkish construction industry in terms of effectiveness of project managers. Among the participants, there are engineers and architects who have experience in various projects from construction of airports, hospitals, roads and viaducts to hydroelectric power plants. Their work description includes from project managers, construction works chiefs, design managers, finishing architects, site engineers to designers. 80 of delivered survey forms completed out of 307 sent out, response rate was 26%. Data collected from survey are used for analysis. Structural equation modeling (SEM) is used as modeling tool which is used to determine whether a certain model is valid, instead of finding a suitable model. Model specification, model identification, test of model fit, and model modification are the steps of structural equation model construction, respectively. There are many excellent SEM software programs, including LISREL, SIMPLIS, SAS CALIS, AMOS, and EQS. In this research, AMOS (Analysis of Moment Structures) is used since it is a user-friendly program and it is easy to follow the processes.

3.2. Questionnaire Survey

Questionnaire survey method which is one of quantitative research methods is used for this research. It emphases on analyses of the data with the help of statistics. Given (2008) stated that questionnaire survey method is the systematic empirical investigation of observable phenomena via statistical, mathematical or numerical data or computational techniques. It focuses on analysis of interrelationship between variables, not process (Denzin and Lincoln, 1998).

Deciding data collection methods, general profile of Turkish construction companies is investigated. Since objective of this research to find out effectiveness of PMs in the Turkish construction industry, it is important to include Turkish construction companies working in Turkey and abroad. Therefore, according to investigation made for data

collection methods, it is decided that online questionnaire will be more efficient and effective way to collect data. The questionnaire was conducted via e-mail to engineers and architects who have completed at least one project in one of Turkish construction companies assuming that they have enough knowledge about success of the project and effectiveness of project managers on project success. Questionnaire survey is filled out by 80 engineers and architects out of 307 sent out.

3.3. Content of the Questionnaire

Questions of the questionnaire are about general information of the company and the project, critical success factors and success criteria. Questions related to critical success factors are separated three main sections which are project managers' skills and qualities, project characteristics and company specific factors. Questions are designed to analyze influence of company specific factors, project characteristics, project managers' skills and qualities on project success.

3.3.1. General Information about the Company and the Project

This section of the questionnaire is designed to get general information about the company and the project to generate general profile of the companies and the projects. Following information is requested in questionnaire for general information:

- Area of expertise of the company.
- Experience of the company in the construction industry.
- Annual turnover of the company.
- Type of the project client.
- Type of the project.
- Actual project duration, in terms of years.
- Total project value, in terms of USD.
- Company status in the project.
- Responders' position in the project.
- Contract type of the project.

3.4. Determinants of Project Success

Determinants of project success, project managers' skills and qualities, project characteristics, and company specific factors are discussed in this section of the study.

3.4.1. Project Managers' Skills and Qualities

This section of the questionnaire is designed according to literature review to get information about level of project managers' skills and qualities to generate general profile of project managers. According to reviewed 31 studies, each item regarding project managers' skills and qualities are marked for each reviewed study. It is realized that some of the items are mentioned in articles more than others which show they are more effective on effectiveness of project managers in the construction industry. Those factors are included in the questionnaire survey. Also, similar meaning items in the table are combined since including them as separate items could confuse responders' mind.

The detail of literature review related to project managers' skills and qualities is shown in Table 3.1. The respondents were asked to evaluate the project managers' skills and qualities based on listed variables using a 1–5 point Likert scale [(1) very low, (2) low, (3) medium, (4) high, and (5) very high]. Followings are the listed variables in questionnaire about level of project managers' skills and qualities:

- PM1: Leadership and strategic decision making skills of PMs.
- PM2: Planning, monitoring and management efficiency of PMs.
- PM3: Communication and social interaction of PMs.
- PM4: Innovative and opportunity seeker PMs.
- PM5: Technical experience level of PMs.
- PM6: Responsibility and commitment of PMs.
- PM7: Effective project team selection and effective team members management of PMs.
- PM8: Clear project policies of PMs.
- PM9: Top management handling of PMs.

Table 3.1. Literature review on project managers' skills and qualities.

Literature Sources	**PM1**	**PM2**	**PM3**	**PM4**	**PM5**	**PM6**	**PM7**	**PM8**	**PM9**
1-Razak et al. (2009)	x	x	x	x	x	x	x	x	
2-Atasoy, (2007)	x	x	x	x		x		x	
3-Belout and Gauvreau, (2001)		x	x						
4-Zavadskas et al. (2010)	x		x	x	x				
5-Pheng and Chuan, (2004)	x		x				x	x	
6-Ogunlana et al. (2000)	x	x	x		x	x			
7-Dainty et al. (2010)	x	x				x	x		
8-Crawford, (2000)	x	x	x		x		x	x	x
9-Turner and Müller, (2005)	x	x	x	x	x		x	x	
11-Nguyen et al. (2004)	x	x		x	x	x	x		
12-P.C. Chan et al. (2004)									
13-Odusami et al. (2001)	x	x	x		x		x		
14-Bryde and Robinson, (2005)		x	x		x	x			x
15-Wang and Huang, (2005)	x	x				x			x
16-Turner and Müller, (2006)	x	x	x	x		x			
17-Turner and Müller, (2009)	x	x	x	x					
18-Turner and Müller, (2007)	x	x	x		x	x		x	x
19-Hughes et al. (2004)					x				
20-Litsikakis, (2006)	x		x	x		x	x		x
21-Torp et al. (2005)		x		x	x	x		x	x
22-Camilleri, (2011)		x				x		x	
23-Ahadzie et al. (2007)	x	x							
24-Fotwe and Mccaffer, (2000)	x	x	x		x		x	x	
25-Chuan and Pheng, (2006)	x	x				x		x	
26-Liu et al. (2002)	x	x	x			x	x	x	x
27-Mustapha and Naoum, (1998)	x	x			x	x	x		
28-Arditi et al. (2008)	x								
29-Chen and Partingon, (2005)	x	x	x		x		x		
30-Iyer and Jha, (2005)	x	x	x		x		x	x	x
31-Yang et al. (2011)	x		x				x		

3.4.2. Project Characteristics

This section of the questionnaire is designed to get information about level of project characteristics to generate general profile of projects. According to reviewed 31 studies, each item regarding project characteristics are marked for each reviewed study.

After comprehensive literature study, it is realized that some of the items are mentioned in articles more than others which show they are more effective on effectiveness of project characteristics in the construction industry. Those factors are included in the questionnaire survey.

The included factors are cooperation and performance level, clarity of project objectives, completeness of contract, completeness of design, performance of other parties, relative significance of project, time limitation, and quality requirements.

In addition, similar meaning items in the table are combined since including them as separate items could confuse responders' mind. The detail of literature review related to project characteristics is shown in Table 3.2.

The respondents were asked to evaluate the project characteristics based on listed variables using a 1–5 point Likert scale [(1) very low, (2) low, (3) medium, (4) high, and (5) very high]. Followings are the listed variables in questionnaire about level of project characteristics:

- PC1: Cooperation and performance level in the project.
- PC2: Clarity of project objectives.
- PC3: Completeness of contract.
- PC4: Completeness of design.
- PC5: Performance of other parties in the project.
- PC6: Relative significance of project.
- PC7: Time limitation in the project.
- PC8: Quality requirements of the project.

Table 3.2. Literature review on project characteristics.

Literature Sources	**PC1**	**PC2**	**PC3**	**PC4**	**PC5**	**PC6**	**PC7**	**PC8**
1-Razak et al. (2009)		x					x	
2-Atasoy, (2007)	x		x		x			x
3-Belout and Gauvreau, (2001)	x				x		x	
4-Zavadskas et al. (2010)								
5-Pheng and Chuan, (2004)	x				x		x	x
6-Ogunlana et al. (2000)								x
7-Dainty et al. (2010)				x			x	x
8-Crawford, (2000)								
9-Turner and Müller, (2005)	x				x			
10-Chan et al. (2004)	x			x	x			
11-Nguyen et al. (2004)	x	x	x		x		x	x
12-P.C. Chan et al. (2004)	x		x		x		x	x
13-Odusami et al. (2001)				x				
14-Bryde and Robinson, (2005)							x	x
15-Wang and Huang, (2005)							x	x
16-Turner and Müller, (2006)	x		x		x			
17-Turner and Müller, (2009)			x				x	x
18-Turner and Müller, (2007)			x			x	x	x
19-Hughes et al. (2004)							x	x
20-Litsikakis, (2006)	x		x		x	x	x	x
21-Torp et al. (2005)	x		x	x	x			
22-Camilleri, (2011)			x			x		
23-Ahadzie et al. (2007)							x	x
24-Fotwe and Mccaffer, (2000)			x				x	x
25-Chuan and Pheng, (2006)	x	x	x		x	x	x	x
26-Liu et al. (2002)	x				x		x	x
27-Mustapha and Naoum, (1998)	x		x		x			
28-Arditi et al. (2008)							x	x
29-Chen and Partingon, (2005)	x			x	x			
30-Iyer and Jha, (2005)	x			x	x			
31-Yang et al. (2011)	x				x		x	x

3.4.3. Company Specific Factors

This section of the questionnaire is designed to get information about company specific factors to generate general profile of companies. According to reviewed 31 studies, each item regarding company specific factors are marked for each reviewed study. It is realized that some of the items are mentioned in articles more than others which show they are more effective on effectiveness of company specific factors in the construction industry. Those factors are included in the questionnaire survey. The included factors are communication with other project participants, communication with authorities, top management support to the actions of PMs, planning, monitoring and management efficiency of company, project participants consultation and troubleshooting ability of company, clear project objectives and policies of company, financial management and solid economic structure of company, human resources management of company, technology utilization for reliable information, communication, and monitoring systems, clear and simple organizational structure of company, experience in similar projects. Moreover, similar meaning items in the table are combined since including them as separate items could confuse responders' mind. The detail of literature review related to company specific factors is shown in Table 3.3. It is asked to evaluate the company specific factors based on listed variables using a 1–5 point Likert scale [(1) very low, (2) low, (3) medium, (4) high, and (5) very high]. Followings are the listed variables in questionnaire about level of about company specific factors:

- CS1: Communication with other project participants.
- CS2: Communication with authorities.
- CS3: Top Management support to the actions of PMs.
- CS4: Planning, monitoring and management efficiency of company.
- CS5: Project participants consultation and troubleshooting ability of company.
- CS6: Clear project objectives and policies of company.
- CS7: Financial management and solid economic structure of company.
- CS8: Human resources management of company.
- CS9: Technology utilization for reliable information, communication, and monitoring.
- CS10: Clear and simple organizational structure of company.
- CS11: Experience in similar projects.

Table 3.3. Literature review on company specific factors.

Literature Sources	**CS1**	**CS2**	**CS3**	**CS4**	**CS5**	**CS6**	**CS7**	**CS8**	**CS9**	**CS10**	**CS11**
1-Razak et al. (2009)									x		
2-Atasoy, (2007)			x	x	x		x			x	x
3-Belout and Gauvreau, (2001)	x		x	x	x	x		x	x		
4-Zavadskas et al. (2010)				x	x		x		x		
5-Pheng and Chuan, (2004)	x		x	x	x		x	x		x	x
6-Ogunlana et al. (2000)	x										x
7-Dainty et al. (2010)	x	x	x	x				x			
8-Crawford, (2000)	x		x	x		x				x	
9-Turner and Müller, (2005)	x		x	x	x			x	x		
10-Chan et al. (2004)	x			x	x			x	x	x	x
11-Nguyen et al. (2004)	x		x	x	x	x			x	x	x
12-P.C. Chan et al. (2004)											
13-Odusami et al. (2001)								x			
14-Bryde and Robinson, (2005)				x		x		x	x	x	
15-Wang and Huang, (2005)		x	x	x		x			x	x	
16-Turner and Müller, (2006)	x	x		x	z						
17-Turner and Müller, (2009)	x			x		x			x	x	
18-Turner and Müller, (2007)	x									x	
19-Hughes et al. (2004)				x	x	x	x	x	x		
20-Litsikakis, (2006)	x		x					x	x		
21-Torp et al. (2005)	x		x	x	x			x	x	x	
22-Camilleri, (2011)				x	x	x	x		x		
23-Ahadzie et al. (2007)				x	x		x		x		
24-Fotwe and Mccaffer, (2000)	x										
25-Chuan and Pheng, (2006)			x	x	x	x		x	x	x	
26-Liu et al. (2002)	x										
27-Mustapha and Naoum, (1998)			x								
28-Arditi et al. (2008)	x			x	x	x	x	x	x		x
29-Chen and Partingon, (2005)	x										
30-Iyer and Jha, (2005)			x	x		x	x		x	x	
31-Yang et al. (2011)	x							x			

3.5. Indicators of Project Success

This section of the questionnaire is designed to get information about project success to generate general profile of success criteria. According to reviewed 31 studies, each item regarding indicators of project success, project success criteria, are marked for each reviewed study.

It is realized that some of the items are mentioned in articles more than others which show they are more important indicators on project success performance in the construction industry. Those indicators are included in the questionnaire survey.

The included indicators are time performance, quality performance, cost performance, HSSE performance, end-user and customer satisfaction from end-product, and satisfaction of project team members and co-partners.

Also, similar meaning items in the table are combined since including them as separate items could confuse responders' mind. The detail of literature review related to the indicators of project success is shown in Table 3.4.

The respondents were asked to evaluate the indicators of project success based on listed variables using a 1–5 point Likert scale [(1) very low, (2) low, (3) medium, (4) high, and (5) very high].

Followings are the listed variables in questionnaire about level of about indicators of project success:

- PS1: Time performance.
- PS2: Quality performance.
- PS3: Cost performance.
- PS4: HSSE performance.
- PS5: End-user and customer satisfaction from end-product.
- PS6: Satisfaction of project team members and co-partners.

Table 3.4. Literature review on project success criteria.

Literature Sources	**PS1**	**PS2**	**PS3**	**PS4**	**PS5**	**PS6**
1-Razak et al. (2009)	x	x	x		x	
2-Atasoy, (2007)	x	x	x	x	x	x
3-Belout and Gauvreau, (2001)	x	x	x		x	
4-Zavadskas et al. (2010)						
5-Pheng and Chuan, (2004)	x	x	x		x	x
6-Ogunlana et al. (2000)	x	x	x		x	x
7-Dainty et al. (2010)	x	x	x	x	x	x
8-Crawford, (2000)						
9-Turner and Müller, (2005)						
10-Chan et al. (2004)						
11-Nguyen et al. (2004)	x	x	x		x	x
12-P.C. Chan et al. (2004)	x	x	x	x	x	x
13-Odusami et al. (2001)						
14-Bryde and Robinson, (2005)	x	x	x		x	
15-Wang and Huang, (2005)	x	x	x	x	x	
16-Turner and Müller, (2006)	x	x	x		x	x
17-Turner and Müller, (2009)	x	x	x		x	x
18-Turner and Müller, (2007)	x	x	x		x	x
19-Hughes et al. (2004)	x	x	x	x		
20-Litsikakis, (2006)	x	x	x		x	
21-Torp et al. (2005)						
22-Camilleri, (2011)	x	x	x		x	
23-Ahadzie et al. (2007)	x	x	x	x	x	
24-Fotwe and Mccaffer, (2000)	x	x	x	x		
25-Chuan and Pheng, (2006)	x	x	x		x	x
26-Liu et al. (2002)	x	x	x			
27-Mustapha and Naoum, (1998)						
28-Arditi et al. (2008)	x	x	x	x		
29-Chen and Partingon, (2005)						
30-Iyer and Jha, (2005)						
31-Yang et al. (2011)	x	x	x			x

3.6. Hypotheses of the Research

Previous studies on the subject are investigated in detail and important points of the studies are included in summary tables, Table 3.1, Table 3.2, Table 3.3, and Table 3.4, to make sure the most frequently mentioned points are investigated in the research. Several interrelations are detected, and more dominant relations are emphasized. Total of six hypotheses are constructed regarding the proposed model to measure effectiveness of project managers in construction projects based on expert opinions and review of literature. Three of the hypotheses are based on the relationship between the determinants and the performance construct. Three of the hypotheses are based on interrelationships among the determinants of performance. Based on heavily investigated relations in literature, the following hypotheses are developed:

- H1: Effectiveness of "Project Managers' Skills and Qualities" has a direct and positive effect on project success.
- H2: Effectiveness of "Project Characteristics" has a direct and positive effect on project success.
- H3: Effectiveness of "Company Specific Factors" has a direct and positive effect on project success.
- H4: Effectiveness of "Project Characteristics" has a direct and positive effect on "Project Managers' Skills and Qualities".
- H5: Effectiveness of "Company Specific Factors" has a direct and positive effect on "Project Managers' Skills and Qualities".
- H6: Effectiveness of "Company Specific Factors" has a direct and positive effect on "Project Characteristics".

4. ANALYSIS OF THE PERFORMANCE MODEL

The statistical analysis of the collected data from Turkish construction companies will be explained in this this chapter. Target construction companies are chosen from the Turkish Construction Employers Association (TCEA) Turkish Contractors Association (TCA), and Association of Turkish Consulting Engineers and Architects (ATCEA). A total of 80 completed questionnaires were returned out of 307 sent out, response rate was 26%. The questionnaire was conducted via e-mail to Turkish construction companies, respondents were asked to fill in the questionnaires based on the project management performance of their completed projects. At this chapter of the study, statistical findings will be summarized, and descriptive statistics will be mentioned (Descriptive statistics including the mean, standard error, median, standard deviation, sample variance, kurtosis, skewness, range, minimum, and maximum values etc. can be found in Appendix B). Moreover, literature based on Analysis of Variance (ANOVA) and structural equation modelling (SEM) will be studied comprehensively. The data will be analyzed with Analysis of Variance (ANOVA) and the model will be analyzed with SEM.

4.1. Descriptive Statistics

Within this study, 80 responses are collected from 38 construction companies. The questionnaire is composed of a total of 44 questions. The first step in the analysis of these data is to search for some descriptive statistics, to identify the general characteristics of the companies and to recognize the overall view of the respondent companies and the projects. The following section discusses the descriptive statistics about the characteristics of the companies and the projects.

4.1.1. General Information about the Respondent Companies

Demographic information regarding the respondent companies indicates some facts about the general profile of the companies participated in the survey. Figures below provide some important information regarding the profile of respondents and project characteristics.

- Type of Business Area.

Figure 4.1 shows the distribution of companies in terms of their business area. According to this figure, respondent companies have expertise mainly on contractors/subcontractors (76%), while small portion consists of investor (13%), project management/consultancy (6%) and designers (5%).

Distribution of types of business area is as follows; 61 of responders are working in companies which act as prime contractor or subcontractor, 10 of them are working in companies act as investor, 5 of them are working in companies act as project consultant or project management company, 4 of them are working in companies act as designer in projects.

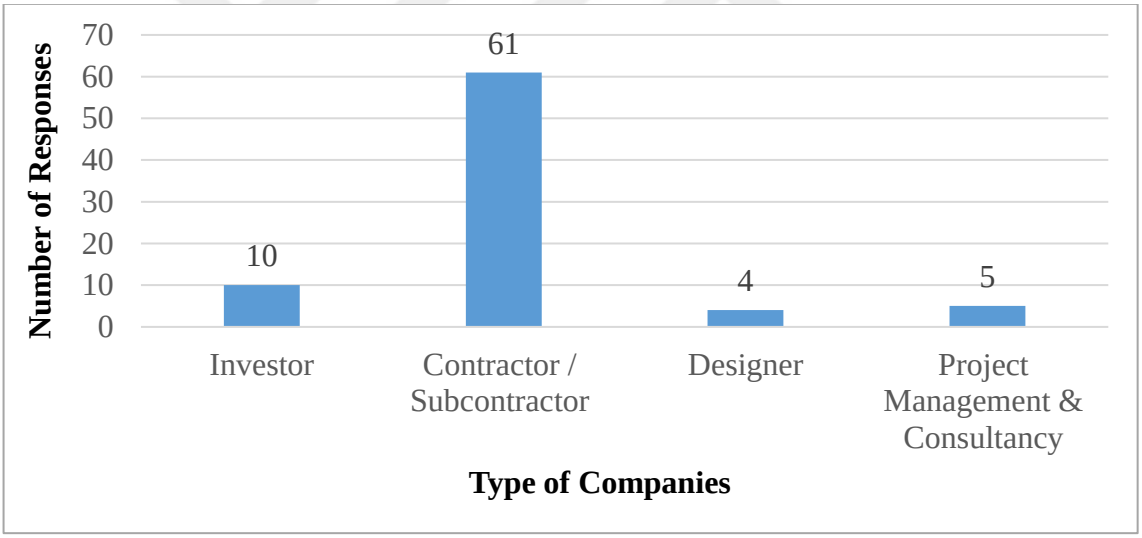

Figure 4.1. Distribution of companies in terms of their business area.

- Number of years of operation in construction sector.

The average age of the respondent companies is 17.19 years. The maximum age is found to be 39 years and minimum to be 1.

The distribution of the average ages of the respondent companies based on their types can be seen in Figure 4.2.

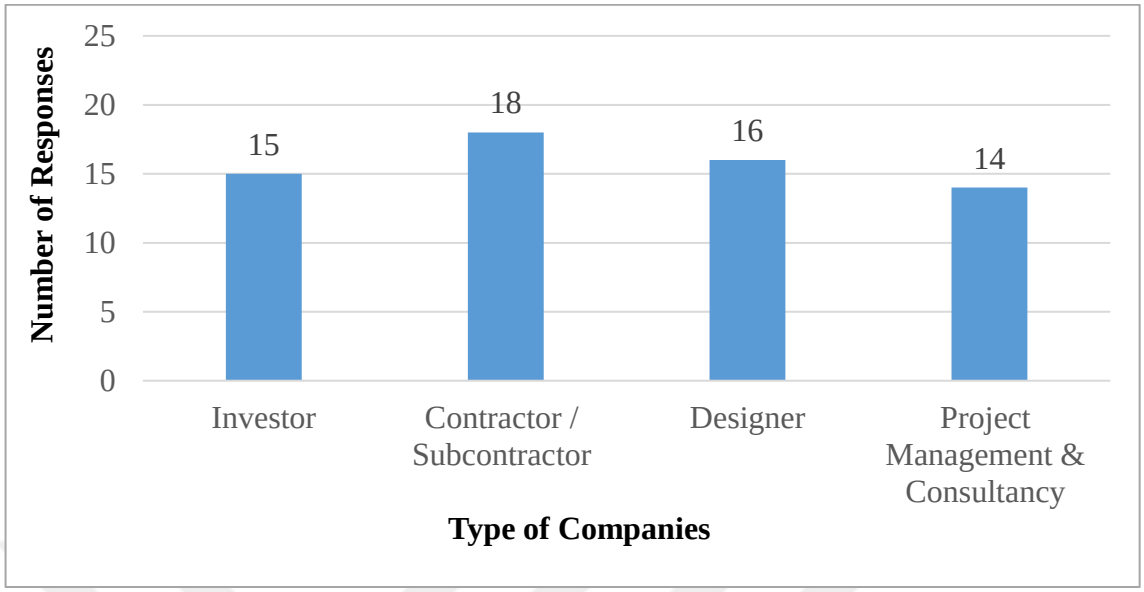

Figure 4.2. Distribution of companies in terms of company age.

Figure 4.3 shows the distribution of companies' ages. It is provided that majority of the responding companies have 11-20 years of experience in the Turkish construction industry. Distribution of companies' experiences in construction industry is as follows; 50 of them have 11-20 years of experience, 17 of them have 0-10 years of experience, 9 of them have 21-30 years of experience, and 4 of them have 31-40 years of experience.

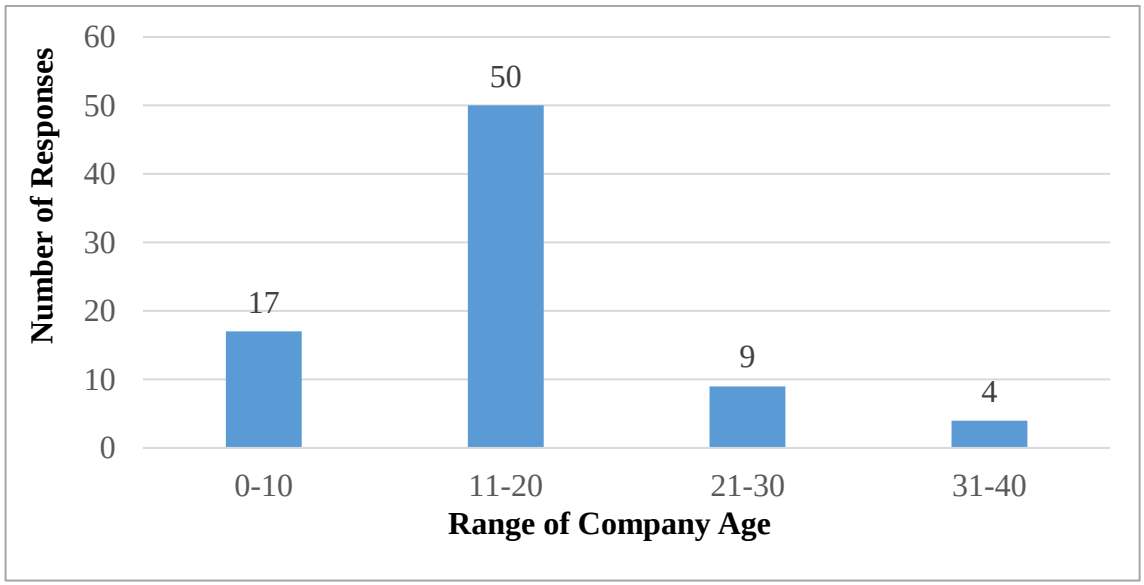

Figure 4.3. Distribution of company age ranges.

- Total turnover.

The average annual turnover of the respondent companies is 523 million USD and the maximum value for turnover is 3.5 billion USD. Figure 4.4 shows average turnover of the responding companies. According to this figure, it is seen that majority of responding companies have average turnover of 671 million USD. Figure 4.5 shows turnover range of the responding companies. According to this figure, it is seen that majority of responding companies have the turnover range of 0-200 million USD.

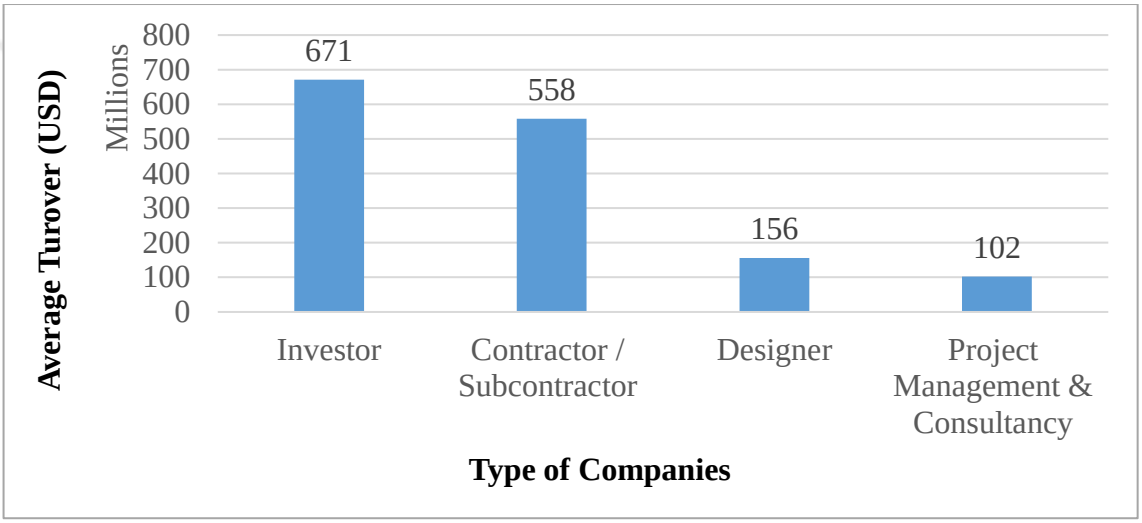

Figure 4.4. Distribution of company types in terms of annual turnover.

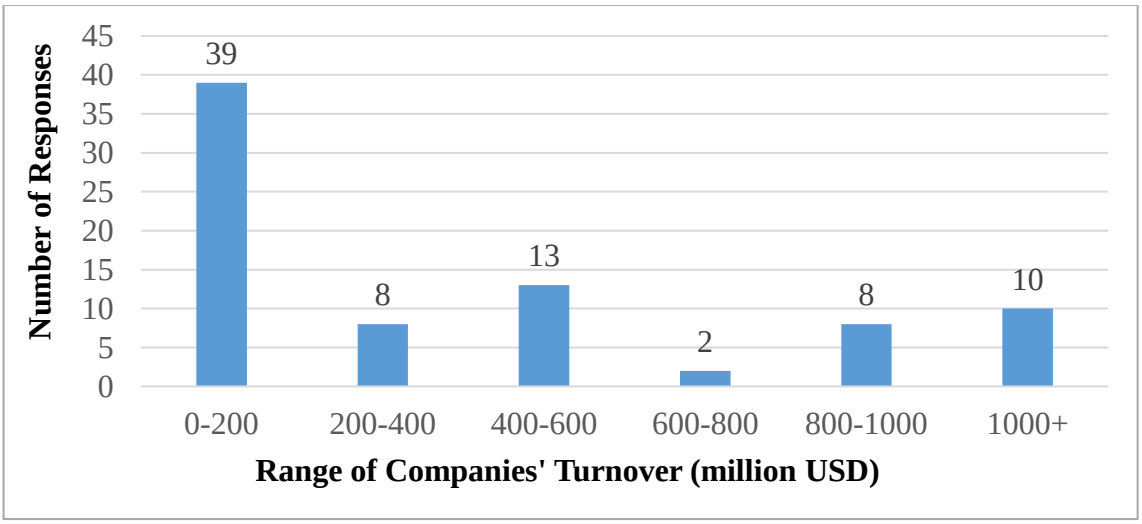

Figure 4.5. Distribution of companies in terms of total turnover.

4.1.2. General Information about the Projects

The figures below provide various information about the projects of the responding companies.

- Type of Project.

Figure 4.6 presents the distribution of projects in terms of the project type. It is seen that most of the projects are transportation projects (46%) where minority involves industrial projects (20%), heavy construction projects (13%), high rise buildings projects (11%), and residential projects (10%).

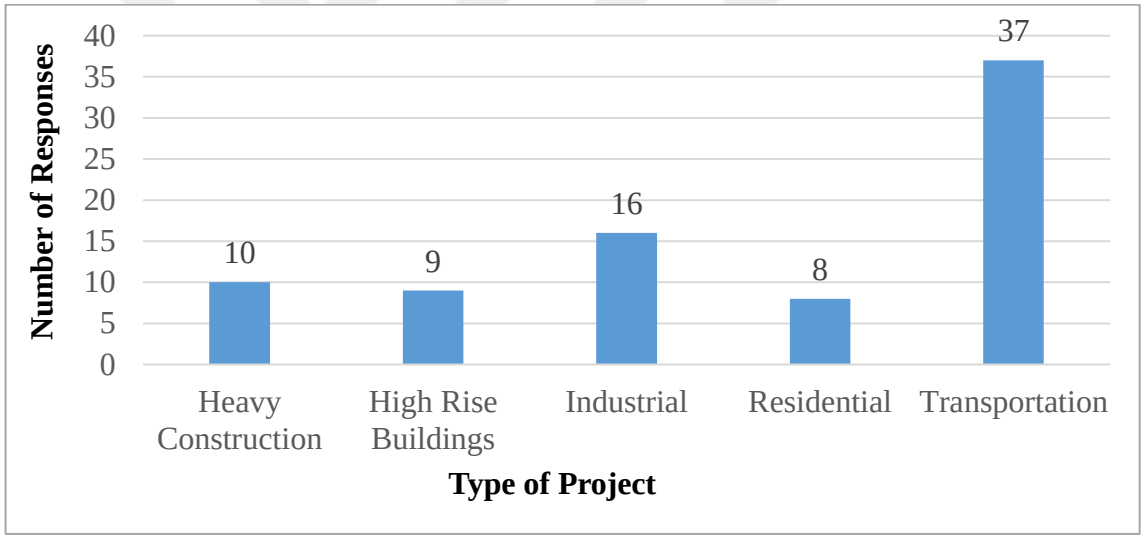

Figure 4.6. Distribution of projects in terms of project type.

- Company Role in the Projects.

Figure 4.7 presents the distribution of project in terms of company role in the project. It is seen that majority of companies have role in the projects as a Contractor. Distribution of the company roles in the projects is as follows; 59 of companies are working as prime contractor, 9 of companies are working as client, 5 of companies are working as subcontractor, 4 of companies are working as consultant and 3 of companies are working as designer.

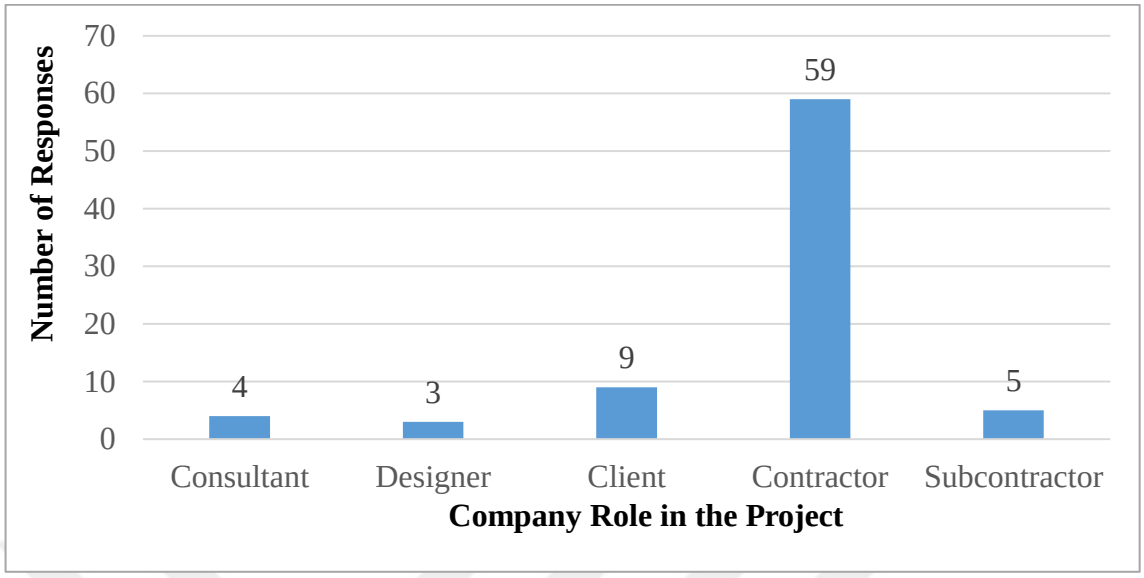

Figure 4.7. Distribution of project in terms of company role in the project.

- Project Completion Time.

Figure 4.8 provides the actual project completion time in years regarding company role in the project. According to this figure, it is reported that the longest project duration belongs to consultants and clients with the completion time of 3.4 and 2.9 years, respectively. The others are prime contractor, subcontractor and designer, respectively.

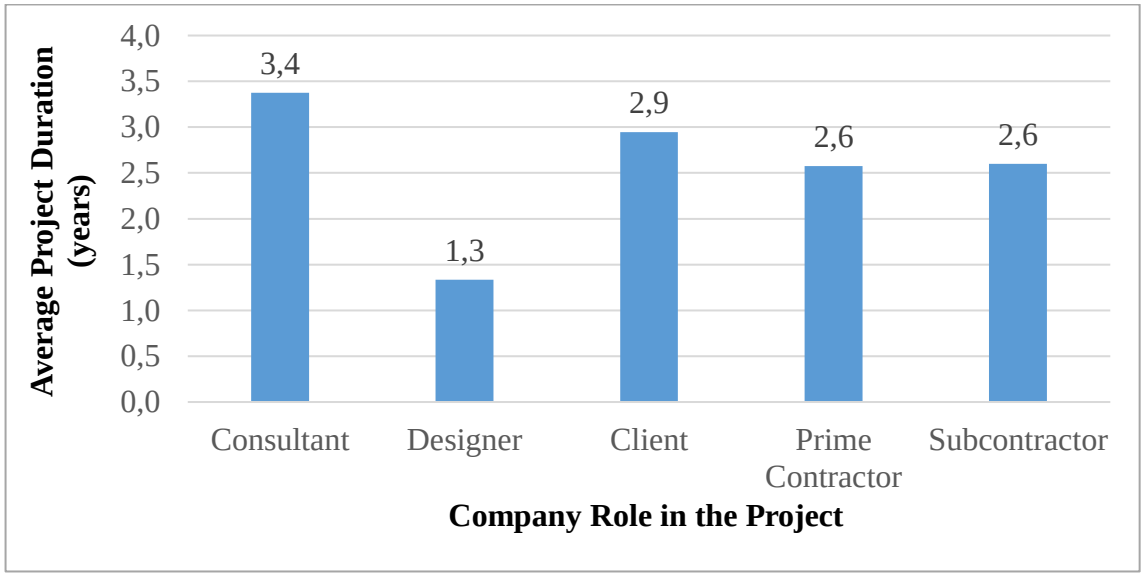

Figure 4.8. Distribution of project completion time in terms of company role.

- Contract Types of Projects.

Figure 4.9 provides distribution of the contract type according to the number of projects. According to this figure, it is seen that majority of the projects were executed with lumpsum contracts. 58 projects were completed with lump sum contract type, 19 projects were completed with unit price contract type and finally 3 projects were executed with cost+fee contract type.

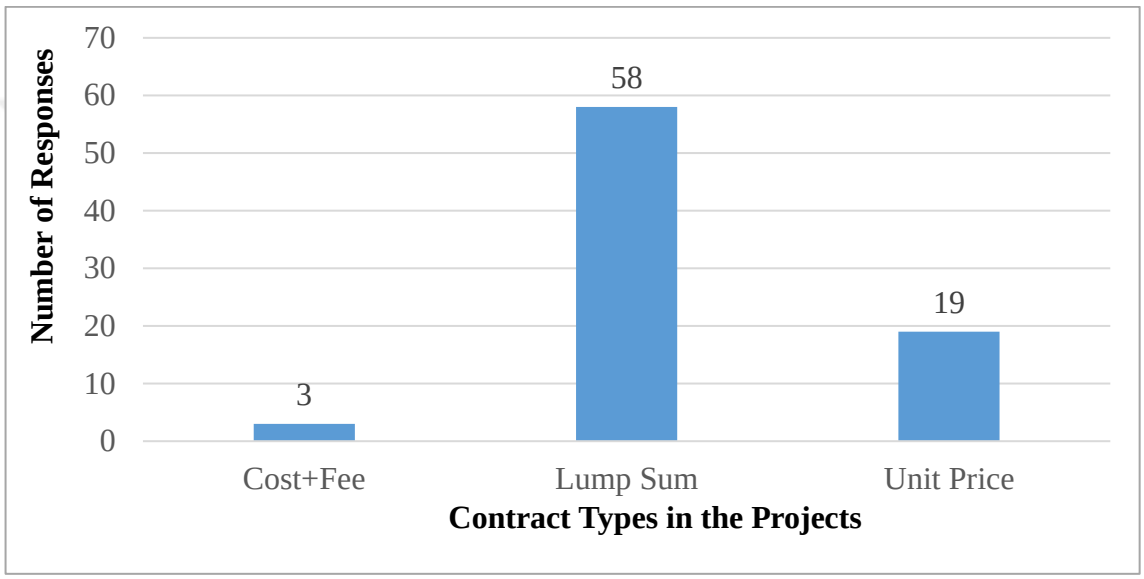

Figure 4.9. Distribution of projects in terms of contract types.

- Average Total Project Values.

Figure 4.10 provides distribution of total average project value in terms of company role in the project.

According to this figure, it is seen that companies in client role in the project has the highest average project value which is 432 million USD. Companies in prime contractor role in the project has the second highest average project value which is 349 million USD although the average project value of the companies in consultant role in the project is 338 million USD which is close to the second highest. Lowest averages project value belongs to the companies with subcontractor role in the project.

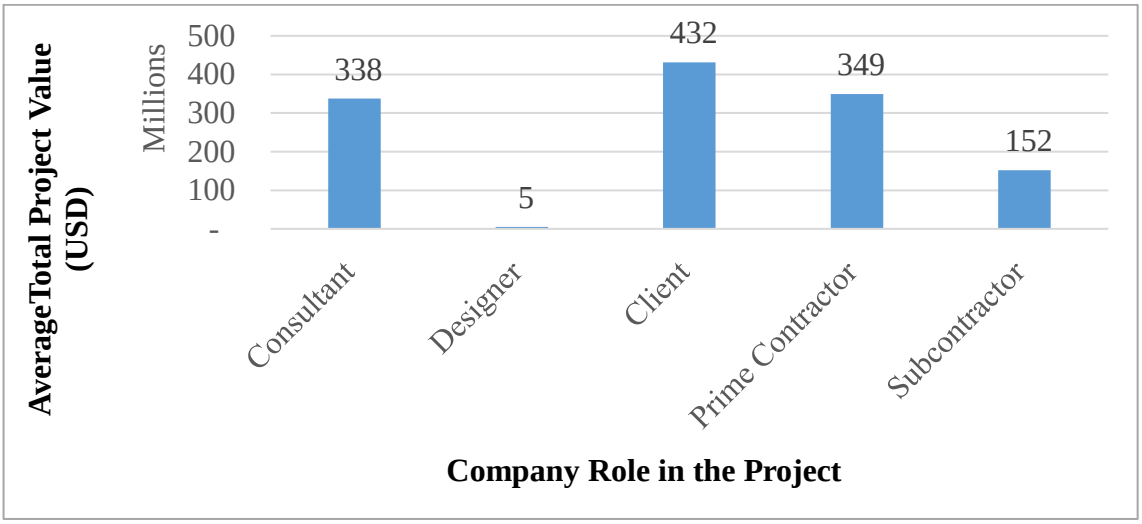

Figure 4.10. Distribution of total average project value in terms of company role.

Figure 4.11 presents distribution of number of projects in terms of the project value. According to this figure, majority of the projects (41) have the project value between 0-200 million USD. Moreover, a considerable portion of the projects was executed with a project value ranging between 200-400 million USD, 800-1000 million USD and over 1000 million USD. Finally, 13 projects were reported that they were executed with project values ranging between 0-200 million USD. It is presented that responding companies who took part in the study are medium to small scale construction companies with 76% coverage of the responding companies, large scale companies are 24% of the responding companies.

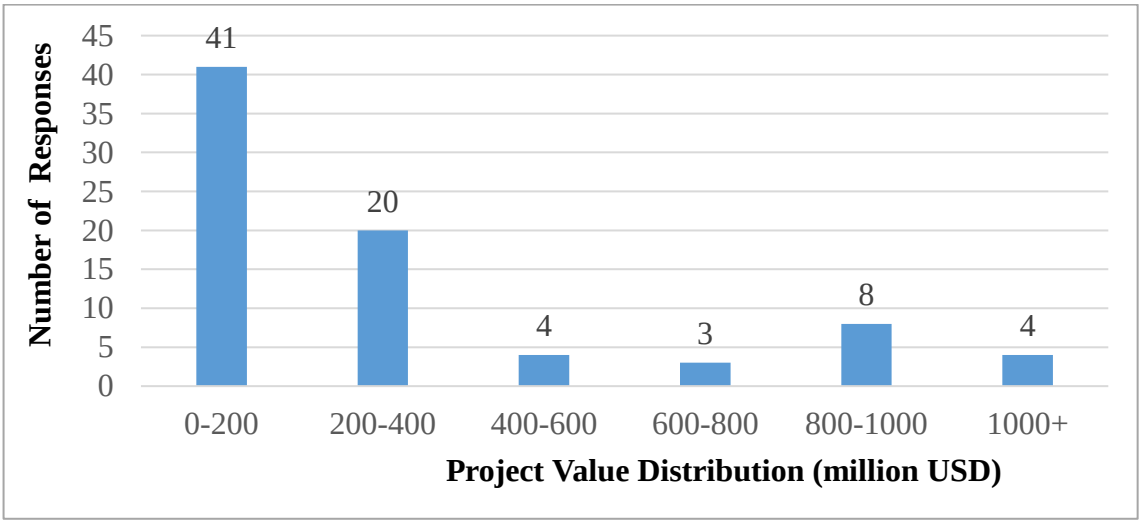

Figure 4.11. Distribution of number of projects in terms of project value.

- Project Client Types.

Figure 4.12 presents distribution of projects in terms of client types in the projects. According to this figure, it is seen that 60% of the clients are from private sector where 40% of the clients are from public sector.

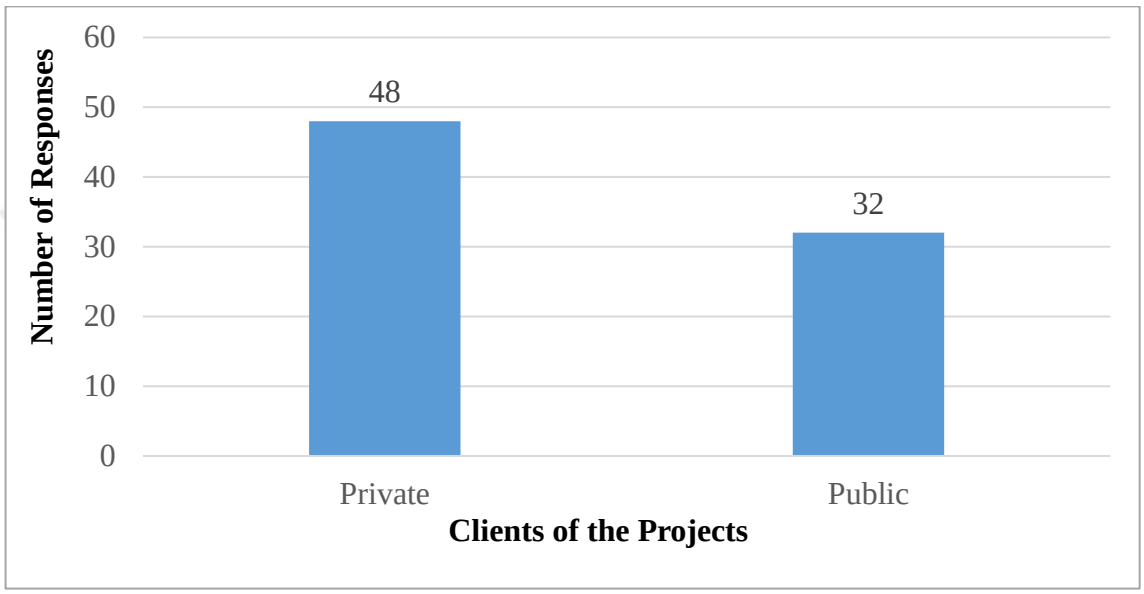

Figure 4.12. Distribution of projects in terms of client types in projects.

- Title of Responders in the Project.

Figure 4.13 presents distribution of responders in terms of their title in the projects. 80 responds received from survey participants which consist of different level of engineers and architects who work in the Turkish construction companies and assuming that they have enough knowledge about success of the project and effectiveness of project managers on project success.

According to the figure, it is seen that 37 of responders are working as “Technical Office Engineer”, 28 of responders are managers who are either manager of whole project or department or section (package), 9 of responders are working as site engineer, 4 of responders are working as designer or architect who are responsible from design, and 2 of responders are working as site chief who are supervisors of site engineers.

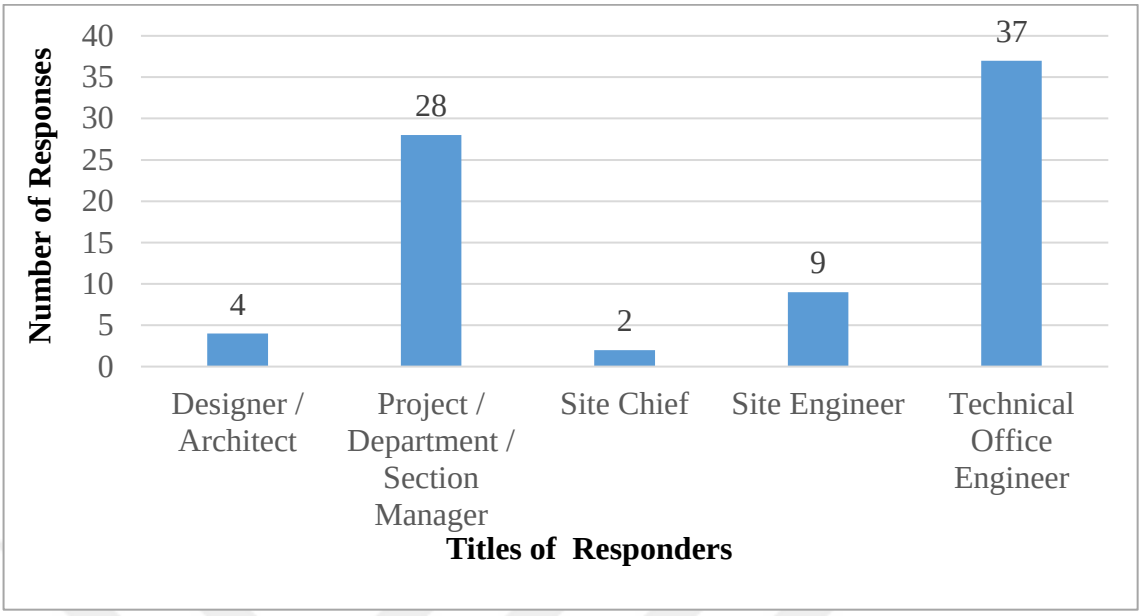

Figure 4.13. Distribution of responders in terms of their title in projects.

4.1.3. Distribution of Rating Levels of Performance Parameters

Performance parameters of the model are investigated through average ratings of respondent companies.

Figure 4.14 provides average ratings of respondent companies for each performance parameters.

The values present that all parameters are found to be valid and comprehensive based on the perceptions of respondent companies. The values show that the study has reached its target population and reinforces the need for comprehensive project success performance model for the Turkish construction industry that can help Turkish construction companies to measure and improve their project success performance.

- Project managers' skills and qualities.

The abbreviations for the components of project managers' skills and qualities can be seen in Table 4.1 below.

Table 4.1. Components of project managers' skills and qualities.

Abbreviation	Components
PM1	Leadership and strategic decision making skills of PM
PM2	Planning, monitoring and management efficiency of PM
PM3	Communication and social interaction of PM
PM4	Innovative and opportunity seeker PM
PM5	Technical experience level of PM
PM6	Responsibility and commitment of PM
PM7	Effective team selection and team members management of PM
PM8	Clear project policies of PM
PM9	Top management handling of PM

Figure 4.14 presents the distribution of components of project managers' skills and qualities. According to this figure, it can be seen that "Technical Experience Level of PM" and "Responsibility and Commitment of PM" parameters are observed to be the best performing among the others. Secondly, it is indicated that the project managers perform well on "Top Management Handling of PM" and "Communication and Social Interaction of PM". The lowest performing component is "Clear Project Policies of PM" which can mean that policies of project managers subject to change due to management requests.

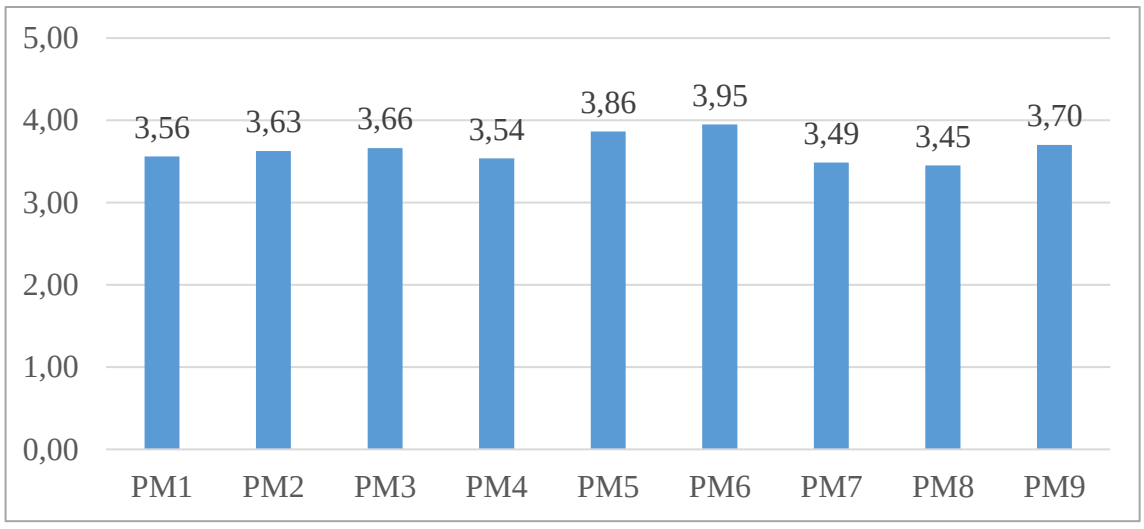

Figure 4.14. Distribution of components of project managers' skills and qualities.

- Project characteristics.

The abbreviations for the components of project characteristics can be seen in Table 4.2 below.

Table 4.2. Components of project characteristics.

Abbreviation	Components
PC1	Cooperation & performance level
PC2	Clarity of project objectives
PC3	Completeness of contract
PC4	Completeness of design
PC5	Performance of other parties
PC6	Relative significance of project
PC7	Time limitation
PC8	Quality requirements

Figure 4.15 presents the distribution of components of project characteristics. According to this figure, “Completeness of Contract”, “Time Limitation” and “Relative Significance of Project” parameters are observed to be the best performing among the others. The least performing component is “Performance of Other Parties” which can mean that responding companies are not happy with performance of other parties in the projects.

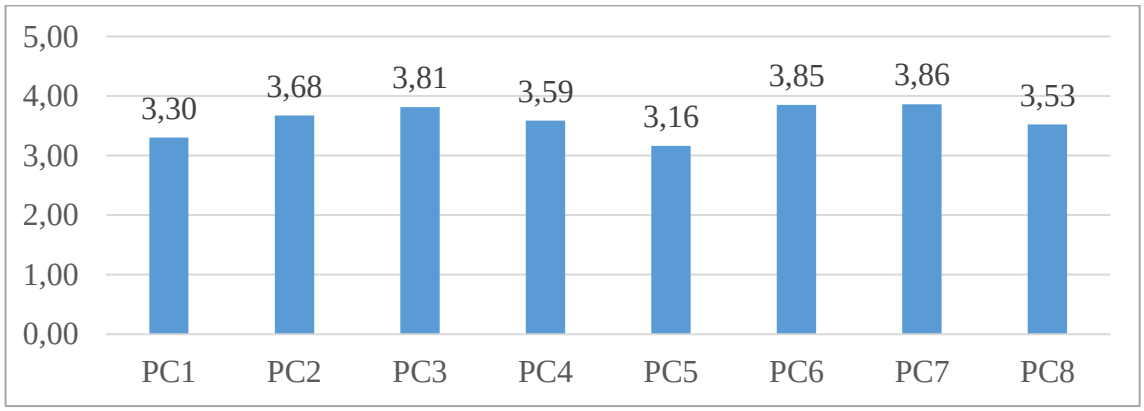

Figure 4.15. Distribution of components of project characteristics.

- Company specific factors.

The abbreviations for the components of company specific factors can be seen in Table 4.3 below.

Table 4.3. Components of company specific factors.

Abbreviation	**Components**
CS1	Communication with other project participants
CS2	Communication with authorities
CS3	Top management support to the actions of project manager (pm)
CS4	Planning, monitoring and management efficiency of company
CS5	Project participants consultation and troubleshooting ability of company
CS6	Clear project objectives and policies of company
CS7	Financial management and solid economic structure of company
CS8	Human resources management of company
CS9	Technology utilization for reliable information, communication, and monitoring systems
CS10	Clear and simple organizational structure of company
CS11	Experience in similar projects

Figure 4.16 presents the distribution of company specific factors. According to this figure, it can be seen that “Experience in Similar Projects” and “Top Management Support to the Actions of Project Manager (PM)” parameters are observed to be the best performing among the others. Secondly, responding companies indicated that they perform well on “Financial Management and Solid Economic Structure of Company” and “Communication with Authorities”. The least important component of characteristics is found to be “Human

Resources Management of Company" which can be explained with Turkish construction companies put less importance on human resources management compared to other parameters.

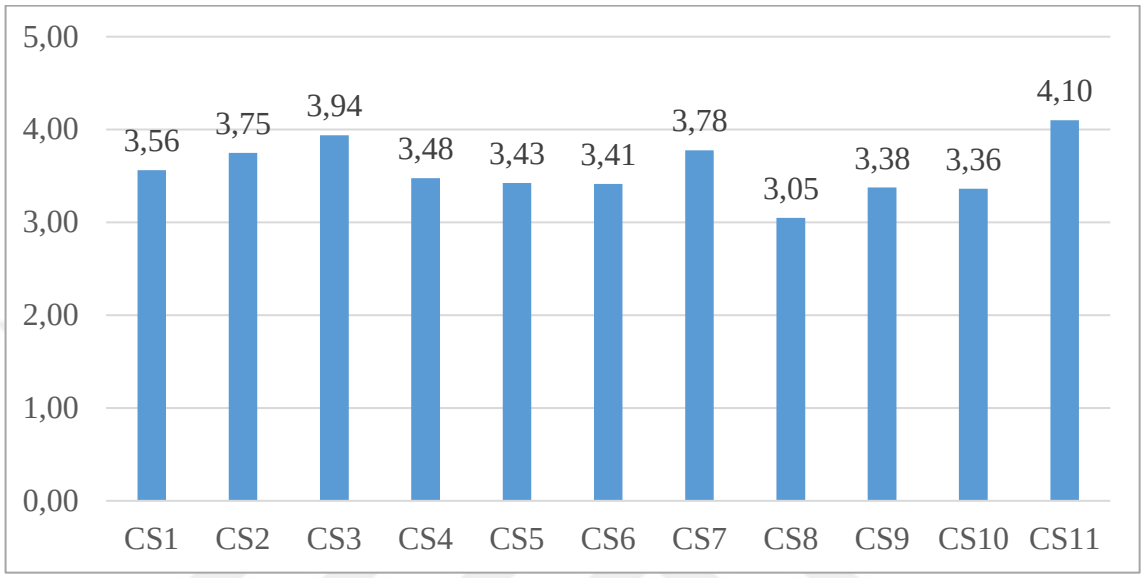

Figure 4.16. Distribution of components of company specific factors.

- Project success.

The abbreviations for the components project success indicators can be seen in Table 4.4 below.

Table 4.4. Components of project success.

Abbreviation	**Components**
PS1	Time performance
PS2	Quality performance
PS3	Cost performance
PS4	HSSE performance
PS5	End-user and customer satisfaction from end-product
PS6	Satisfaction of project team members and co-partners

Figure 4.17 presents the distribution of components of project success indicators. According to this figure, it can be seen that “End-User and Customer Satisfaction from End-Product” and “Time performance” parameters are observed to be the best performing among the others. Secondly, responding companies indicated that they perform well on “Cost performance” and “Quality performance”. The least important component of characteristics is found to be “Health, safety, security and environment (HSSE) performance” which can be explained with Turkish construction companies put more importance to performance on time, quality and cost than “Health, safety, security and environment (HSSE) performance”.

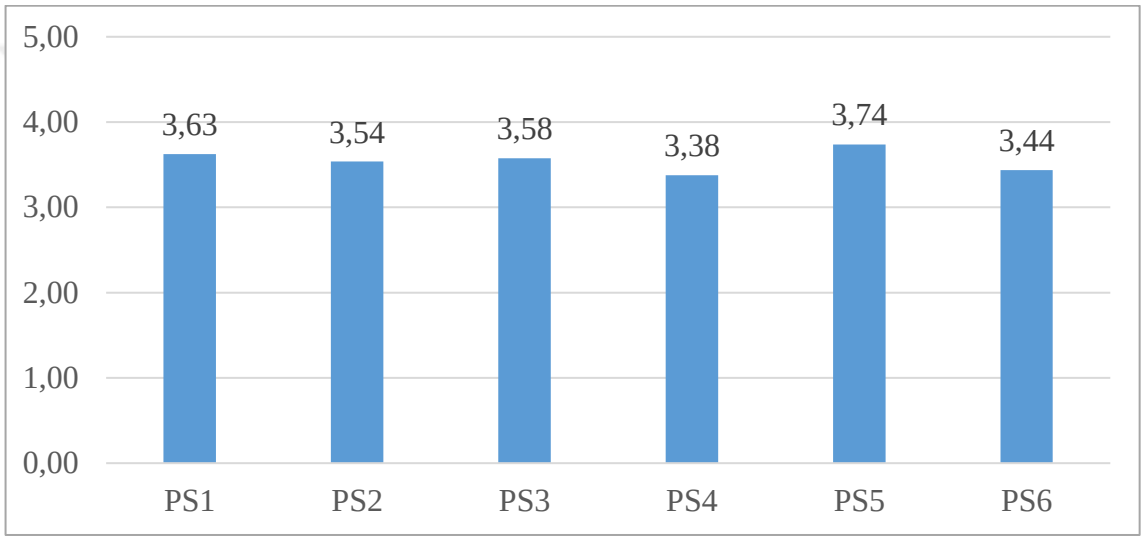

Figure 4.17. Distribution of components of project success indicators.

4.2. Analysis of Variance (ANOVA)

The one-way ANOVA, analysis of variance, is an extension of the t-test for comparing the means of more than two samples. It is used to detect differences among the means of the samples. Although the results of a one-way ANOVA provide if there is what is known as a main effect of the explanatory variable, the initial results will not provide which groups are different from one another. In order to determine which groups are different from one another, a post-hoc test is used. Post-hoc and contrast tests are conducted after a one-way ANOVA to determine which groups differ from one another. There are many different post-hoc analyses and contrast analyses that could be performed following a one-way ANOVA. In this research, two of the most common tests known as Least Significant Difference (LSD)

Test, and Contrast Test are used. Least Significant Difference (LSD) test is the original solution to determine which groups differ from one another, developed by Fisher, was to explore all possible pair-wise comparisons of means comprising a factor using the equivalent of multiple t-tests. The null hypothesis is rejected when the test significance level (p-value) is less than 0.05 at the 95% confidence interval. Rejecting the null hypothesis means that there are statistically significant differences between groups.

- ANOVA - Emphasis on project success criteria by company types.

ANOVA test was carried out to find out whether company types, which are investors, contractors/subcontractors, designers and project management/consultancy, have different views on the project success criteria. Time performance, quality performance, cost performance, HSSE performance, end-user and customer satisfaction, and satisfaction of project team members and co-partners are project success criteria of the research.

ANOVA test was conducted using SPSS. The results of the ANOVA are presented in Table 4.5. The null hypotheses are not rejected for time performance, quality performance, HSSE performance, end-user and customer satisfaction, and satisfaction of project team members and co-partners since their p-values are more than 0.05 at the 95% confidence interval. It means that there are no statistically significant differences between company types on time performance, quality performance, HSSE performance, end-user and customer satisfaction, and satisfaction of project team members and co-partners.

The null hypothesis is rejected only for cost performance where p-value is 0.029, less than 0.05 at the 95% confidence interval. Rejecting hypothesis means that there are statistically significant differences between group on the cost performance. Further tests, Least Significant Difference (LSD) Test and Contrast Test, are conducted to reveal which company type has statistically significant difference.

The results of Least Significant Difference (LSD) Test are presented in Table 4.6. The results revealed that mean difference of designers compared to others is significant at 0.05 level and significant values matching with designers are less than 0.05.

Table 4.5. ANOVA - Emphasis on project success criteria by company types.

	Company Types	Mean		Sum of Squares	df	Mean Square	F-value	p-value
Time performance	1	3.50	Between Groups	4.897	3	1.632	1.884	0.139
	2	3.74	Within Groups	65.853	76	0.866		
	3	3.25	Total	70.750	79			
	4	2.80						
Quality performance	1	3.30	Between Groups	5.545	3	1.848	1.840	0.147
	2	3.67	Within Groups	76.343	76	1.005		
	3	3.00	Total	81.888	79			
	4	2.80						
Cost performance	1	3.60	Between Groups	7.068	3	2.356	3.170	0.029*
	2	3.69	Within Groups	56.482	76	0.743		
	3	2.50	Total	63.550	79			
	4	3.00						
HSSE performance	1	2.90	Between Groups	3.854	3	1.285	1.603	0.196
	2	3.49	Within Groups	60.896	76	0.801		
	3	3.25	Total	64.750	79			
	4	3.00						
End-User and Customer Satisfaction	1	3.70	Between Groups	0.958	3	0.319	0.480	0.697
	2	3.79	Within Groups	50.530	76	0.665		
	3	3.50	Total	51.488	79			
	4	3.40						
Satisfaction of Project Team Members and Co-Partners	1	3.40	Between Groups	4.092	3	1.364	1.683	0.178
	2	3.49	Within Groups	61.596	76	0.810		
	3	3.75	Total	65.688	79			
	4	2.60						
1. Investors, 2. Contractors/Subcontractors, 3. Designers, 4. Project Management								

In addition, contrast test is conducted to ascertain designers in the Turkish construction industry are statistically different on cost performance, results are provided in Table 4.7. Results of contrast test unveiled that cost performance of designers in the Turkish construction industry are statistically different since significant value is 0.047 less than 0.05. It can be explained that project designer companies in the construction projects are mainly work and time performance oriented companies rather than being cost performance oriented companies like investors, contractors/subcontractors, and project management/consultancy companies.

Table 4.6. LSD Test - Emphasis on cost performance by company types.

(I) Company Type	(J) Company Type	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Investors	Contractors/ Subcontractors	-0.089	0.294	0.764	-0.670	0.500
	Designers	1.100*	0.510	0.034	0.080	2.120
	Project management	0.600	0.472	0.208	-0.340	1.540
Contractors/ Subcontractors	Investors	0.089	0.294	0.764	-0.500	0.670
	Designers	1.189*	0.445	0.009	0.300	2.070
	Project management	0.689	0.401	0.090	-0.110	1.490
Designers	Investors	-1.100*	0.510	0.034	-2.120	-0.080
	Contractors/ Subcontractors	-1.189*	0.445	0.009	-2.070	-0.300
	Project management	-0.500	0.578	0.390	-1.650	0.650
Project management/ consultancy companies	Investors	-0.600	0.472	0.208	-1.540	0.340
	Contractors/ Subcontractors	-0.689	0.401	0.090	-1.490	0.110
	Designers	0.500	0.578	0.390	-0.650	1.650

Table 4.7. Contrast Test - Emphasis on cost performance by company types.

Contrast		Company Type			
		Investors	Contractors/ Subcontractors	Designers	Project management
1		1	1	-3	1
	Value of Contrast	Std. Error	t	df	Sig. (2-tailed)
Cost Performance	2.79	1.381	2.019	76	0.047

- ANOVA - Emphasis on project success criteria by company size.

ANOVA test was carried out to find out whether company sizes have different views on the project success criteria. Time performance, quality performance, cost performance, HSSE performance, end-user and customer satisfaction, and satisfaction of project team members and co-partners are project success criteria of the research.

ANOVA test was conducted using SPSS. The results of the ANOVA are presented in Table 4.8.

The null hypotheses are not rejected for any of project success criteria since their p-values are more than 0.05 at the 95% confidence interval. It means that there are no statistically significant differences between company sizes on time performance, quality performance, cost performance, HSSE performance, end-user and customer satisfaction, and satisfaction of project team members and co-partners.

- ANOVA - Emphasis on project success criteria by project types.

ANOVA test was carried out to find out whether project types, heavy construction, high rise buildings, industrial, residential, and transportation, have different views on the project success criteria. Time performance, quality performance, cost performance, HSSE performance, end-user and customer satisfaction, and satisfaction of project team members and co-partners are project success criteria of the research.

ANOVA test was conducted using SPSS. The results of the ANOVA are presented in Table 4.9.

The null hypotheses are not rejected for any of project success criteria since their p-values are more than 0.05 at the 95% confidence interval. It means that there are no statistically significant differences between project types on time performance, quality performance, cost performance, HSSE performance, end-user and customer satisfaction, and satisfaction of project team members and co-partners.

Table 4.8. ANOVA - Emphasis on project success criteria by company size.

	Annual Turnover (million USD)	Mean		Sum of Squares	df	Mean Square	F-value	p-value
Time performance	0-200	3.51	Between Groups	4.876	5	0.975	1.095	0.370
	200-400	3.75	Within Groups	65.874	74	0.890		
	400-600	3.46	Total	70.750	79			
	600-800	4.50						
	800-1000	3.50						
	1000+	4.10						
Quality performance	0-200	3.56	Between Groups	9.615	5	1.923	1.969	0.093
	200-400	3.13	Within Groups	72.272	74	0.977		
	400-600	3.77	Total	81.888	79			
	600-800	4.00						
	800-1000	2.75						
	1000+	4.00						
Cost performance	0-200	3.51	Between Groups	2.787	5	0.557	0.679	0.641
	200-400	3.38	Within Groups	60.763	74	0.821		
	400-600	3.69	Total	63.550	79			
	600-800	3.50						
	800-1000	3.38						
	1000+	4.00						
HSSE performance	0-200	3.26	Between Groups	2.170	5	0.434	0.513	0.765
	200-400	3.25	Within Groups	62.580	74	0.846		
	400-600	3.69	Total	64.750	79			
	600-800	3.50						
	800-1000	3.38						
	1000+	3.50						
End-User and Customer Satisfaction	0-200	3.69	Between Groups	5.311	5	1.062	1.702	0.145
	200-400	3.75	Within Groups	46.177	74	0.624		
	400-600	3.69	Total	51.488	79			
	600-800	4.50						
	800-1000	3.25						
	1000+	4.20						
Satisfaction of Project Team Members and Co-Partners	0-200	3.54	Between Groups	8.220	5	1.644	2.117	0.073
	200-400	3.50	Within Groups	57.467	74	0.777		
	400-600	3.00	Total	65.688	79			
	600-800	4.00						
	800-1000	2.88						
	1000+	3.90						

Table 4.9. ANOVA - Emphasis on project success criteria by project types.

	Project Types	Mean		Sum of Squares	df	Mean Square	F-value	p-value
Time performance	Heavy Cons.	3.10	Between Groups	6.924	4	1.731	2.034	0.098
	High Rise	3.33	Within Groups	63.826	75	0.851		
	Industrial	3.88	Total	70.750	79			
	Residential	3.25						
	Transportation	3.81						
Quality performance	Heavy Cons.	3.50	Between Groups	0.494	4	0.123	0.114	0.977
	High Rise	3.33	Within Groups	81.394	75	1.085		
	Industrial	3.56	Total	81.888	79			
	Residential	3.63						
	Transportation	3.57						
Cost performance	Heavy Cons.	3.10	Between Groups	4.674	4	1.168	1.488	0.214
	High Rise	3.22	Within Groups	58.876	75	0.785		
	Industrial	3.81	Total	63.550	79			
	Residential	3.63						
	Transportation	3.68						
HSSE performance	Heavy Cons.	3.40	Between Groups	2.456	4	0.614	0.739	0.568
	High Rise	3.00	Within Groups	62.294	75	0.831		
	Industrial	3.56	Total	64.750	79			
	Residential	3.13						
	Transportation	3.43	Total	64.750	79			
End-User and Customer Satisfaction	Heavy Cons.	3.60	Between Groups	0.658	4	0.164	0.243	0.913
	High Rise	3.56	Within Groups	50.830	75	0.678		
	Industrial	3.81	Total	51.488	79			
	Residential	3.75						
	Transportation	3.78						
Satisfaction of Project Team Members and Co-Partners	Heavy Cons.	3.50	Between Groups	2.248	4	0.562	0.665	0.619
	High Rise	3.00	Within Groups	63.439	75	0.846		
	Industrial	3.38	Total	65.688	79			
	Residential	3.50						
	Transportation	3.54						

- ANOVA - Emphasis on project success criteria by contract types.

ANOVA test was carried out to find out whether contract types, cost+fee, lump sum, and unit price have different views on the project success criteria. Time performance, quality performance, cost performance, HSSE performance, end-user and customer satisfaction, and satisfaction of project team members and co-partners are project success criteria of the research. ANOVA test was conducted using SPSS. The results of the ANOVA are presented in Table 4.10. The null hypotheses are not rejected for cost performance and HSSE performance since their p-values are more than 0.05 at the 95% confidence interval. It means that there are no statistically significant differences between contract types on cost performance and HSSE performance.

Table 4.10. ANOVA - Emphasis on project success criteria by contract types.

	Contract Types	Mean		Sum of Squares	df	Mean Square	F-value	p-value
Time performance	Cost+Fee	4.00	Between Groups	6.874	2	3.437	4.143	0.020*
	Lump Sum	3.78	Within Groups	63.876	77	0.830		
	Unit Price	3.11	Total	70.750	79			
Quality performance	Cost+Fee	4.67	Between Groups	6.815	2	3.408	3.495	0.035*
	Lump Sum	3.60	Within Groups	75.072	77	0.975		
	Unit Price	3.16	Total	81.888	79			
Cost performance	Cost+Fee	4.00	Between Groups	3.616	2	1.808	2.323	0.105
	Lump Sum	3.67	Within Groups	59.934	77	0.778		
	Unit Price	3.21	Total	63.550	79			
HSSE performance	Cost+Fee	3.33	Between Groups	1.212	2	0.606	0.735	0.483
	Lump Sum	3.45	Within Groups	63.538	77	0.825		
	Unit Price	3.16	Total	64.750	79			
End-User and Customer Satisfaction	Cost+Fee	4.67	Between Groups	6.440	2	3.220	5.504	0.006*
	Lump Sum	3.83	Within Groups	45.048	77	0.585		
	Unit Price	3.32	Total	51.488	79			
Satisfaction of Project Team Members and Co-Partners	Cost+Fee	4.33	Between Groups	11.984	2	5.992	8.591	0.000*
	Lump Sum	3.60	Within Groups	53.704	77	0.697		
	Unit Price	2.79	Total	65.688	79			

The null hypothesis is rejected for time performance where p-value is 0.029, quality performance where p-value is 0.035, end-user and customer satisfaction where p-value is 0.006, satisfaction of project team members and co-partners where p-value is 0.000. which are less than 0.05 at the 95% confidence interval. Rejecting hypothesis means that there are statistically significant differences between group on the time performance, quality performance, end-user and customer satisfaction, and satisfaction of project team members and co-partners. Further tests, Least Significant Difference (LSD) Test and Contrast Test, are conducted to reveal which contract type has statistically significant difference on which project success criterion. For time performance, the results of Least Significant Difference (LSD) Test are presented in Table 4.11. The table reveals that mean difference of unit price contracts compared to others is significant at 0.05 level and significant values matching with unit price are less than 0.05. In addition, contrast test is conducted to ascertain unit price contracts are statistically different on time performance, results are provided in Table 4.12. According to results of contrast test, it is unveiled that time performance of unit price contracts are statistically different since significant value is 0.024 less than 0.05. It is concluded that time performance of construction companies which have unit price contracts in the projects is statistically different than construction companies which have cost+fee or lump sum contracts in the projects. This can be explained that time performance is not main goal of construction companies which have unit price contracts in the projects since they get paid with unit price of work done. Time delay does not affect the company in terms of cost as much as construction companies which have projects with lumpsum and cost+fee contracts.

Table 4.11. LSD Test - Emphasis on time performance by contract types.

(I) Contract Type	(J) Contract Type	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Cost+Fee	Lump Sum	0.224	0.539	0.679	-0.850	1.300
	Unit Price	0.895	0.566	0.118	-0.230	2.020
Lump Sum	Cost+Fee	-0.224	0.539	0.679	-1.300	0.850
	Unit Price	.671*	0.241	0.007	0.190	1.150
Unit Price	Cost+Fee	-0.895	0.566	0.118	-2.020	0.230
	Lump Sum	-.671*	0.241	0.007	-1.150	-0.190

Table 4.12. Contrast Test - Emphasis on time performance by contract types.

Contrast			Contract Type		
			Cost+Fee	Lump Sum	Unit Price
1			1	1	-2
	Value of Contrast	Std. Error	t	df	Sig. (2-tailed)
Time Performance	1.57	0.682	2.294	77	0.024

For quality performance, the results of Least Significant Difference (LSD) Test are presented in Table 4.13. The table reveals that mean difference of cost+fee contracts compared to others is significant at 0.05 level and significant values matching with cost+fee are less than 0.05. In addition, contrast test is conducted to ascertain cost+fee contracts are statistically different on quality performance, results are provided in Table 4.14. According to results of contrast test, it is unveiled that quality performance of cost+fee contracts are statistically different since significant value is 0.031 less than 0.05. It is concluded that quality performance of construction companies which have cost+fee contracts in the projects is statistically different than construction companies which have unit price or lump sum contracts in the projects. This can be explained that construction companies working with cost+fee contracts can focus on quality performance since they do not have a lot of time limitation and the good quality performance means more prestige for company and more payment.

Table 4.13. LSD Test - Emphasis on quality performance by contract types.

(I) Contract Type	(J) Contract Type	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Cost+Fee	Lump Sum	1.063	0.585	0.073	-0.100	2.230
	Unit Price	1.509*	0.613	0.016	0.290	2.730
Lump Sum	Cost+Fee	-1.063	0.585	0.073	-2.230	0.100
	Unit Price	0.446	0.261	0.092	-0.070	0.970
Unit Price	Cost+Fee	-1.509*	0.613	0.016	-2.730	-0.290
	Lump Sum	-0.446	0.261	0.092	-0.970	0.070

Table 4.14. Contrast Test - Emphasis on quality performance by contract types.

Contrast			Contract Type		
			Cost+Fee	Lump Sum	Unit Price
1			-2	1	1
	Value of Contrast	Std. Error	t	df	Sig. (2-tailed)
Quality Performance	-2.57	1.17	-2.199	77	0.031

For end-user and customer satisfaction, the results of Least Significant Difference (LSD) Test are presented in Table 4.15. The table reveals that mean difference of unit price contracts compared to others is significant at 0.05 level and significant values matching with unit price contracts are less than 0.05. In addition, contrast test is conducted to ascertain unit price contracts are statistically different on end-user and customer satisfaction, results are provided in Table 4.16. According to results of contrast test, it is unveiled that end-user and customer satisfaction of unit price contracts are statistically different since significant value is 0.002 less than 0.05. It is concluded that end-user and customer satisfaction for construction companies which have unit price contracts in the projects is statistically different than construction companies which have cost+fee or lump sum contracts in the projects. This can be explained that construction companies working with unit price contracts are interested in end-user and customer satisfaction since it is the main factor affecting the amount will be received from the contract.

Table 4.15. LSD Test - Emphasis on end-user satisfaction by contract types.

(I) Contract Type	(J) Contract Type	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Cost+Fee	Lump Sum	0.839	0.453	0.068	-0.060	1.740
	Unit Price	1.351*	0.475	0.006	0.400	2.300
Lump Sum	Cost+Fee	-0.839	0.453	0.068	-1.740	0.060
	Unit Price	0.512*	0.202	0.013	0.110	0.910
Unit Price	Cost+Fee	-1.351*	0.475	0.006	-2.300	-0.400
	Lump Sum	-0.512	0.202	0.013	-0.910	-0.110

Table 4.16. Contrast Test - Emphasis on end-user satisfaction by contract types.

Contrast			Contract Type		
			Cost+Fee	Lump Sum	Unit Price
1			1	1	-2
	Value of Contrast	Std. Error	t	df	Sig. (2-tailed)
Quality Performance	1.86	0.573	3.251	77	0.002

For satisfaction of project team members and co-partners, the results of Least Significant Difference (LSD) Test are presented in Table 4.17. The table reveals that mean difference of unit price contracts compared to others is significant at 0.05 level and significant values matching with unit price contracts are less than 0.05. In addition, contrast test is conducted to ascertain unit price contracts are statistically different on satisfaction of project team members and co-partners, results are provided in Table 4.18. According to results of contrast test, it is unveiled that satisfaction of project team members and co-partners with unit price contracts are statistically different since significant value is 0.000 less than 0.05. It is concluded that satisfaction of project team members and co-partners for construction companies which have unit price contracts in the projects is statistically different than construction companies which have cost+fee or lump sum contracts in the projects. This can be explained that companies with unit price contracts can focus on satisfaction of project team and co-partners since they can benefit from unit price contract by providing enough personnel, material and tools for each department in the project.

Table 4.17. LSD Test - Emphasis on project team satisfaction by contract types.

(I) Contract Type	(J) Contract Type	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Cost+Fee	Lump Sum	0.730	0.494	0.144	-0.250	1.710
	Unit Price	1.544*	0.519	0.004	0.510	2.580
Lump Sum	Cost+Fee	-0.730	0.494	0.144	-1.710	0.250
	Unit Price	0.814*	0.221	0.000	0.370	1.250
Unit Price	Cost+Fee	-1.544*	0.519	0.004	-2.580	-0.510
	Lump Sum	-0.814	0.221	0.000	-1.250	-0.370

Table 4.18. Contrast Test - Emphasis on project team satisfaction by contract types.

Contrast			Contract Type		
			Cost+Fee	Lump Sum	Unit Price
1			1	1	-2
	Value of Contrast	Std. Error	t	df	Sig. (2-tailed)
Quality Performance	2.36	0.626	3.769	77	0.000

4.3. Structural Equation Modeling (SEM)

Structural equation modeling (SEM) is a multivariate statistical analysis technique that can be used to analyze complex relationships between independent variables and dependent variables. The variables in the model may be discrete or continuous. SEM is a confirmatory technique, it is not exploratory technique. Instead of finding a suitable model. it is used to determine whether a certain model is valid. However, suitable model can be found by checking validity of various models using SEM (Hoyle, 1995; Kline, 1998; Byrne, 2006). Simultaneous equation modeling, causal modeling, path analysis, analysis of covariance structures, confirmatory factor analysis, and dependence analysis are all special cases of SEM (Kline, 1998).

SEM deals with latent and measured variables. A latent variable is a variable which cannot be observed directly and must be inferred from measured variables. Latent variables are also called as factors, constructs or unobserved variables. A measured variable is a variable that can be observed directly and is measurable. Measured variables are also called as observed variables, manifest, or indicator variables. The general form of a SEM consists of two parts which are the structural model and the measurement model (Kline, 1998). The structural equation model presents the causal relationships among the latent variables and describes the causal effects and the amount of unexplained variance. SEM is excellent for analyzing complex and multidimensional relationships and is the only analysis that provides complete and concurrent tests of all the relationships. The measurement model presents how

the latent variables, or the hypothetical constructs are measured in terms of the observed variables, and it describes the measurement properties such as the validities and reliabilities of the observed variables.

4.3.1. Definitions of Terms

A typical SEM has the following components (Ozorhon, 2007):

- Path diagram: Path diagrams present the investigator in a visual way to examine the outputs.
- Measurement models: Measurement models provides an early hypothesis about relations between observed variables and latent variables. Confirmatory Factor Analysis (CFA) is used for measurement models. Their purposes are to depict how well the observed variables serve as a measurement instrument for latent variables.
- Structural models: Structural models present the relationships among the latent constructs. In a structural model, two-headed arrows represent correlational relations where one-headed arrows represent regression relationships.
- Observed variables: Observed variables are also called manifest or indicator variable. Their independent and dependent latent variables are designated by X and Y, respectively. Observed variables can be manipulated by researchers and their effects can be observed.
- Latent variables: Latent variables can only be measured indirectly and their effects cannot be observed directly. Instead, effects of observed variables can be used to represent the latent variables' effects. They are unobservable, hypothetical constructs.
- Latent endogenous variables: Latent endogenous variables are also called latent dependent variables. These variables are described as the effects of other latent variables. Measurements of these variables are made on observed dependent variables. They are designated by (η).
- Latent exogenous variables: Latent exogenous variables are also called latent independent variables and these variables affect other variables in the model. Measurements of these variables are made on observed independent variables. They are designated by (ξ).

- Direct effect: Direct effect represents causal effects that are presumed to flow from one latent variable to another. Statistical estimates of direct effects are named path coefficients.
- Indirect effect: Indirect effect is also called mediator effect and it involves one or more intervening variables that transmit some of the casual effects of prior variables onto subsequent variables.
- Diagrammatic syntax: Diagrammatic syntax is where the latent variables or factors are indicated by circles. The observed variables are indicated by squares.

Structural equation models are most often represented graphically. Figure 4.18 represents a simple graphical representation of a structural equation model. The model provides the effect of latent variable Y1 on latent variable Y2. The model also shows that manifest variables are used to represent the latent variables. In the figure, manifest variables are shown in the rectangles, the latent variables are shown in the ellipses, and measurement errors are shown in circles. The arrows represent the direction of the effects. When the directional arrow between Y1 and Y2 is on a two-way arrow form, it is stated that the model is a confirmatory factor analysis (CFA) that tests whether manifest variables explain latent variables well (convergent validity), and whether Y1 and Y2 are different (discriminant validity) (Xiong et al. 2015).

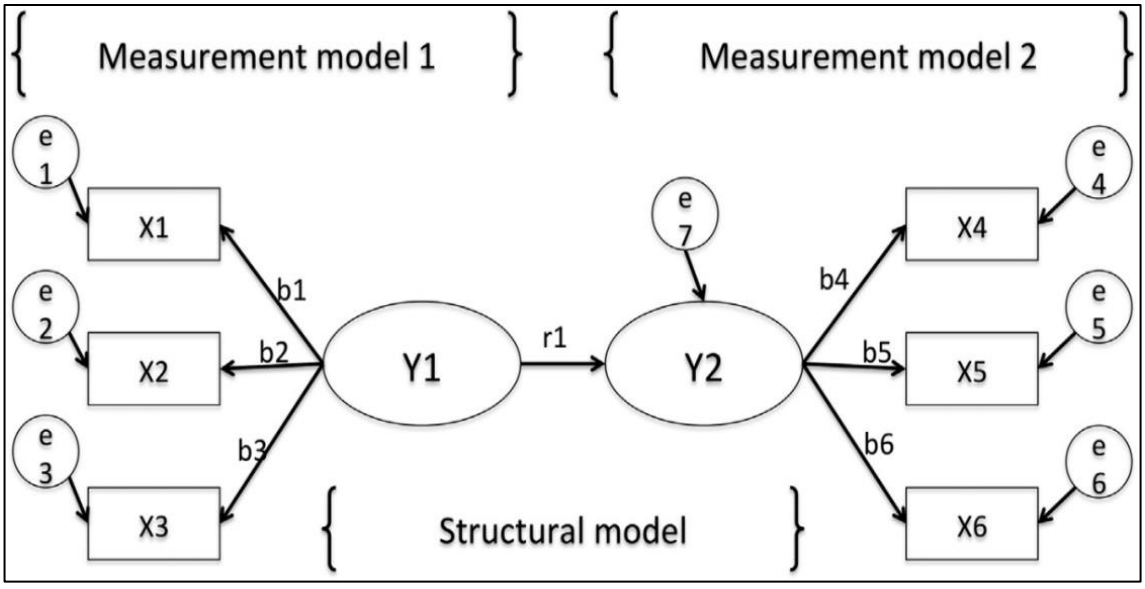

Figure 4.18. Schematic diagram of structural equation model (Xiong et al. 2015).

4.3.2. Steps of SEM

SEM consists of four main steps; model specification, model identification, test of model fit, and model modification (Ozorhon, 2007).

- Model specification represents the formal statement of a model where relationships between variables are determined by setting parameters fixed or free. Selection of which are to be used as fixed or free should be consistent with the researcher's a priori hypothesis. A theory based model generates its own unique covariance matrix.
- Model identification and estimation relies on the selection of model and the specification of fixed, free or constrained parameters. For each free parameter from the observed data, a unique value should be obtained. There are various methods of model estimation such as generalized least squares (GLS), maximum likelihood (ML), weighted least-squares (WLS), asymptotically distribution free (ADF) estimator, unweighted least-squares (ULS), and two-stage least-squares (TSLS). The selection of method is dependent on the sample size and distribution of the data.
- Model fit or goodness of fit can be assessed by examination of the analysis results based on various fit indices explained below:

  (i). Chi-Square ($\chi 2$) is the measure of how close the observed values are to the expected values under the fitted model. This statistic depends on generalized likelihood ratio. Low and non-significant chi-square values are desired. It has two drawbacks. First drawback is that there is no standardized way to interpret it since its lower bound is zero, there is no upper level. Second drawback is that it is very sensitive to sample size, where it tends to give significant values with larger samples.

  (ii). Goodness of Fit Index (GFI) is less sensitive to sample sizes and which are more standardized than other indices. Its values range between 0 (poor fit) and 1 (perfect fit). The values greater than 0.9 are acceptable for GFI.

  (iii). Comparative fit index (CFI) compares the existing model fit with a null model, in other words independence model by assumption of uncorrelated latent variables. CFI is a commonly used test statistic in the model fit

interpretation in SEM. Values of CFI ranges from 0 to 1. CFI close to 1 presents a very good fit. The values equal or greater than 0.9 are acceptable for CFI. which indicates that 90% of the covariance in the data can be reproduced by the given model.

(iv). Incremental Fit Index (IFI) compares the existing model fit with a null model which makes it like CFI. It is insensitive to sample size. IFI greater than 0.9 are acceptable and the maximum value of perfect fit might go over 1.0.

(v). Normed fit index (NFI) represents the proportion by which the researcher's model improves fit compared to the null model. Values of NFI range from 0 (poor fit) to 1 (perfect fit). By convention, values below 0.9 means the need for re-specification of the model.

(vi). Non-normed Fit Index (NNFI), also known as Tucker-Lewis index, compares the researcher's model with a baseline model. Values of NNFI range from 0 (poor fit) to 1 (perfect fit).

(vii). Adjusted Goodness of Fit Index (AGFI) is generally used in more complex models. AGFI adjusts GFI which is affected by the number of indicators of each latent variable. Like GFI, its range is between 0 and 1 and values greater than 0.9 are acceptable for GFI.

(viii). Root Mean Square Error of Approximation (RMSEA) presents a measure for discrepancy between the hypothesized model and the population covariance matrix. Values of RMSEA range from 0 to 1 where lower than 0.10. 0.05. and 0.01 indicate a good fit, a very good fit, and perfect fit, respectively.

- Model modification is required when the model is inconsistent with the data collected and when the estimated covariance matrix does not provide a reasonable and parsimonious explanation of the data. The model modification is achieved by changing model parameters. Some or all the parameters may be constrained to be equal across groups when analyzing samples from several populations simultaneously.

4.3.3. SEM Software Packages

There are different software programs for SEM including LISREL, SIMPLIS, SAS

CALIS, AMOS, and EQS. In this research, AMOS (Analysis of Moment Structures) is used since it has easy to follow the processes and it is a user-friendly software program.

4.3.4. Benefits of SEM

SEM serves purposes similar to multiple regression, but having superiorities over multiple regression since it includes the modelling of interactions, correlated independents, nonlinearities, measurement error, correlated error terms, multiple latent independents each measured by multiple indicators, and one or more latent dependents also each with multiple indicators. SEM can be used as a powerful alternative to multiple regression, factor analysis, path analysis, time series analysis, and analysis of covariance. SEM is more of an extension of the general linear model (GLM) of which includes multiple regression. SEM is powerful in comparing alternative models so as to determine relative model fit where regression is highly susceptible to error of interpretation by misspecification (Isik, 2009). Advantages of SEM over other methods in modeling are as follows:

- Easy to use SEM's graphical modelling interface.
- Using confirmatory factor analysis to reduce measurement error by having multiple indicators per latent variable.
- The desirability of testing models overall instead of individual coefficients.
- Testing models with multiple dependents.
- Testing coefficients across multiple groups.
- Modelling mediating variables instead of being restricted to an additive model.
- Modelling error terms.
- Handling difficult data. i.e. time series with auto correlated error. non-normal data. incomplete data.

Compared to other types of multivariate-data analysis methods, SEM has three distinct characteristics which are ability to estimate multiple and interrelated dependence relationships, ability to define a model explaining the entire set of relationships, and ability to represent unobserved concepts in these relationships and to correct measurement errors in the estimation process (Hair et al. 1998).

4.4. Analysis of the Measurement Model

First step in constructing a structural model is specification of the relationships among the latent variables and determination of the measurement method of those latent variables. 34 variables were identified as the key components of project success factors and project success criteria in this research. After that, the hypotheses were constructed among those latent variables which are "Project Managers' Skills and Qualities", "Project Characteristics", "Company Specific Factors", and "Project Success". The data collected from a total of 80 questionnaires were analyzed using AMOS, an SEM tool. Although there are different recommendations for SEM sample size, there is still no strict rule in determining an accurate sample size requirement. The sample size requirements for structural equation models vary from 30 up to 450 cases (Wolf et al. 2013). However, it is not easy to decide a correct minimum sample size considering all conditions (MacCallum and Tucker, 1991). The sample size of this research is in accordance with the researchers' recommendations (MacCallum and Tucker, 1991; Wolf et al. 2013).

4.4.1. Validity of the Project Success Measures and Indicators

Construct validity testing of project success model represents the degree to which a latent variable measure what it intends to measure. Construct validity testing consists of various sub-dimensions, all of which must be achieved to ensure construct validity. The sub-dimensions are content validity, scale reliability, convergent validity, and discriminant validity.

- Content Validity Testing: Content validity is the degree that a construct is represented by its components that cover the domain of meaning for the construct (Dunn et al. 1994). Researchers' insight and judgment are accepted to satisfy content validity since there is no formal statistical test (Garver and Mentzer, 1999). The content validity testing is conducted based on discussed or conducted studies by the academic and professional experts regarding the project success measures. In this regard, an extensive literature survey was conducted to unveil variables that define latent variables. Table 4.19 presents the latent and constituent variables.

Table 4.19. Latent and constituent variables.

Model Variables
Project manager (pm) skills & qualities
Leadership and strategic decision making skills of PM
Planning, monitoring and management efficiency of PM
Communication and social interaction of PM
Innovative and opportunity seeker PM
Technical experience level of PM
Responsibility and commitment of PM
Effective project team selection and effective team members management of PM
Clear project policies of PM
Top management handling of PM
Project characteristics
Cooperation & performance level
Clarity of project objectives
Completeness of contract
Completeness of design
Performance of other parties
Relative significance of project
Time limitation
Quality requirements
Company specific factors
Communication with other project participants
Communication with authorities
Top management support to the actions of project manager (PM)
Planning, monitoring and management efficiency of company
Project participants consultation and troubleshooting ability of company
Clear project objectives and policies of company
Financial management and solid economic structure of company
Human resources management of company
Technology utilization for information, communication, and monitoring systems
Clear and simple organizational structure of company
Experience in similar projects
Project Success
Time performance
Quality performance
Cost performance
HSSE performance
End-user and customer satisfaction from end-product
Satisfaction of project team members and co-partners

- Scale Reliability Testing: Reliability is usually defined as the consistency of measurement. In the structural model, the reliability of a measure is the magnitude of the direct relations where all variables excluding the error terms have on that measure (Bollen, 1989). The scale reliability represents the internal consistency of a latent variable and is determined by a coefficient called Cronbach's alpha. The main goal of reliability testing is to determine how well each observed indicator represents its correspondent latent variable. According to analysis results conducted on SPSS (Statistical Package for the Social Sciences). Cronbach's alpha values were all above 0.70, which is satisfactory as the minimum value recommended by Nunally (1978). Cronbach's alpha coefficients of all latent variables are provided in Table 4.20.

Table 4.20. Cronbach's Alpha coefficients of the latent variables.

Latent Variables	**Cronbach's Alpha Values**
Project manager (PM) skills & qualities	0.926
Project characteristics	0.897
Company specific factors	0.913
Project success	0.890

- Convergent Validity Testing: Convergent validity is a test to determine whether all items measuring a latent variable cluster together and form a single latent variable. There are two methods to assess convergent validity; examination of overall goodness of fit and assessment of factor loadings. Convergent validity can be assessed by the investigation of the statistical significance of each construct's factor loadings (Anderson and Gerbing, 1988). Convergent validity exists if factor loadings are statistically significant (Dunn et al. 1994). For assessment of convergent validity, the researcher should also examine overall fit of the measurement model, magnitude, direction, and statistical significance of the estimated parameters between latent variables and their indicators. The analyses conducted in AMOS resulted that all factor loadings are significant at $\alpha = 0.05$. Table 4.21 shows latent and constituent variables of the model with factor loadings.

Table 4.21. Latent and constituent variables of the model with factor loadings.

No	Model Variables	Factor Loadings
F1	**Project Manager (PM) Skills & Qualities**	-
V1	Leadership and strategic decision making skills of PM	0.822
V2	Planning, monitoring and management efficiency of PM	0.793
V3	Communication and social interaction of PM	0.707
V4	Innovative and opportunity seeker PM	0.735
V5	Technical experience level of PM	0.718
V6	Responsibility and commitment of PM	0.817
V7	Effective project team selection and team members management of PM	0.793
V8	Clear project policies of PM	0.726
V9	Top management handling of PM	0.775
F2	**Project Characteristics**	-
V10	Cooperation & performance level	0.735
V11	Clarity of project objectives	0.681
V12	Completeness of contract	0.778
V13	Completeness of design	0.534
V14	Performance of other parties	0.761
V15	Relative significance of project	0.785
V16	Time limitation	0.742
V17	Quality requirements	0.771
F3	**Company specific factors**	-
V18	Communication with other project participants	0.654
V19	Communication with authorities	0.530
V20	Top management support to the actions of PM	0.570
V21	Planning. Monitoring and management efficiency	0.768
V22	Project participants consultation and troubleshooting	0.781
V23	Clear project objectives and policies of company	0.804
V24	Financial management and solid economic structure	0.772
V25	Human resources management of company	0.771
V26	Reliable information, communication, and monitoring	0.719
V27	Clear and simple organizational structure of company	0.712
V28	Experience in similar projects	0.671
F4	**Project Success**	-
V29	Time performance	0.856
V30	Quality performance	0.847
V31	Cost performance	0.771
V32	HSSE performance	0.544
V33	End-user and customer satisfaction from end-product	0.829
V34	Satisfaction of project team members and co-partners	0.753

- Overall fit of the model can also be determined by the examination of goodness of fit indices. The goodness of fit was examined through Chi-square ($\chi 2$). This test is useful to reveal any significant difference between the actual and predicted matrices. The better fit is observed when the Chi-square ($\chi 2$) is smaller. A ratio of $\chi 2$/df (degree of freedom) is proposed as a fit measure in AMOS. Marsh and Hocevar (1985) expressed that a $\chi 2$/df ratio lower than 5.0 is an acceptable range. However, there is no agreed consensus on $\chi 2$/df value. Several other indices were also used in assessment of goodness of fit for comparing the proposed model to the null or independence model. The measures are Tucker-Lewis index (TLI) (Tucker and Lewis, 1973), relative fit index (RFI) (Bollen, 1986), and comparative fit index (CFI) (Bentler, 1990). The values of the indices range from 0 to 1.0. Values are close to 1.0 indicate a good fit. The root mean square error of approximation (RMSEA) (Steiger and Lind, 1980) involves a built-in correction for model complexity. Values less than 0.10 shows acceptable fit for RMSEA (Kline, 1998).
- Discriminant Validity Testing: Discriminant validity represents the principle that different constructs are not highly correlated to prevent constructs from measuring the same thing. Discriminant validity is satisfied when it is ensured that different constructs measure different things specifically when constructs are highly correlated or similar in nature. Items in different scales should not converge or load closely with each other since highly correlated different constructs can measure the same construct. For this reason, relatively low correlations between constructs shows the presence of discriminant validity. In this research, intercorrelations for all constructs are studied to ensure discriminant validity. The correlation matrices calculated for all constructs shows that all intercorrelations are below 0.90, which means that there is no multicollinearity (Hair et al. 1998). The investigation of intercorrelations reveals that all variables are different from each other which means that constructs have discriminant validity. Correlation matrices are presented in Appendix C.

4.5. Analysis of the Structural Model

Literature reviews were conducted comprehensively to develop a structural model. For examination of direct and indirect relations between dependent and independent variables,

SEM was chosen as the research method for the proposed model. SEM is useful to test the hypotheses between the validated constructs. Based on the hypotheses of the model, interrelations among the determinants of project success and effects of those on project success performance are analyzed.

4.5.1. Specification of the Model

Literature reviews were conducted comprehensively to develop a structural model to determine a conceptual model to picture how the project success factors named as determinants interact directly or indirectly and affect project success performance. The model was proposed as shown in Figure 4.19 based on in-depth literature review.

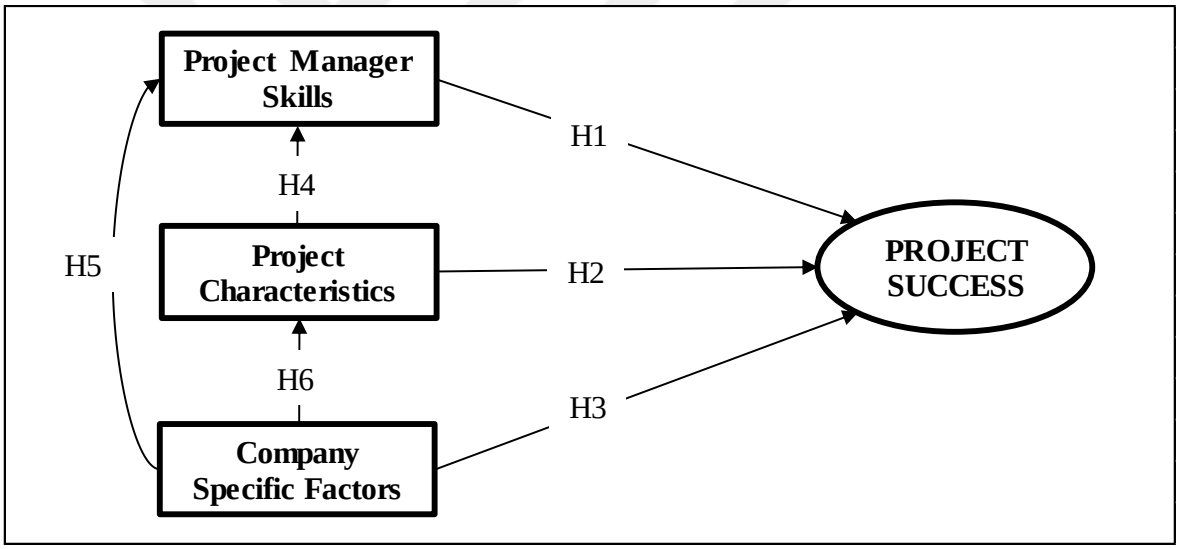

Figure 4.19. Project success framework model.

In in addition to the diagram of the model, the model can alternatively be described as a set of equations. The model is described by following the direct path equations:

- Project Success = pathcoefficient1*project manager skills+ path coefficient 2* project characteristics + path coefficient 3* company specific factors + error term 1.
- Project Manager Skills = path coefficient 4* project characteristics + path coefficient 5* company specific factors + error term 2.

- Project Characteristics = path coefficient 6* company specific factors + error term 3.

4.5.2. Estimation and Identification of the Model

Several methods exist for assessment of model estimation, maximum likelihood (ML), generalized least squares (GLS), asymptotically distribution free (ADF) estimator, and robust statistic are some of frequently used methods. ML method describes the derivation of parameter estimates, which maximize the likelihood (the continuous generalization) where the data (the observed covariances) taken from the population. ML estimators are the ones maximizing the likelihood parameters of a sample that is actually observed (Winer et al. 1991).

The population distribution for the endogenous variables is multivariate normal according to one of the assumptions of ML estimations. There are other estimation methods than ML which are based on various parameter estimation theories however other estimation methods are not used as often. The use of another estimation method requires explicit justification where ML exists (Kline, 1998).

Normality is not obliged in robust method, which is one of its' advantages. In robust method, standard errors and chi-square are corrected to non-normality case. The Chi Square test is corrected conceptually as stated by Satorra and Bentler (1994). In addition, Bentler and Dijsktra (1985) developed robust standard errors as the outputs of the robust analysis and they are treated as correct in large samples although the distributional assumption of the variables is wrong (Bentler, 2006). Robust statistics have been shown to perform better than uncorrected statistics especially where assumption of normality fails to hold although robust statistics have computationally demanding character (Chou et al. 1991; Hu et al. 1992). One of significant shortcomings of robust statistics is being only computed from the raw data (Byrne, 2006).

The selection of estimation method is dependent on the distribution of the data and the sample size. Thus, evaluation of non-normality and evaluation of sample size should be addressed at the first stage of the selection of the estimation method.

SEM usually hypothesizes the multivariate normality of data. Normality hypothesis is rejected when the estimated z-score (critical ratio) is over ± 1.96 interval in a 0.05 confidence level (Mardia, 1970). In this study, robust methodology was applied since the data was found to be non-normal. Several estimation methods are provided by AMOS such as maximum likelihood (ML), generalized least squares (GLS), unweighted least squares (ULS), Browne's asymptotically distribution-free criterion (ADF), and scale-free least squares. The model can be analyzed in AMOS using more than twenty fit statistics including Chi-square, AIC, Browne-Cudeck (BCC), ECVI, RMSEA a root mean square residual; Hoelter's critical n, and Bentler-Bonett and Tucker-Lewis indices. In this study, ML with robust estimators is directed in AMOS as previously recommended by Yuan et al. (2005). Moreover, robust model fit indices such as TLI, CFI, and RMSEA are included.

4.5.3. Evaluation of the Model Fit

Evaluation of the model fit means that how well the model explains the data. The proposed model is completed when the fit of the structural model to the data is satisfactory. In this study, it is presented that the model fit is ensured, and the model explains the data well. The initial structural equation model with the path coefficients is shown in Figure 4.20.

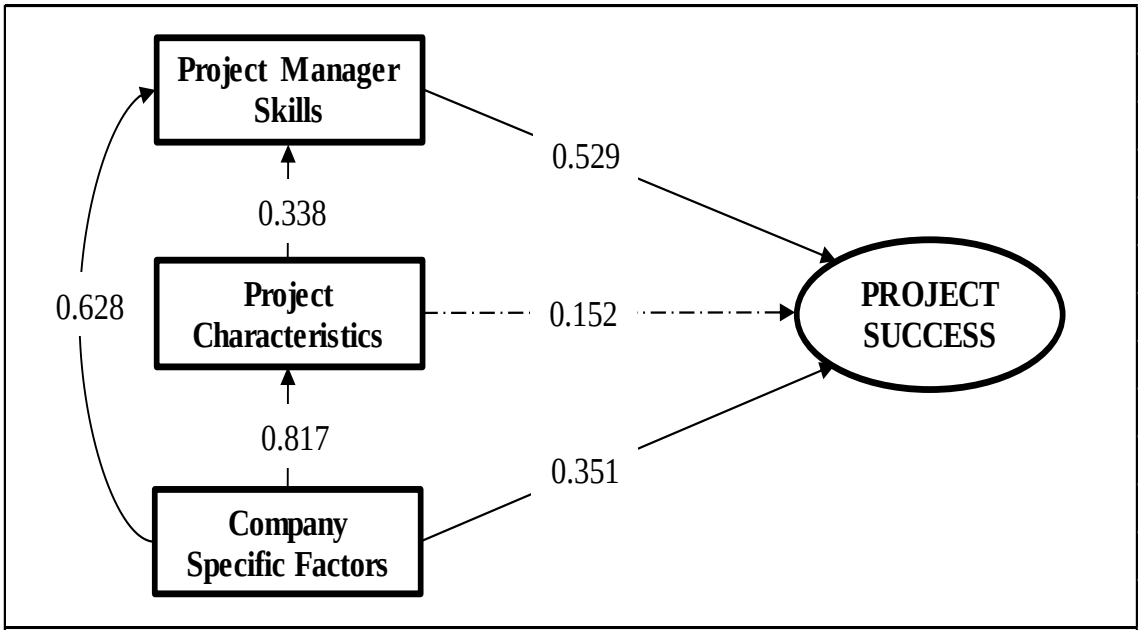

Figure 4.20. The initial structural equation model with path coefficients.

The equations are as follows based on the initial structural equation model:

- Project Success = 0.529*project manager skills+ 0.152* project characteristics + 0.351* company specific factors + 0.009D (R2=0.987).
- Project Manager Skills = 0.338* project characteristics + 0.628* company specific factors + 0.088D (R2=0.855).
- Project Characteristics = 0.817* company specific factors + 0.105D (R2=0.670).

Based on the analysis result, insignificant paths were found. The relation between project characteristics and project success (path coefficient 0.152) was found statistically insignificant at 0.05 level. Therefore, those paths were removed from the initial model. The modified structural equation model with path coefficients is shown in Figure 4.21.

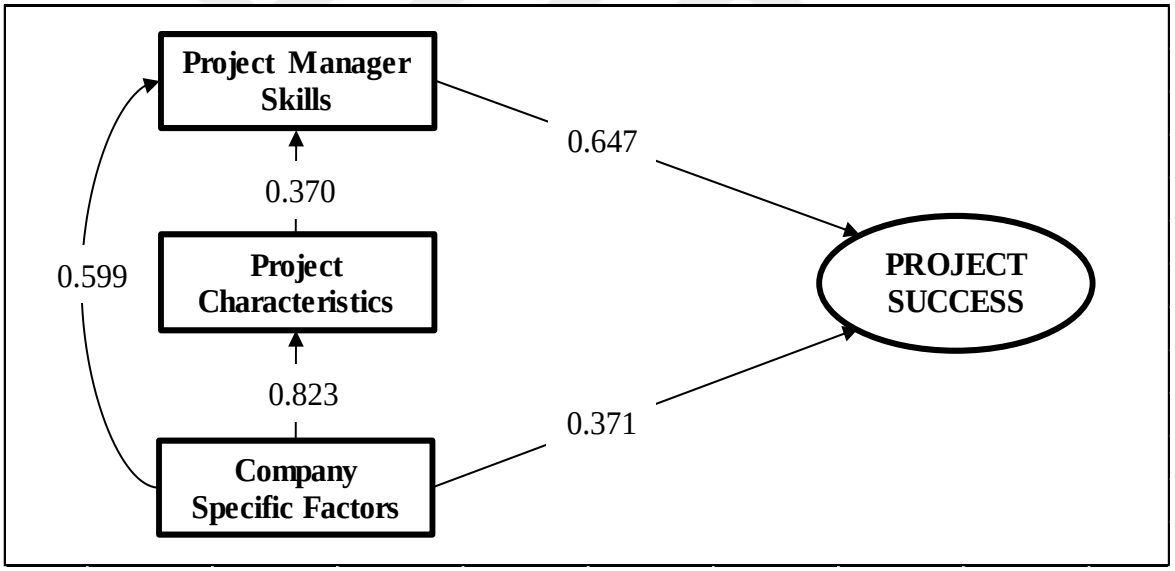

Figure 4.21. The modified structural equation model with path coefficients.

The equations are as follows based on the modified structural equation model:

- Project Success = 0.647*project manager skills + 0.371* company specific factors + 0.007D (R2=0.990).
- Project Manager Skills = 0.370* project characteristics + 0.599* company specific factors + 0.084D (R2=0.861).

- Project Characteristics = 0.823* company specific factors + 0.103D (R2=0.677).

The analysis results indicated that project manager skills (0.647) and company specific factors (0.371) have a significant and positive effect on project success. Moreover, project characteristics (0.370) and company specific factors (0.599) have a significant and positive effect on project manager skills. Additionally, company specific factors have a significant and positive effect on project characteristics. The hypotheses among those were all validated by the analyses results. On the other hand, effect of project characteristics (0.152) on project success were not found to be significant. A detailed discussion related to why some of hypotheses were not validated is given in the "summary and discussion" section.

Traditional definition of reliability is the internal consistency of the constructs. In a structural model, reliability is the magnitude of the direct relations with the measure for which the reliability is examined (except the error terms) (Bollen, 1989). In this study, assessment of the reliability test is done by Cronbach's 'α' coefficient. The reliabilities of the initial and modified model are satisfied when Cronbach's 'α' coefficient is over 0.7 (Nunnally, 1978). The goodness of fit is assessed by Chi-square test. In SEM, Chi-square ($\chi 2$) detects any significant difference between the actual and predicted matrices. The better fit is observed when $\chi 2$ value is smaller. $\chi 2$/df (degree of freedom) is used as a fit measure in AMOS. A ratio lower than 5.0 is satisfactory even though there is no agreed consensus on $\chi 2$/df value. (Marsh and Hocevar, 1985). In this study, other measures used for comparing the proposed model to the null or independence model are Tucker-Lewis index (TLI) (Tucker and Lewis, 1973) relative fit index (RFI) (Bollen, 1986). and comparative fit index (CFI) (Bentler, 1990). The values of those indices range from 0 to 1.0 where values approaching 1.0 refers good fit. However, a cutoff value of 0.9 for a measure of good fit is recommended by several studies (Mandal et al. 2011; Hsieh and Tsai, 2013). The root mean square error of approximation (RMSEA) (Steiger and Lind, 1980) is a parsimony-adjusted index. RMSEA involves a built-in correction for model complexity. RMSEA values less than 0.10 shows acceptable fit according to the researchers (Kline, 1998). However, precise numerical cutoff values for RMSEA should not be considered too seriously as indicated in several of studies (Hayduk and Glaser, 2000; Steiger, 2000). Moreover, research studies

have previously mentioned that these cutoff points are subjective measures relying on the substantial amount of experience (Steiger, 1989; Browne and Cudeck, 1993).

Table 4.22 presents the reliability values and fit indices for the initial and modified model. The $\chi 2$/df ratios were smaller than 3 as suggested by Kline (1998). The RFI, TLI, and CFI values are around 0.9, which indicates a slightly good fit of the model to the data. In addition, the RMSEA values were found to be below the recommended value of 0.10 (Kline, 1998). The correlation matrices (See Appendix C) calculated for all constructs indicate that all intercorrelations are below 0.90, which means that there is no multicollinearity (Hair et al. 1998). These values present that the fit between the final model and the data is quite satisfactory.

Table 4.22. Reliability values and fit indices for the initial and final model.

Index	**Recommended Value**	**Initial Model**	**Final Model**
Cronbach's Alpha	>0.7	0.971	0.971
$\chi 2$/df	< 3.0	1.466	1.467
RFI	0 (no fit) to 1 (perfect fit)	0.675	0.674
CFI	0 (no fit) to 1 (perfect fit)	0.877	0.876
TLI	0 (no fit) to 1 (perfect fit)	0.867	0.867
RMSEA	< 0.10	0.077	0.077

5. SUMMARY AND DISCUSSION

In this study, a questionnaire survey as a quantitative method was used to measure project success performances of construction companies. Through a comprehensive literature review and discussions with industry experts, content validity of the measures is accomplished. A structural equation model was proposed to assess the empirical validity of the measures containing reliability, convergent, and discriminant validity. The major objective of this study was to propose suitable performance metrics. In this regard, time performance, cost performance, quality performance, HSSE performance, satisfaction of project team members and client satisfaction were proposed as the valid indicators of project success performance. As the determinants of project success performance, the proposed model also included three constructs which are "Project Managers' Skills and Qualities". "Project Characteristics". and "Company Specific Factors". In the modified measurement model, all constructs of the model were validated and were found to be the best performing among the others. Therefore, there was no need to delete any of those indicators from the model. Additionally, satisfactory reliability values and fit indexes were found. Finally, after validation of all constructs in the model, the hypothesized relations between determinants and the project success performance and the relations between the determinants were tested and insignificant paths were eliminated from the model. Although project characteristics are found to be insignificant, several studies indicate that project characteristics have a significant effect on project success (Nguyen et al. 2004; Litsikakis, 2006; Chuan and Pheng, 2006; Atasoy, 2007). In the study, insignificant effect of project characteristics in the study can be explained that project manager skills and company specific factors have better performing effects than project characteristics on project success. It must be remarked that project characteristics still have an indirect effect on project success through project manager skills.

5.1. Project Managers' Skills and Qualities

According to comprehensive literature research, "Leadership and Strategic Decision Making Skills of Project Manager (PM)", "Planning. Monitoring and Management

Efficiency of PM", "Communication and Social Interaction of PM", "Innovative and Opportunity Seeker PM", "Technical Experience Level of PM", "Responsibility and Commitment of PM", "Effective Project Team Selection and Effective Team Members Management of PM", "Clear Project Policies of PM", and "Top Management Handling of PM" were determined the best performing among the others.

The analysis of the proposed project success performance model revealed that project managers' skills and qualities have a direct and significant effect (0.647) on the project success performance.

Considering the high factor loadings of the variables of project managers' skills and qualities shown in Table 5.1, recommendations to increase project success performance are that working with responsible and committed project managers (factor loading: 0.817) with high leadership and strategic decision making skills (0.822), efficient planning, monitoring, and management skills (0.793), effective team selection and management skills (0.793), innovative and opportunity seeker skills (0.735), clear project policies (0.726), good technical experience (0.718), and communication and social skills (0.707). Project managers can enable more effective project and project team with coordination of project team members to make sure completion of assignments in predetermined time (Gido and Clements, 2003). It is clear that two of project managers' skills and qualities have more effectiveness than others, where they are "responsibility and commitment" and "leadership and strategic decision making skills". Effectiveness of "responsibility and commitment" and "leadership and strategic decision making skills" on project success are repeatedly mentioned in several studies (Mustapha and Naoum, 1998; Ogunlana et al. 2000; Liu et al. 2002; Pheng and Chuan, 2006; Atasoy, 2007; Razak et al. 2009; Dainty et al. 2010).

Moreover, the model revealed that there is a strong link between project managers' skills and company specific factors (0.599) and between project managers' skills and project characteristics (0.370). Therefore, one must note that for increased project success performance, the association of project managers' skills and company specific factors and the association of project managers' skills and project characteristics should not be discarded.

Table 5.1. Factor loadings of the variables of project managers' skills and qualities.

Model Variables - Project Manager (PM) Skills & Qualities	Factor Loadings
Leadership and strategic decision making skills of PM	0.822
Planning, monitoring and management efficiency of pm	0.793
Communication and social interaction of PM	0.707
Innovative and opportunity seeker PM	0.735
Technical experience level of PM	0.718
Responsibility and commitment of PM	0.817
Effective project team selection and management of PM	0.793
Clear project policies of pm PM	0.726
Top management handling of PM	0.775

5.2. Project Characteristics

The best performing variables of project characteristics are determined according to comprehensive literature review and discussions with industry experts as "Cooperation & Performance Level", "Clarity of Project Objectives", "Completeness of Contract", "Completeness of Design", "Performance of Other Parties", "Relative Significance of Project", "Time Limitation", and "Quality Requirements". The analysis of the proposed project success performance model revealed that project characteristics has an indirect effect on the project success. However, project characteristics can affect project success through having a positive effect on project managers' skills and qualities (0.370). As shown in Table 5.2, construction companies stated that significance of the project among other projects of the company (0.785), completeness of contract (0.778), and high quality requirements (0.771) are the main indicators of the project characteristics as this also stated by several researchers Litsikakis (2006), Pheng and Chuan (2006), and Turner and Müller (2007). Considering the high factor loadings of the variables of project characteristics, one must recommend for enhanced project success performance that companies should focus on increasing performance of other parties in the projects (0.761), cooperation and performance level in the projects (0.735), and having better planning for time management in the projects (0.742). Companies should also focus on making sure project participants understand the

project objectives clearly (0.681) and having completed design (0.534) for achieving higher project success.

Table 5.2. Factor loadings of the variables of project characteristics.

Model Variables - Project Characteristics	Factor Loadings
Cooperation & performance level	0.735
Clarity of project objectives	0.681
Completeness of contract	0.778
Completeness of design	0.534
Performance of other parties	0.761
Relative significance of project	0.785
Time limitation	0.742
Quality requirements	0.771

5.3. Company Specific Factors

Company specific factors are determined by various methods. However, extensive literature review and discussion with industry experts revealed that followings are the best performing variables of company specific factors; “Communication with Other Project Participants”, “Communication with Authorities”, “Top Management Support to the Actions of Project Manager (PM)”, “Planning, Monitoring, and Management Efficiency of Company”, “Project Participants Consultation and Troubleshooting Ability of Company”, “Clear Project Objectives and Policies of Company”, “Financial Management and Solid Economic Structure of Company”, “Human Resources Management of Company”, “Technology Utilization for Reliable Information, Communication, and Monitoring Systems”, “Clear and Simple Organizational Structure of Company”, and “Experience in Similar Projects”. The analysis of the proposed project success performance model revealed that company specific factors have a direct and significant effect (0.371) on the project success. Moreover, analysis results revealed that company specific factors have a direct and significant effect (0.599) on project managers’ skills and qualities. According to responding construction companies, clear project objectives and policies of company (0.804), project

participants consultation and troubleshooting ability of company (0.781), financial management and solid economic structure of company (0.772), human resources management of company (0.771), and planning, monitoring, and management efficiency of company (0.768) are the best performing indicators of well structured corporate construction company as this also stated by several researchers Hughes et al. (2004), Camilleri (2011), and Arditi et al. (2008). Considering the factor loadings of the variables of project characteristics shown in Table 5.3, one must recommend for enhanced project success originating from company specific factors that companies should focus on benefiting from technology for reliable monitoring and information systems (0.719), having simple and well understood organizational structure in the company (0.712), increasing experiences in similar projects (0.671), and better communication and understanding with other project participants (0.654). Companies should also focus on increasing communication channels for better relationships with authorities (0.530) and providing company management level support for the decisions and actions of the project manager (0.570) for achieving higher project success with the higher corporate level of company.

Table 5.3. Factor loadings of the variables of company specific factors.

Model Variables - Company Specific Factors	**Factor Loadings**
Communication with other project participants	0.654
Communication with authorities	0.530
Top management support to the actions of project manager	0.570
Planning, monitoring, and management efficiency of company	0.768
Project participants consultation and troubleshooting ability	0.781
Clear project objectives and policies of company	0.804
Financial management and solid economic structure	0.772
Human resources management of company	0.771
Tech utilization for information, communication, and monitoring	0.719
Clear and simple organizational structure of company	0.712
Experience in similar projects	0.671

5.4. Project Success

Project success is important for construction companies. According to extensive literature research, time performance, cost performance, quality performance, HSSE performance, satisfaction of project team members, and client satisfaction are proposed as the valid indicators of project success performance. Considering the high factor loadings of the variables of project success shown in Table 5.4, companies are more sensitive about time performance (0.856), quality performance (0.847), and customer satisfaction (0.829) for managing enhanced success in the projects. Effects of time performance, quality performance, and customer satisfaction on project success are previously stated in several studies (Belout and Gauvreau, 2001; Bryde and Robinson, 2005; Wang and Huang, 2005; Turner and Müller, 2006; Dainty et al. 2010; Camilleri, 2011). Cost performance (0.771), satisfaction of project team members and co-partners (0.753), and HSSE performance (0.544) have also been indicated as the well performing indicators of project success.

Table 5.4. Factor loadings of the variables of project success.

Model Variables - Project Success Indicators	**Factor Loadings**
Time performance	0.856
Quality performance	0.847
Cost performance	0.771
HSSE performance	0.544
End-user and customer satisfaction from end-product	0.829
Satisfaction of project team members and co-partners	0.753

6. CONCLUSIONS

Construction industry becomes more dynamic day by day. Changes in technology, construction methods, and project budgets cause more dynamic construction industry. Project participants especially project managers are obliged to deal with all these constantly changing components. In this dynamic construction industry, project managers (PMs) can be main source of competitive advantage for construction companies. Efficiency of project can be improved with examination of project success and critical success factors. The main target of this study is to determine effects of two important issues. The first one is effectiveness of PMs in the Turkish construction industry, and the second one is proportional effects of critical success factors on project success of Turkish construction industry.

Comprehensive literature review was conducted to determine the most convenient components that have effect on effectiveness of PMs and project success. Then, correlation between those components were identified and the proposed model was tested based on data collected from Turkish construction companies. Structural equation modeling (SEM) was used for testing.

In this study, a project success framework model is proposed for Turkish construction companies. In this respect, project success factors were utilized as the main determinants of project success. The model consists of a total of 4 latent variables and their constituent 34 variables.

An online questionnaire survey was administered to Turkish construction companies. Within this study, 80 responses are collected from 38 Turkish construction companies. The questionnaire is composed of a total of 44 questions. Respondent companies have expertise mainly on contractors/subcontractors (76%), while small portion consists of investor (13%), project management/consultancy (6%), and designers (5%). It is seen that respondent companies have mainly have transportation projects (46%), where minority involves industrial projects (20%), heavy construction projects (13%), high rise buildings projects

(11%), and residential projects (10%). Moreover, 60% of the clients are from private sector where 40% of the clients are from public sector.

6.1. Major Findings and Contributions of the Study to Literature

Data collected from the companies were analyzed using Structural Equation Modeling (SEM), which is utilized to validate the model and test the hypotheses. Findings of the study reveal that project managers' skills and qualities and company specific factors have a direct effect on project success. Moreover, it is observed that project characteristics have no direct effect on project success. However, indirect contribution to project success by project characteristics is observed. Based on the findings of the study, following recommendations are provided to improve project success performance:

- According to findings of the study, responding companies consider project managers have the most effect on project success. Based on high effect of project managers' skills and qualities on project success, it is recommended that companies should focus on working with skilled project managers by having well-structured recruitment process for project managers. Responsible and committed project managers with high leadership and strategic decision making skills are well performing parameters of project success performance in the Turkish construction companies. Therefore, providing management and supervisory skills training and leadership development programs for project managers is recommenced for Turkish construction companies. In addition, project managers who have good social skills, efficient planning, monitoring and management skills along with effective team selection and management skills are highly effective on project success. Encouraging work progress meetings and social meetings between project managers and team members outside of work hours is recommended to increase efficiency in monitoring and management of project activities and social interaction among project team members. It is also advised for Turkish construction companies that human resources department should focus on teaming up engineers and architects who have showed good performance working together in previous projects. It is also recommended management teams of Turkish construction companies can be helpful to their project managers in achieving project

success by making sure that project policies are clearly explained to project managers and transferring technical data and strategies from previous projects to project managers. Turkish construction companies are encouraged to use their resources and support for hiring and working with skillful project managers for long term success in their various projects.

- Findings of the study are revealed that company specific factors and project characteristics have direct effect on project managers. For having enhanced project success, it is recommended that project objectives and policies of company are explained well to the project managers. It is also suggested to have good financial management by benefiting from various financial management software such as SAP, Oracle Netsuite, Procore, etc. Human resources management in the company is another a significant effect on project success. Company specific recruitment and personnel feedback processes are recommended to be structured in the company to provide efficient human resources management which can be achieved by outsourcing weak areas of human resources, deriving lessons from mistakes of human resources in previous projects and increasing efficiency with human resources software such as SAP Success Factors, Zenefits, BambooHR, and Gusto. In achieving higher project success, project managers can also benefit from improvements in various components of project characteristics. Therefore, the project contract is advised to be complete and to cover on all possible issues related the project. It is suggested to monitor the project activities and take necessary actions for improvements of performances of other parties in the projects, which will be helpful project managers in achieving higher project success. It is recommended to integrate Building Information Modeling (BIM) in the projects or at least schedule and monitor project activities on software like Primavera and MS Project.
- Based on indirect effect of project characteristics on project success, companies are advised to choose project team members suitable to each other for high level of cooperation and performance level. It is also recommended to prioritize the projects according to significance levels for the company in terms of financial management and prestige Setting clear project objectives is advised for enhanced project success. As another strategy, companies are suggested to determine quality requirements based on

the projects, the contracts and the clients for better financial and material management which can be achieved by having in-house quality check team and procedure.

- It is also revealed that company specific factors have a direct effect on project success according to findings of the study. It is advised that human resources department is carefully structured and managed by benefiting from experienced human resources specialist and managers and getting regular feedback from employees. As another strategy, it is highly recommended that having clear company policies are beneficial on achieving high level of corporate structure as well as on well-being of the project. The company policies can be emphasized by monthly email newsletters, decorating offices with slogans focusing on company policies, and annual meetings with company management team and employees. Moreover, financial management and solid economic structure of the company is an important effect in enhanced project success. Therefore, timely payments of salaries, managing always being on positive cash flow, closely planning and monitoring of company finance, benefiting from various financial management softwares (SAP, Oracle Netsuite, Procore) are highly recommended. Finally, it is advised that project participants' troubles are addressed and solved in timely manner for increased project success which can be possible by enabling easy feedback mechanism in the company.

6.2. Limitations of the Study

Limitations of the research are mainly based on data collection process. Data of the research may not cover shareholders' perspective on effectiveness of PMs in the Turkish construction companies since questionnaire survey is administered to only engineers and architects who are working in the Turkish construction companies not shareholders of the companies. Further analysis is needed to understand shareholders' perspective on effectiveness of PMs in the Turkish construction companies. Findings of the research are based on the proposed framework which represents the experiences and opinions of Turkish construction companies. In this study, perspectives of only Turkish construction companies were acquired since questionnaire survey was administered to Turkish construction companies. The main input of the study to literature is that it presents construction specific measures based on Turkish construction industry for project success performance. Data from

construction companies from different countries might result in varying findings. Study provides a general framework; the model could present different results depending on the respondent, project size, and the project type. Although sample size was small for such a statistical analysis, satisfactory results were obtained by benefiting from the robust method capability included in AMOS analysis.

6.3. Recommendations for Future Work

The proposed model is designed according to requirements of current Turkish construction industry. In future, a new model may be utilized by new data collection to track the changes in the construction industry, which will be helpful to compare the results and observe the similarities and differences between the current and future construction industry.

In addition, data from companies of other nationalities can be collected to utilize similar models using the same parameters in this study, which will be helpful to compare the results and observe the similarities and differences between Turkish and other countries' construction industry.

The proposed model is utilized based on construction industry. As a future study, the model could also be used in other industries and the results may be used for comparison.

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APPENDIX A: DESCRIPTIVE STATISTICS

As a sample questionnaire, questions asked to respondents in the questionnaire are written below.

Please answer the questions as per your experience in one of the completed projects.

(i). Please state the main business area of the company.

- Investor.
- Prime contractor / Subcontractor.
- Project management and consultancy.
- Project design.
- Other.

(ii). Please state experience of the company in the construction industry in terms of years.

(iii). Please state annual turnover of the company in terms of USD.

(iv). Please state type of the project client.

- Public.
- Private.

(v). Please state type of the project.

- Industrial.
- Heavy construction (Dam, flood control, dredging, etc.).
- High rise buildings.
- Residential.
- Highway construction.

(vi). Please state actual project duration in terms of years.

(vii). Please state total project value in terms of USD.

(viii). Please state the company role in the project.

- Partnership.
- Prime contractor.
- Subcontractor.
- Designer.
- Consultant.

(ix). Please state your position in the project.

- Project / Department / Section Manager.
- Site Chief.
- Site Engineer.
- Designer / Architect.
- Technical Office Engineer.

(x). Please state the contract type of the project.

- Lump Sum.
- Unit Price.
- Cost+Fee.
- Incentive Contract.

(xi). To what extent do the following factors describe your project manager in the project?

Table A.1. Project manager skills and qualities in the questionnaire

#	Factors	Very Low	Low	Medium	High	Very High
1	Leadership and strategic decision making skills of project manager					
2	Planning, monitoring, and management efficiency of project manager					
3	Communication and social interaction of project manager					
4	Innovative and opportunity seeker project manager					
5	Technical experience level of project manager					
6	Responsibility and commitment of project manager					
7	Effective project team selection and effective team members management of project manager					
8	Clear project policies of project manager					
9	Top management handling of project manager					

(xii). To what extent do the following factors describe characteristics of the project?

Table A.2. Project characteristics in the questionnaire

#	Factors	Very Low	Low	Medium	High	Very High
1	Cooperation & performance level					
2	Clarity of project objectives					
3	Completeness of contract					
4	Completeness of design					
5	Performance of other parties					
6	Relative significance of project					
7	Time limitation					
8	Quality requirements					

(xiii). To what extent do the following factors describe the company you were working in during the project?

Table A.3. Company specific factors in the questionnaire

#	Factors	Very Low	Low	Medium	High	Very High
1	Communication with other project participants					
2	Communication with authorities					
3	Top management support to the actions of project manager					
4	Planning, monitoring, and management efficiency of company					
5	Project participants consultation and troubleshooting ability of company					
6	Clear project objectives and policies of company					
7	Financial management and solid economic structure of company					
8	Human resources management of company					
9	Technology utilization for reliable information, communication, and monitoring systems					
10	Clear and simple organizational structure of company					
11	Experience in similar projects					

(xiv). To what extent do the following indicators describe the success of the project?

Table A.4. Project success criteria in the questionnaire

#	Indicators	Very Low	Low	Medium	High	Very High
1	Time performance					
2	Quality performance					
3	Cost performance					
4	HSSE performance					
5	End-user and customer satisfaction from end-product					
6	Satisfaction of project team members and co-partners					

APPENDIX B: DESCRIPTIVE STATISTICS

Table B.1. Descriptive statistics of general information on respondent companies.

Statistics	Age	Company Turnover ($M)	Project Value ($M)
Mean	17.19	523.50	332.84
Sum	1375.07	41880.29	26626.86
Median	17.19	250.00	165.00
Std. Deviation	7.34	702.16	396.77
Kurtosis	1.41	5.36	3.30
Skewness	0.68	2.21	1.72
Range	38.00	3499.70	1999.90
Minimum	1.00	0.30	0.10
Maximum	39.00	3500.00	2000.00

Table B.2. Descriptive statistics of project manager skills & qualities.

Statistics	V1	V2	V3	V4	V5	V6	V7	V8	V9
Mean	3.56	3.63	3.66	3.54	3.86	3.95	3.49	3.45	3.70
Sum	285.00	290.00	293.00	283.00	309.00	316.00	279.00	276.00	296.00
Median	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
Std. Deviation	0.95	1.04	1.04	1.03	0.92	0.91	0.84	0.95	0.99
Variance	0.91	1.07	1.09	1.06	0.85	0.83	0.71	0.91	0.97
Kurtosis	0.46	0.67	0.01	-0.50	-0.04	1.47	0.74	0.91	0.53
Skewness	-0.63	-0.87	-0.65	-0.32	-0.51	-1.03	-0.48	-0.75	-0.74
Range	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
Minimum	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Maximum	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00

Table B.3. Descriptive statistics of project characteristics.

Statistics	V10	V11	V12	V13	V14	V15	V16	V17
Mean	3.30	3.68	3.81	3.59	3.16	3.85	3.86	3.53
Sum	264.00	294.00	305.00	287.00	253.00	308.00	309.00	282.00
Median	3.00	4.00	4.00	4.00	3.00	4.00	4.00	4.00
Std. Deviation	0.77	0.81	0.86	0.81	0.77	0.83	0.91	0.91
Variance	0.59	0.65	0.74	0.65	0.59	0.69	0.83	0.83
Kurtosis	0.04	0.84	1.74	0.53	0.31	2.34	1.10	0.22
Skewness	-0.41	-0.66	-0.98	-0.44	0.05	-1.08	-0.86	-0.43
Range	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
Minimum	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Maximum	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00

Table B.4. Descriptive statistics of company specific factors

Stat.	V18	V19	V20	V21	V22	V23	V24	V25	V26	V27	V28
Mean	3.56	3.75	3.94	3.48	3.43	3.41	3.78	3.05	3.38	3.36	4.10
Sum	285.00	300.00	315.00	278.00	274.00	273.00	302.00	244.00	270.00	269.00	328.00
Med.	4.00	4.00	4.00	4.00	3.00	3.50	4.00	3.00	4.00	4.00	4.00
St. D.	0.67	0.91	0.77	0.78	0.82	0.84	0.94	0.91	0.95	0.86	0.84
Var.	0.45	0.82	0.59	0.61	0.68	0.70	0.89	0.83	0.90	0.74	0.70
Kurt.	-0.17	0.10	-0.05	0.45	0.12	-0.05	-0.05	-0.14	0.30	0.44	0.06
Skewn.	0.02	-0.52	-0.41	-0.74	-0.24	-0.38	-0.56	-0.20	-0.73	-1.03	-0.73
Range	3.00	4.00	3.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	3.00
Min.	2.00	1.00	2.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	2.00
Max.	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00

Table B.5. Descriptive statistics of project success criteria.

Statistics	V29	V30	V31	V32	V33	V34
Mean	3.63	3.54	3.58	3.38	3.74	3.44
Sum	290.00	283.00	286.00	270.00	299.00	275.00
Median	4.00	4.00	4.00	3.00	4.00	4.00
Std. Deviation	0.95	1.02	0.90	0.91	0.81	0.91
Variance	0.90	1.04	0.80	0.82	0.65	0.83
Kurtosis	0.24	0.22	0.47	-0.30	2.10	0.03
Skewness	-0.65	-0.58	-0.55	0.02	-0.96	-0.48
Range	4.00	4.00	4.00	4.00	4.00	4.00
Minimum	1.00	1.00	1.00	1.00	1.00	1.00
Maximum	5.00	5.00	5.00	5.00	5.00	5.00

APPENDIX C: CORRELATION MATRICES

Table C.1. Intercorrelations for the variables of project manager skills.

F1	V1	V2	V3	V4	V5	V6	V7	V8	V9
V1	1.000	0.717	0.525	0.617	0.578	0.673	0.632	0.624	0.667
V2	0.717	1.000	0.491	0.523	0.501	0.703	0.604	0.583	0.583
V3	0.525	0.491	1.000	0.642	0.542	0.541	0.536	0.499	0.688
V4	0.617	0.523	0.642	1.000	0.570	0.554	0.526	0.459	0.522
V5	0.578	0.501	0.542	0.570	1.000	0.637	0.494	0.531	0.524
V6	0.673	0.703	0.541	0.554	0.637	1.000	0.625	0.564	0.644
V7	0.632	0.604	0.536	0.526	0.494	0.625	1.000	0.670	0.666
V8	0.624	0.583	0.499	0.459	0.531	0.564	0.670	1.000	0.603
V9	0.667	0.583	0.688	0.522	0.524	0.644	0.666	0.603	1.000

Table C.2. Intercorrelations for the variables of project characteristics.

F2	V10	V11	V12	V13	V14	V15	V16	V17
V10	1.000	0.546	0.565	0.304	0.579	0.528	0.602	0.547
V11	0.546	1.000	0.678	0.355	0.493	0.475	0.558	0.526
V12	0.565	0.678	1.000	0.417	0.621	0.601	0.550	0.563
V13	0.304	0.355	0.417	1.000	0.496	0.418	0.267	0.401
V14	0.579	0.493	0.621	0.496	1.000	0.574	0.592	0.525
V15	0.528	0.475	0.601	0.418	0.574	1.000	0.627	0.657
V16	0.602	0.558	0.550	0.267	0.592	0.627	1.000	0.529
V17	0.547	0.526	0.563	0.401	0.525	0.657	0.529	1.000

Table C.3. Intercorrelations for the variables of company specific factors.

F3	V18	V19	V20	V21	V22	V23	V24	V25	V26	V27	V28
V18	1.000	0.462	0.436	0.499	0.569	0.505	0.463	0.490	0.520	0.409	0.372
V19	0.462	1.000	0.467	0.313	0.280	0.454	0.423	0.336	0.347	0.264	0.417
V20	0.436	0.467	1.000	0.409	0.402	0.355	0.523	0.401	0.381	0.360	0.325
V21	0.499	0.313	0.409	1.000	0.648	0.647	0.579	0.643	0.562	0.457	0.470
V22	0.569	0.280	0.402	0.648	1.000	0.574	0.664	0.628	0.491	0.566	0.416
V23	0.505	0.454	0.355	0.647	0.574	1.000	0.627	0.619	0.505	0.580	0.501
V24	0.463	0.423	0.523	0.579	0.664	0.627	1.000	0.588	0.494	0.524	0.560
V25	0.490	0.336	0.401	0.643	0.628	0.619	0.588	1.000	0.623	0.492	0.524
V26	0.520	0.347	0.381	0.562	0.491	0.505	0.494	0.623	1.000	0.670	0.496
V27	0.409	0.264	0.360	0.457	0.566	0.580	0.524	0.492	0.670	1.000	0.547
V28	0.372	0.417	0.325	0.470	0.416	0.501	0.560	0.524	0.496	0.547	1.000

Table C.4. Intercorrelations for the variables of project success criteria.

F4	V29	V30	V31	V32	V33	V34
V29	1.000	0.685	0.690	0.417	0.681	0.677
V30	0.685	1.000	0.655	0.479	0.774	0.643
V31	0.690	0.655	1.000	0.323	0.613	0.493
V32	0.417	0.479	0.323	1.000	0.465	0.335
V33	0.681	0.774	0.613	0.465	1.000	0.708
V34	0.677	0.643	0.493	0.335	0.708	1.000