

IMPACTS OF PARTICIPANT RELATED FACTORS
ON REBAR SUPPLY CHAIN PERFORMANCE IN SMEs

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ABSTRACT

IMPACTS OF PARTICIPANT RELATED FACTORS ON REBAR SUPPLY CHAIN PERFORMANCE IN SMEs

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The improvement of construction systems and management systems do not move together in construction industry, not using the effective management approaches decrease the productivity of the work. The firms both in national and international area in manufacturing industry use supply chain management to preserve their competitive force.

As material costs account for a high percentage of the overall cost, the success of a project is heavily dependent on material related factors and processes. In Turkey because of extensively using in-situ concrete in construction, the supply chain for reinforcement and concrete is very important. One of the components of concrete is “re-bar” and its supply chain, rbSC (rebar supply chain) was investigated within the scope of this research.

In this study a framework was developed on the basis of the information from a literature survey and a field-test consisting of face-to-face interviews and questionnaire to determine the factors affecting the rbSC externally and those related

to the supply chain participants. The developed rbSC performance framework was analyzed with Structural Equation Modeling rules. LISREL software was used, and the outputs of LISREL were evaluated by relationing with the information obtained from literature survey. The developed framework can be used to maximize both effectiveness of the rbSC process and efficiency of time and cost related issues in the rbSC. rbSC performance was associated with the project performance at the end of the study to reach a higher-level scale.

The difference between the performance ratings obtained by self-assessment of a participant and those obtained through assessment done by the others was used to determine the affects of cultural issues on performance. Common reasons for the lower performance were analyzed due to cultural context and recommendations were set down for rbSC participants to solve the problems.

Keywords: supply chain management, construction industry, factors in rbSC, rebars, culture in construction, LISREL.

ÖZ

KÜÇÜK VE ORTA ÖLÇEKLİ FİRMALARDA İNŞAAT DEMİRİ TEDARİK ZİNCİRİ KATILIMCILARININ İNŞAAT DEMİRİ TEDARİK ZİNCİRİ PERFORMANSINA ETKİLERİ

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İnşaat sektöründe, yapım sistemleriyle yönetim sistemlerinin birbirine paralel ilerlememesi ve sektörde etkin yönetim anlayışının kullanılmaması yapılan işteki verimliliği düşürmektedir. Tedarik zinciri yönetimi, günümüzde imalat sektöründe, ulusal ve uluslararası alanda rekabet gücünü korumak isteyen firmaların kullandığı ve çok yarar sağladığı yaklaşım olmuştur.

İnşaat malzemelerinin toplam maliyet içinde önemli bir yüzdeye sahip olmaları, inşaat projelerinin başarılarının malzemeye bağlı faktörlerden etkilendiğini göstermektedir. Türkiye’de inşaat yapımında yerinde döküm betonun yaygın olarak kullanılıyor olması betonarme ile ilgili tedarik zincirlerinin önemini arttırmaktadır. Betonarmenin bileşenlerinden biri olan inşaat demiri ve inşaat demirinin tedarik zinciri (idTZ) çalışma konusu olarak ele alınmıştır.

Bu tezde literatür çalışmasından ve saha çalışmalarından elde edilen verilerle inşaat demiri tedarik zincirine etki eden faktörlerin tedarik zinciri performansına etkileri modellenmiştir. Modelleme yapısal eşitlik modelleme kuralları ile LISREL

program ortamında alıřtırılmıř, elde edilen sonular yorumlanmıřtır. Yapılan bu alıřma inřaat demiri tedarik zincirini etkileyen faktrleri ve bunların iliřkilerini gsterdiđi iin tedarik zincirinin performansını arttırmak iin kullanılabilir. alıřmanın sonunda inřaat demiri tedarik zincirinin performansı proje performansı ile iliřkilendirilmiřtir.

Firmaların kendileri iin yaptıkları performans deđerlendirmeleri ve diđer firmaların onlar iin yaptıkları deđerlendirmelerde ıkan fark, inřaat demiri tedarik zinciri zerinde kltr ile ilgili konuların etkisini arařtırmada kullanılmıřtır. Dřk performans iin ortak nedenler kltrel bađlamda incelenmiř ve tedarik zinciri katılımcılarına karřılařtıkları problemleri zmek iin nerilerde bulunulmuřtur.

Anahtar Kelimeler: tedarik zinciri ynetimi, inřaat sektr, idTZ faktrleri, inřaat sektrnde kltr, inřaat demiri, LISREL.

*To my parents,
my daughter Elif Duru and my husband İbrahim*

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LIST OF ABBREVIATIONS

AE	Architectural/Engineering
BOQ	Bill of Quantity
B2B	Business to Business
CAD	Computer Aided Design
CFA	Confirmatory Factor Analysis
CFI	Comparative Fit Index
CONT	Contractor Related Factors
CSC	Construction Supply Chain
CSLP	Construction Layout Planning
CS²	Construction Supply Chain Simulator
EXT	External Factors
GA	Genetic Algorithm
GFI	Goodness of Fit Index
HTML	Hypertext Markup Language
MMAS	Max-Min Anr System
NFI	Normed Fit Index
PROJ	Project Performance Factors
rbSC	Re-bar Supply Chain
RCC	Reinforced Cement Concrete
RMSEA	Root Mean Square Error of Approximation

SC	Supply Chain
SCC	Supply Chain Council
SCM	Supply Chain Management
SUBCONT	Sub-Contractor Related Factors
SCOR	Supply Chain Operations Reference
SEM	Structural Equation Modeling
SMEs	Small and Medium Enterprise
SOAP	Simple Object Access Protocol
SRB	Supply Chain of Steel Reinforced Bars
SUP	Supplier Related Factors
TÜİK	The Turkish Statistics Agency
XML	Extensible Markup Language
XSL	Extensible Stylesheet Language
UDDI	Universal Description, Discovery and Integration

CHAPTER 1

INTRODUCTION

In this chapter are first presented, under respective sub-headings, the argument for and objectives of the study being reported on herein. Again under a dedicated sub-heading, it continues with a brief overview of the general procedure followed in its conduct and ends with a succinct description of what is covered in each of the remaining chapters, under the sub-heading titled "Disposition".

1.1 Argument

The complexities, pitfalls and ordeals of the construction industry at large are only too well known to its practitioners, worldwide. Yet no simple and straightforward means of avoiding these at one go from the onset to the very end has so far been developed and put into effect. As Kalu (2003) pointedly notes, the rate at which the construction industry adopts "modern" management techniques particularly in relation to the planning and execution of large projects continues to be relatively low when compared to other similarly "complex" ones. As with almost all other industries, one innocent obstacle that lies in the way of "progress" is the diversity of the work force both white and blue collar involved in the process.

Another in some contrast to how it is in those others is the factor of location: The simple fact that what is to be made becomes absolutely fixed in place once all the 'making' actually starts. There is no simple 'production line' where everything gets fitted as the 'product to be' moves step by step on, to finally end up 'on the market'. The production usually starts 'on demand'. The situation in the construction industry is almost impossible to manage effectively.

Be this as it may, Dubois & Gadde (2000) point out that a good number of solutions both technical, (such as pre-fabrication and modularization) and managerial (such as the 'just-in-time' and the 'total quality management'

systems) have nevertheless been proposed and put into occasional practice, albeit with limited success.

One system that has emerged over the last two decades. According to Fotwe, Thorpe and McCaffer (2001), strong claims to have finally “fit the bill” especially where the construction industry is concerned has been called Supply Chain Management (SCM). O'Brien (1998) describes this as a system that takes a holistic view of all production activities-including those of autonomous units (sub-contractors and the like) and seeks an overall optimization of these. This is in sharp contrast to the more conventional approaches of planning and contracting that merely seek to optimize individual activities.

Many authors (*e.g.*, Bertelsen & Nielsen, 1997; Othman & Rahman, 2010) concur that for the construction industry material costs account for roughly 50% of overall cost. Labor coming in second at 30%, management and supervision third at 15% and heavy equipment last at 5%. Among the overall cost of all materials as might go into any given building of a utilitarian nature, that with by far the greatest share is devoted to making just one component, which itself also happens to be almost completely hidden from view. The structure in Turkey, with the exception of certain large-scale industrial and public buildings, fire codes prescribe this structure to be in reinforced cement concrete (RCC). Statistical data from the Türkiye İstatistik Kurumu (the Turkish Statistics Agency, TÜİK) shows that this amounts to roughly 98% of all construction in terms of built floor area while of this total, about 93% consists of construction where concrete was placed in situ; in other words, with the supply chain for both the reinforcement and for the concrete of the rcc combination extending all the way to the site.

A perhaps more serious repercussion for the latter case is that the two components are not independent of each other since no concrete can be poured until all reinforcement called ‘re-bars’ for short is in place. An aspect of even greater import in this vein, *i.e.*, use of in-situ concrete, that further extends the re-bar supply chain (rbSC) arises from the additional site work brought on by way of what is known as the ‘bending schedule’.

Even this brief overview immediately suggests that potentially large economies of significant magnitude are reducing both waste of time and material in the rbSC and most so for RCC buildings put up using the *in-situ* method of construction. Be this as it may, a crucial aspect noted by Gunasekaran, Patel and McGaughey (2004) is that not many construction companies have actually succeeded in fully realizing this potential simply because they have failed to develop the performance measures and metrics needed by the supply chain (SC) system for maximization of both effectiveness and efficiency. Lee and Billington (1992) even earlier observed that the discrete sites in a supply chain cannot contribute to such maximization if each were to pursue goals independent of each other.

Such being the overall situation for RCC, by itself the most costly component of building construction, it seemed only worthwhile to further pursue the matter, in order to first define relevant factors for effecting rbSC. From this would then be developed a more comprehensive checklist to serve as a framework for not just rbSC, but also for the general case of all building components. This framework would then have to be field-tested in terms of 'real' projects so as to demonstrate the value of rbSC for the building industry in realizing the potential mentioned above.

As the evaluation of the rbSC related factors differ for importance levels and performance ratings for self-assessment and the other participant's assessments, it was noticed that there was a need to investigate. The main problem areas and the causes behind them in cultural perspective. Specific cultural dimensions were associated with the difference between the assessments of factors.

1.2 Objectives

In accordance with the salient points raised in the preceding section, the major objectives of the study in question were to:

- Review and evaluate current concepts and methods of SCM in the building industry with its sub issues.
- Determine rbSC process for SMEs (Small and medium enterprises);
- Construct a framework that consists of rbSC performance and project performance and participant related factors and their relationships;

- Analyse the impacts of participant related factors on rbSC performance;
- Analyse the impacts of cultural dimensions of rbSC participants to determine the causes of the problems in the chain;
- Develop a model on the basis of Structural Equation Modeling (SEM) to evaluate field data, as compiled by a purpose designed questionnaire, and determine the impacts of rbSC indicators on rbSC and project performance; and
- Set down germane recommendations for the perusal of construction participants in order to increase the efficiency of their SCM procedures.

1.3 Procedure

In fulfilling the objectives cited above, the procedure adopted here inevitably resolved itself into a number of discrete phases. The first of these covered a germane literature survey on SCM and the associated performance measurement phenomena, both for the general case and for the rbSC, in particular.

A preliminary field investigation was then done to determine the sample space for those construction companies considered to be qualified respondees. This was in preparation for the next phase-which consisted of a questionnaire survey and informal face-to-face interviews with the sample companies on their evaluation of proposed performance criteria.

Responses from the previous phase (data) were then compiled so as enable evaluation by the SEM technique building up “the framework” mentioned above. Self-assessment and other participant’s assessments of participant related factors were used to analyze the affects of culture on rbSC participant’s behavior. Conclusions were then formulated in order to implement specific aspects of the revised model, as different cases warranted.

1.4 Disposition

There are five chapters to this report. This first, containing the argument, the objectives and the procedure of the investigation along with this disposition, which sums up what follows in the remaining chapters, gives a broad overview of its most salient features.

The second presents a summary of literature on the construction industry at large with subtopics of site management, materials management and supply chain management, and the specific factors that have impacts on rbSC with the related subjects to rbSC performance.

The third chapter is where a thorough description of study material as both the physical setting and the potentials of this setting are provided, together with the method used in first defining the study sample and then in arriving at results.

While the fourth sets out the data collected and five sets out specific results obtained from the analyses described in the preceding chapter and discusses these in view of its objectives and the reports in the literature. The sixth concludes the study by summarizing its findings evaluates the significance of these and offers pertinent and practical recommendations for future applications.

CHAPTER 2

SURVEY OF LITERATURE

This literature review covers a total of 87 sources and 3 websites. It consists of topics related to construction industry in general, supply chain management in construction industry, factors related to supply chain performance, culture in construction and structural equation modeling.

2.1 Overview of Construction Industry

According to Vrijhoef and Koskela (1999) construction industry is a specific type of project industry with certain peculiarities which influence the characteristics of constructed products, ways of production and the industry itself. The peculiarities of the construction industry were discussed in three topics by the same authors. These topics are as below:

- Site production: Product dependent organization on outdoor conditions.
- One-of-a kind production: The uniqueness of the products according to its location, environment and etc.
- Temporary organization: The organizations usually formed as part of the products constructed.

Harbhajan (2009) defined construction as a process of building infrastructures which may be in the form of residential / commercial / institutional buildings, roads, bridges, airports, and factories. The same author determined the resources to succeed in the process of building infrastructures in six groups. These are;

- construction materials,
- man power-skilled and unskilled labor,
- construction equipment-machinery,
- power,

- construction space,
- funds.

Building projects are very complex, involving hundreds of parts and components, mostly made or assembled on site usually without any standardization (Lee, Kim, Cho and Kang, 2009). The features of construction products mentioned by Vrijhoef and Koskela (2005) are immobility, complexity, long product life cycles, high capital intensity, and high impact on surroundings. The same authors further specified the most important characteristics of the industry as fragmentation level and the low level of the efficiency.

Site management activities, construction planning and scheduling activities and material related activities are the main topics that need to be taken into consideration. Zhang, Ma and Cheng (2001) specified that site activities are not only complex but also time-consuming. Site set-up is defined by Zhang *et al.* (2001) as site space allocation for material storage, working areas, units of accommodation, plant positions, general circulation areas, and also access and egress for deliveries and emergency services. According to Zhang *et al.* (2001) construction site management involves rational layout of site facilities, optimum usage of space, and dynamic management of plants with three main issues in management, resource, time and cost. The same authors specified that organizing, planning and managing these resources influences security, machine running, material supply and power supply which in turn influence the construction progress and its cost. On the other hand Thomas, Riley and Messner (2005) specified resource planning (labor, material, and equipment), time planning and space planning as the main concerns of the site management.

For visual and intelligent management of the construction site Zhang *et al.*, (2001) developed a 4D visualization construction site management by linking a construction activity schedule to a 3D visualization model. By the way the site managers can dynamically plan temporary facilities layout and control the use of site space according to construction schedules or construction progress and relevant resource requirement.

Zhongli, Nakagava and Kensei(2010) developed a construction site work management system. It reduces the burden of input from mobile phones from the viewpoint of user-centered design to eliminate the troublesome task of writing and retyping data. By this system the foremen, the project manager, the engineers, the workers at the head offices of the contractor and sub-contractors join together to do the activities.

On the other hand Hinze (2008) defined planning as the process of defining goals, developing strategies, and utilizing tasks, schedules and resources to attain them. All construction projects require planning. They usually require their designers and constructors to produce something large and unique over a long time scale, in the open air, in a place where few or even no production facilities exist before the project starts (Vrijhoef & Koskela, 2005). Hamzeh (2009) specified that the term planning can be applied to the whole of a construction project, from beginning to end, from inception and feasibility study to final commissioning and handing over the completed works to the client. There are too many complex considerations made during the clients and contractors planning process.

Mubarek (2010) defined scheduling as the determination of the timing and sequence of operations in the project and their assembly to give the overall completion time which shows the result that scheduling focuses on one part of the planning effort. The same author determined the reasons of contractors scheduling the projects as below:

- To calculate the project completion date.
- To calculate the start and end of a specific activity.
- To coordinate among trades and subcontractors and expose and adjust conflicts.
- To predict and calculate the cash flow.
- To improve work efficiency.
- To serve an effective project control tool.
- To evaluate the effect of changes.
- To prove delay claims.

Key topics in scheduling of the projects are the completion of work, key procurement and subcontracting dates and completion of various phases like; construction, start up/commissioning, demobilization and project closeout (Douglas, 2009).

Several researchers deal with materials in the construction industry. Shmanske (2003) specified that materials constitute a large proportion of the total cost of construction and managing material related issues play a significant role in enhancing the effectiveness of a contractor. Perdomo (2004) emphasized that materials are one of the most important areas that require special attention while creating a project's master plan as well as the daily construction progress. In the study, the author developed a framework that identifies and describes all phases of materials management with detail mappings of essential decisions such as type and amount of material needed, place of material procurement, way of delivery and place of storing on site.

Hellman and Gadde (1996) specified that purchased goods and services account for more than two-thirds of total construction costs. Further they pointed out the considerable amount of indirect costs in total, which are related to the materials supply. Manufactured materials must be stored, transported and restored before it is assembled or “consumed” at the construction site.

Navon and Berkovich (2005) divide the problems associated with materials into two categories. The first group is about the problems related with the purchasing and supply of materials (scheduling the supply of materials to the site, and disparity between the order and the materials actually arriving to the site. The second group problems are related to the logistics (monitoring materials on site, follow up the movement of materials around the site and hauling of materials).

Perdomo (2004) points out that the procurement and purchasing activities are important to minimize the waste of time, labor and money. Not finishing the construction within the given duration in the contract results in penalties. Managing the flow of materials delivered to the site and within the site by means of materials handling is important to decrease the total time and cost. Warehousing activities

need taking care to minimize material wastage because of wrong site set up, unsuitable storage conditions, double handling, theft and loss. Recording the arriving and remaining materials timely and accurately is also important to decrease the waste amount and prevent payment delays (Perdomo, 2004).

The material related problems mentioned above find solutions in the definitions of supply chain management (SCM) offered by different authors. Stevens (1986) defined the SCM as “a management system to synchronize the requirements of the customer with the flow of materials from suppliers in order to affect a balance between what are often seen as conflicting goals of high customer service, low inventory management, and low unit cost”.

According to Monezka, Trent and Handfield (1998), SCM traditionally separate materials functions to report to an executive responsible for coordinating the entire material process, and also requires joint relationships with suppliers across multiple tiers. The primary objective of SCM is to integrate and manage the sourcing, flow and control of materials using a total systems perspective across multiple functions and multiple tiers of suppliers”.

Similarly Jones and Riley (1985) noted that “SCM deals with the total flow of materials from suppliers through end users”. Tan *et al.* (1998) stated that supply chain management encompasses materials / supply management from the supply of basic raw materials to final product. Min and Zhou (2002) defined a supply chain as “a combination of two main processes which are material management (inbound logistics) and physical distribution (outbound logistics) aiming to coordinate all operations within the two main processes.

2.2 Supply Chain Management in Construction Industry

Vrijhoef and Koskela (2000) defined construction supply chain (CSC) with three specific peculiarities. First one is related with the place of the activities materialized - construction factory. Second is about the instability, fragmentation, separation of the activities (*e.g.* design and construction process) in the supply chain. The third one is about the procurement system of the supply chain that it is make-to-order supply chain. Construction supplies chains characterized by the involvement

of many companies from a wide variety of types. A construction project involves a diverse group of participants including contractors, architects, engineers, laborers and developers (Issa, Flood and Caglasin, 2003).

Meng (2012) specified that a construction supply chain is more complex and involves a larger number of key participants such as project client, consultants, main contractor, specialist contractors and various suppliers. The author added that main contractor is both supplier of project client and the customer of specialist contractors. According to Meng's (2012) point of view client-contractor relationship is upstream while main contractor-specialist contractor relationship is downstream.

The planning and management of supply chains require properly specifying the participating members and relationships among them. Cheng, Law, Bjornson, Jones and Sriram (2010) determined that construction supply chains consist of numerous participants and are complex in structure.

Xue, Wang, Shen and Yu (2007) defined CSC as consisting of all construction business processes, from the demands of the client, conceptual, design and construction to maintenance, replacement and eventual decommission of building, and organizations and added that CSC is a flow of information, materials, services and the flow of funds between client, designer, contractor and supplier.

SCs can be analyzed from different point of views to increase the effectiveness and the efficiency of the process. Some authors concentrated on the areas of improving business and supply chain processes, the technologies used during the flow of process (Hong-Minh, Barker and Naim, 2001; Edum-Fotwe, Thorpe and McCaffer, 2001). Some others specified the most important issues in SC as cost, purchasing behaviour and sustainability (Proverbs and Holt, 2000; Ofori, 2000; Dubois and Gadde, 2000). One other part that was frequently analyzed by the authors was the participants of SCs, their relationships and their evaluation in the SC (Akintoye, McIntosh, Fitzgerald, 2000; Briscoe, Dainty and Millet, 2001; Carter, Smeltzer and Narasimhan, 1998).

In this section of the study, models developed for construction supply chain are examined. Different models have been proposed for construction supply chain focusing on different topics in SC.

The Oracle Company developed (www.oracle.com.tr) a framework (Figure 2.1) that includes the participants of construction supply chain and determined the value adding participant groups in the chain. Types of relationships were also determined in the framework by arrows presented with different line types. The framework is developed for large size companies. The supply chains' for large companies usually have more participant groups than supply chains formed by SMEs. As it is seen in Figure 2.1 the process is mostly managed by the main contractor, who in turn sub-contracts the separate work packages.

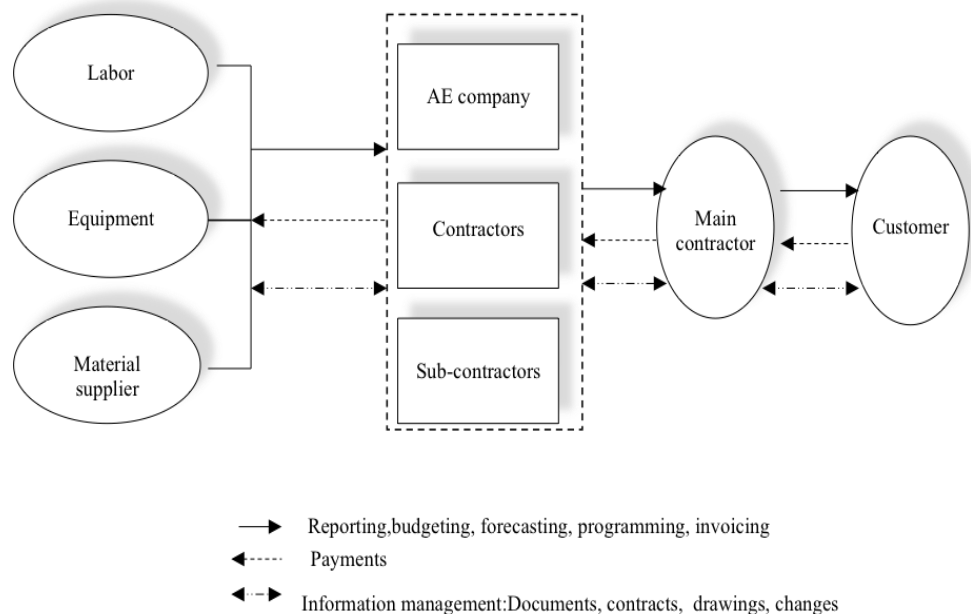


Figure 2.1 Construction industry supply chain (adopted from www.oracle.com.tr)

The Supply Chain Council (SCC) (1998), developed a framework called Supply Chain Operations Reference (SCOR) modelling for supply chain standardization, measurement, and improvement based on five key supply chain processes which are plan, source, make, deliver and return. This model was used both in manufacturing industry and construction industry.

Cheng *et al.* (2010) studied on construction supply chains. They used SCOR frameworks and developed a performance monitoring framework. This framework was adopted to service oriented areas. By this model participants relationships within the structure of supply chain determined in a coordinated way.

Min and Bjornsson (2008) developed an “agent based Construction Supply Chain Simulator (CS²) that leverages computer agent’s technology for modelling a virtual construction supply chain”. Material and information simulation can be done by this simulator. Information was collected in a global repository. Each network joint can just access to the information they required for their work process. The contractors use this system through a web browser and order their materials from the global repository.

London (2004) developed a construction supply chain model that accentuates procurement activities within the construction supply chain. Strategic supply chain procurement model is concerned with organizing and managing the assets along the supply chain for effective leverage for the client against the interests of other participants.

Perdomo (2004) developed a framework to identify and describe all phases of materials management for an integrated, holistic view of all factors that affect the total cost of materials and material shortages.

Huang (2003) developed a simulation model for a beam assembly line of steel fabrication to organize the SCM in steel fabrication construction. A linear regression model is used to provide a more precise measured unit in the steel-manufacturing phase.

Ericsson (2001) developed a simulation model of construction supply chain called “chainsim” based on a large standard project data allowing cyclical activities. The model simulated the site office, the construction site, the design offices, the subcontractors’ office and the transport company. The simulation demonstrated that better scheduling and use of resources are the most important issues in the process.

Morledge *et al.* (2004) identified a number of problems within the UK construction industry that come into being through the use of SCM as below:

- Fragmentation of participants
- Adversarial relations
- Project uniqueness
- Separation of design and production teams
- Competitive tendering.

According to Bresnen (2007) SCM is underdeveloped in construction and added that there is a need to develop learning and to move away from a project-based mindset towards a supply-chain mindset.

The objective of supply chain management is determined as minimizing the chain members total cost of manufacturing, materials, labor, transportation, inventory, and information, for all parties concerned (Schary and Skjöt-Larsen,1995). Different authors interested in different SCs in construction industry. To reach the objective written above Ericsson (2001) pointed out the importance of the relationships and the necessity of opening the companies' books to each other, to compare the cost of each stage in the chain, and to strive jointly towards a minimum cost for the whole. Below are some important studies done for construction SCM which are helpful to provide an approach for rbSC.

Polat (2005) developed a simulation-based decision support tool for contractors to assist them in selecting the most economical materials management system by recommending buffer sizes, a scheduling practice, and lot sizes given the special conditions of the project. The author focused on the supply chain of reinforcing steel bars (rebar). Three case studies were taken into account to take decisions about buffer size (large, medium, small) and scheduling practice (optimistic, neutral or pessimistic) and lot size (large and small). In the case studies, using the developed simulation-based decision support tool provided the contractor with a cost saving of 4.2-7.3%.

Castro (2003) concentrated in the development of a business-to-business (B2B) e-work solution for the integration of the supply chain of rebar. Supply chain

of steel reinforced bars (SRB) was analyzed and an e-Business solution was developed for the integration of quantity take-off and procurement of SRB by using HTML, XML, XSL and Javascript. The expectation and satisfaction for the B2B e-work system determined to analyze the performance of the proposed B2B e-work solution among the users (designer, contractor and rebar supplier). Electronic tools, new approaches in information exchange and integration is composed in this B2B e-work solution.

Tserng *et al.* (2006) developed a rebar supply chain model of a steel factory that can be used by raw material suppliers, owners and steel factories. Optimization of the process decrease the inventory cost.

Anson and Wang (1998) made a research to utilize the labor and equipment resources in situ concreting of buildings in Hong Kong. Construction sites and ready mixed plants were observed to obtain productivity information. Planting rates, pour size, type of pour, supply of concrete have been studied and benchmarks have been produces for Hong Kong and comparison with other countries with other countries were made.

Although different researchers have analysed the SC for different materials to increase the effectiveness of the process there is a gap in the area of developing a model that consist of participants of rebar supply chain and their inter relationships. Especially for SMEs. Therefore, this study focused on the performance of rbSC on the role of participants in small and medium sized projects.

2.3 Factors impacting rbSC performance and project performance

This section focuses on the factors that have impacts on the rebar supply chain (rbSC) performance and project performance in order to determine the participants of the rebar supply chain. The factors studied in literature were analysed to determine the factors that will be used in the questionnaire survey of this study. The participants of rbSC for SMEs were determined through the literature survey and through the evaluation of this literature survey with the contractors who were interviewed before preparing the questionnaire. For this study the factors effecting rbSC performance were grouped as participant related factors and external factors.

The main participants of rbSC are main contractors, who undertake the construction of the project and are referred to as the contractor in this study; sub-contractors, suppliers and AE companies. The information gathered from literature for the factors determined were summarized in the following sections.

2.3.1 Contractor related factors

Polat (2005) specified the contents of the activities of rbSC with the designing, detailing, reckoning, milling, fabricating, delivery and assembly. The details that were written under the activities were analysed according to the doer of the activity by the help of the interviews. The activities of contractors in rbSC can be listed as follows:

- Analyzing the projects (architectural, mechanical, electrical),
- Preparing quantity surveys,
- Prepare the order according to master supply schedule,
- Prepare the procurement process of rebar,
- Negotiate with the rebar fabricator and approve it,
- Control the installed rebar,
- Plan and manage the financial issues about the procurement of suppliers and sub-contractors (Polat, 2005).

Problems related to managing the flow of materials can be found in every organization. Materials account for a big part of products and project costs (Perdomo, 2004).

Past experience of the contractor is an important variable for measuring performance. Past performance focuses on the quality of the contractor's past work. Holt, Olomolaiye and Harris (1994) specified that contractors past experience in terms of size of the projects completed plays an important role in the overall satisfaction of the client with the construction projects.

Briscoe *et al.* (2001) specified the issues related to problem solving in construction industry with the words of “Problem solving often involves a set of specific knowledge-based abilities to overcome design, production, and plant and

transport difficulties. Many SME companies, which engage in highly specialized activities, are likely to exhibit strong skills in these areas, but often such skills will have been acquired through learning-by-doing.“ (Briscoe *et al.*, 2001)

A number of attributes that will affect contractor related factors, including insurance cover, operating and machinery, communication system, efficiency of cash flow methods are related to the economic power of the contractor and have affects on SC success (Chan *et al.*, 2004).

Palaneeswaran, Kumaraswamy and Zhang (2001) identified a generic source selection process among those ‘competent’ and ‘credible’ applicants whose performance can be expected to best meet the clients’ requirements. In this paper source selection processes along different construction supply chain routes were examined. Source selection was used as a generic term including the selection of contractor, suppliers, vendors and design builders. To reach the best performance by the determined source selection was the main aim in the paper. Past experience, past performance, financial capabilities (annual turnover, net tangible assets, liquidity), quality concerns (ISO 9000 certification), organization and management system (documentation system, communication system, project management, design and construction control, organizational structure, organizational culture, staff motivation, staff training, materials management), team relationships, technology using capacity (specialized equipment), insurance cover (coverage of defects liability, coverage of workers, coverage of damages/injuries), equipment (ownership of equipment), human resources (qualification and amount of qualified managers), partnering (partnering experience and performance), location of the head office are the measures used in the framework developed by Palaneeswaran *et al.* (2001) to reach best source selection in the supply chain that consists contractor, designer, sub-contractor and vendor.

A wide range of generic skills in use across all industrial sectors was formulated by the recent British Skills Survey (Ashton, Davies, Felstead and Green, 1999). Briscoe, Dainty and Millet (2001) examined the skills requirements necessary for effective supply chain partnerships in accordance with the British Skills Survey in the construction industry. The skills related to contractors are;

- Client-contractor relationships,
- Planning and problem solving capability of the contractor (work scheduling-networking, trouble shooting and problem solving),
- Manual skills of the contractor (operating and machinery).

2.3.2 AE company related factors

Analyzing technical documents, preparing pre-designs, structural design of the project, preparing detailed cut and bent rebar drawings, preparing design changes were specified as the AE companies workloads in rbSC by Polat (2005). Specialized expertise of design team, their usage of information and CAD technologies, their organizational culture to form a coordination with the other participants and working related with work schedules to prevent design delays were assessed as important points in the survey as Palaneeswaran *et al.*(2000) mentioned in their paper.

With the use of internet, data can be exchanged effectively in spite of geographic constraints. Web-based technologies developed such as Extensible Mark-up Language (XML), Simple Object Access Protocol (SOAP), Universal Description, Discovery and Integration (UDDI) and e-work, the Internet provides a suitable platform for the success deployment of e-Business in the construction industry (Castro, 2003).

Formal and informal design communication, design completeness in the beginning of construction process, level of modularization, level of automation and design control meetings are some of the critical success factors determined by Kog and Loh (2012) that are related to instructiveness of the design group.

Skill requirements for designer participants in construction supply chain are collected under design communication heading (Briscoe *et al.*, 2001). The authors emphasize that design companies need to communicate effectively with those other participants and transfer drawings and details in the supply chain by using computer technology.

2.3.3 Sub-contractor related factors

Chun *et al.* (1999) defined project participants as the key players, including project manager, client, contractor, consultants, sub-contractors, supplier and manufacturers. The rebar sub-contractors duty can be summarized as to prepare the rebar according to the technical drawings and place the cut and bent rebar in formwork (Polat, 2005). Their duty starts just after the excavation of the site. Briscoe *et al.* (2001) explored some skills for the participant of the supply chain for more efficient supply networks. For sub-contractors, skills to increase the efficiency were divided into two main categories: “hard” skills of vocational nature and “soft” skills which are generic and are applied most commonly in non-manual works.

Skills related to sub-contractors that were determined by Briscoe *et al.* (2001) for effective supply chain partnerships in the construction industry are as follows:

- Writing and reading skills: Managers of the participants of the supply chains do not have further and higher education qualifications. Writing/reading technical documents are essential for successful partners.
- Teamwork: Leadership and motivation of workforce are critical for success of the groups. For smaller companies that take role in the supply chain having managers that have ability to lead their staff through the process and achieve good relationships within their working groups is very important.

Gunasekaran, Patel and Mc Gaughey (2004) specified the importance of performance measurement and metrics in setting objectives, evaluating performance. The authors developed a framework to promote a better understanding of importance of SCM performance measurement and metrics. Performance measures and metrics were presented considering the four major supply chain process (plan, source, make/assemble/ and deliver) in this study. Percentage of defects, capacity utilization, was two metrics used under make/assemble activities.

Hanafi, Khalid, Razak and Abdullah (2010) identified the main factors influencing labor productivity in the operation of the installation of prefabricated

components at construction sites. The authors used 42 factors to assess the labor productivity and identified the most important factors as follows:

- Planning and scheduling of work
- Availability of machinery and components
- Project design team professionalism
- Competency of site supervisor
- Skilfulness of workforce
- Availability of precise tools and workforce
- Adequate information and implementation control level of fixing the component at construction sites.

Jiukental (2009) identified 83 factors affecting construction labor through two latent variable groups. The first group was related to direction, coordination, engineering and drawing management, construction equipment and material. The second group consists of project management related factors, foremen competency, training, worker qualification.

2.3.4 Supplier related factors

Suppliers play important roles in supply chains. Perdomo (2004) specified the relationship between the contractor and supplier crucial for the success of a project. He added that the good relationship with the suppliers, increase the expectation of better prices and more reliable delivery dates. Good relationships are important for lower costs. Ordering materials with lower prices without problem is possible on good terms. On the other hand bad relationships caused late and wrong deliveries which effect the total cost and completion day of the product.

Capability of supplier, competency of supplier's proposed team, supplier team turnover rate, supplier top management support, supplier track record, suppliers' level of service are the supplier related success factors determined by Kog and Loh (2012).

Price stability, total cost, failures prevention, appearance and function, on time delivery, technical assistance and support, cooperation and communication, buyer-

supplier relationship, capability, reliability, flexibility, payment terms, reputation, and past records were the criteria developed for an effective and efficient material supplier selection for property developers by Lam, Tao and Lam (2010). The model was used for four material purchases for validation and the results revealed that the model can be adopted in construction materials supplier selection by the property developers.

As mentioned under sub-contractor related factors, Gunasekaran *et al.* (2004) developed performance related metrics related to four supply chain activities. The metrics specified under source and delivery activities were mostly related to the suppliers. “Supplier delivery performance, supplier lead-time against industry norm, supplier pricing against market, efficiency of purchase order cycle time, efficiency of cash flow method were the metrics defined for source activities. Quality of delivered goods, on time delivery of goods, effectiveness of delivery invoice methods, number of faultless delivery notes invoiced, percentage of urgent deliveries, delivery reliability performance were the metrics defined under delivery process.” (Gunasekaran *et al.*, 2004)

Briscoe *et al.* (2001) determined supplier communication as a skill requirement for effective supply chain in the construction industry. Since the profitability of the companies in the chain determined by the ability to obtain supplies of right quality, on time at the most favoured prices purchasing and order chasing and product knowledge were found to be important attributes.

2.3.5 External factors

Chan and Chan (2004) specified the importance of “environment” since it has an effect on project performance. In their papers, the authors described “environment” as all external influences on the construction process, including social, political, and technical systems. The variables used to measure this factor were specified as economic, social, political, physical, industrial environment and the level of technology advanced (Chan and Chan, 2004).

Kog and Loh (2012) determined different critical success factors (CSFs) for different components of construction projects as perceived by different professions.

Political risk, economic risk, approval authorities and legal issues related risks are the ones related to external issues.

2.3.6 rbSC Performance

Gunesekaran *et al.* (2001) specified that the efficiency of the process is one of the key factors of SC, the amount of missing / wrong / damaged / defective products are important to minimize the unit cost of the product. To increase the profitability of the project the amount of missing/wrong/damaged/defective products should be low.

Responsiveness to customers is about the time between the demand and its delivery to the customer. It is important for customer satisfaction and schedule performance of the project (Chen *et al.*, 2004).

Kumar *et al.* (2006) specified the importance of the flexibility in supply chain. The authors added that flexibility is mandatory for company's competitiveness and saw flexibility as a reaction to environmental uncertainty. On the other hand Upton (1994) specified flexibility as "the ability to change or react with little penalty in time, effort, cost or performance". Supply chain flexibility was analysed in three topics. The first one was about the product flexibility which was about the ability to customize product or service to meet customer specification. Second one was the volume flexibility that was about the ability to adjust capacity to meet changes in demand. And lastly new product flexibility was deal with the ability to rapidly introduce new products (Agus, 2011). Volume flexibility is important for all of the SC participants, as it is about the ability to increase and decrease the production or material amount. New product flexibility is mostly related to the AE companies as it deals with the ability of planning, producing new projects (Agus, 2011).

Frohlich and Westbrook (2001) classified supply chain integration into two types. Coordination and integration of the suppliers, manufacturers and customers for the flow of materials was in the scope of the first type. The second type was about the backward flow of information from customers to the raw material manufacturers. Stock *et al.* (2000) analysis supply chain integration with the groups take part in.

Lee (2000) suggested three key dimensions that constitute supply chain as;

1. Information integration (sharing information and knowledge among supply chain members),
2. Coordination (redeployment of decision making authority, work and resources),
3. Organizational linkage (tight organizational relationships with supplier).

Stock *et al.* (2000) analysed SC integration for both information flow and collaboration of the participants. Good communication and information flow are the keys to the effectiveness of the execution of integration. SC integration is important for measuring the level of the SC strategy perception. As it is difficult to implement a SC system with its rules, competitive advantage through other companies in the sector will be the result. Without integration, each company will continue to maximise the achievement of its own objectives (Qrunfleh, 2010).

2.3.7 Project Performance

Chan and Chan (2004) specified that process success should be estimated according to its confirmatory to the specifications determined for the project. Reaching to the specified outcomes is an ultimate goal for every project. Different researchers determined different factors to measure project success. According to Parfitt and Sanvido (1993) “success is an intangible perceptible feeling, which varies with different management expectations, among persons with the phases of the project.” Chan and Chan (2004) specified some basic criteria for project success as cost, time and quality. Pinto and Pinto (1991) add project psychosocial outcomes like satisfaction of interpersonal relations and satisfaction of the participants with the outcomes to the measures of project performance. Subjective measures such as participants’ satisfaction level are known as “soft” measures (Chan & Chan, 2004).

Kometa, Olomolaiye and Harris (1995) used a more comprehensive approach to assess project success by including safety, economy (construction cost), running/maintenance cost, time and flexibility to users. Kumaraswamy and Thorpe (1996) included meeting budget, schedule, quality of workmanship, client and

project manager's satisfaction, transfer of technology, friendliness of environment, health and safety to the basic measures (time, cost and quality).

Atkinson (1999) divided the project in two stages to assess the project success. The first stage namely, delivery stage the measures were defined to reach the aim "doing it right". This aim consisted of cost, time, quality and efficiency. Then, in the first post delivery stage the aim is "getting it right" with the meaning of benefitting all stakeholders. In the second post delivery stage the aim is "getting them right" that pointed the customer and success of business.

2.4 Overview of Culture

Baskerville (2003) pointed out the difficulties in giving a specific definition for the term "culture" since the points of views differ for different disciplines. Hofstede and Hofstede (2005) defined culture as the collective programming of the mind that distinguishes the members of one group or category of people from another. On the other hand Maloney and Federle (1991) defined culture as "the set of assumptions shared by members of the organisation about the desired and appropriate behaviours, including how these assumptions are reinforced and how they are communicated to members, old and new".

According to Hofstede and Hofstede (2005) there are four terms that covers the total concept to describe cultural differences. These are symbols, heroes, rituals and values. Symbols are used for the words, gestures, pictures, or objects that have a meaning only recognized by those who share the culture. Heroes are defined as the persons, alive or dead, real or imaginary that serves as models for behaviour. On the other hand, rituals are collective activities to reach desired ends within a culture. Finally, values are defined as the broad tendencies to prefer certain states of affairs over others.

A different statement was that "culture involves at least three components: what people think, what they do, and the material products they produce. Thus, mental processes, beliefs, knowledge and values are aspects of culture. Culture also has several properties: it is shared, learned, symbolic, transmitted cross-

generationally, adaptive and integrated.” (Bodley, 1994). Bodley (1994) also added that a human can learn culture.

Group property instead of individuals, dealing with emotions and intellect, sharing experiences of groups from the history, using symbols, changeability because of the changing circumstances of groups, fuzziness because of contradictions, paradoxes, ambiguities and confusion are the aspects identified by Cameron and Quinn (2005) that are widely concurred by the researchers studied on this issue.

Ankrah and Langford (2005) pointed out the different culture dimensions mapping the cultural differences. They did this by values and practices adopted by the organization. Hofstede and Hofstede (2005) defined a dimension as an aspect of a culture that can be measured relative to other cultures.

The survey administered by Hofstede between 1967-1973 was answered by the respondents more than fifty countries which meant that a large sample. First of all four basic problem areas corresponding to four dimensions were defined. After some research Hofstede (2001) added the fifth dimension to his study. The five dimensions developed by Hofstede are described below (Hofstede and Hofstede, 2005).

- *Power distance*: The equality between the members of the institutions or organizations is the main expectations for the countries. The family, the school and community are the groups that can be specified under institutions and the spaces where the people work can be specified under organization term.
- *Collectivism versus individualism*: Individualism refers to weak interrelations for individuals and collectivism refers to strongly related individuals or groups.
- *Femininity versus masculinity*: Masculine society is the one which there is a distinction between man and women and on the other hand in feminine societies the roles are overlapped for the genders (Hofstede and Hofstede, 2005).

- *Uncertainty avoidance*: The essence of uncertainty is related to the subjective experience of a feeling.
- *Long-term versus short-term orientation*: In long-term orientation future related issues are important. On the other hand, short-term orientation deals with the past and present issues.

Another well-known classification used in the business world is done by Trompenaars (1993). According to the results gathered from a survey conducted in 39 countries, a seven dimensions group was developed to differ the values between cultures. These dimensions are:

- 1) universalism versus particularism,
- 2) individualism versus communitarianism,
- 3) diffuseness versus specificity,
- 4) affectivity versus neutrality,
- 5) achievement versus ascription,
- 6) relation to nature and
- 7) time orientation.

The universalism-particularism dimension addresses the significance of rules versus relationships. People in universalistic cultures believe general rules, codes, values, and standards take precedence over particular needs. The law is considered more significant than human-being's relationships universalistic cultures. Particularistic cultures view the ideal culture in terms of human friendship, extraordinary achievements, and intimate relationships (Trompenaars and Woolliams, 1999).

As for the individualism versus communitarianism dimension, people in individualistic cultures are more concerned about their personal growth. Communitarianism cultures are more concerned about the overall good of the group (Trompenaars and Woolliams, 1999).

Specific individuals concentrate on hard facts, standards, and contracts. In diffusely-oriented cultures, all relationship elements are related to each other. (Trompenaars and Woolliams, 1999).

The affective versus neutral dimension deals with emotions' concealing or showing. In an affective culture, people do not object to the display of emotions. In a neutral culture, it is incorrect to express feelings overtly (Trompenaars and Woolliams, 1999).

The inner- directed versus outer-directed dimension explains the differences in perception to whether people control the environment or vice versa. The way people relate to their environment is linked to how they control their own lives and destiny. Internalistic people see nature as a complex machine controlled with the right expertise. They do not believe in luck or predestination. Externalistic people see mankind as one of nature's forces, so they should operate in harmony with the environment. They do not believe they can shape their own destiny. Dilemmas arising include being driven by conscience or responding to outside influence and creation of one's own strategy or diffusing with others (Trompenaars and Woolliams, 1999).

The sequential versus synchronic time dimension describes if things are completed one after the other or altogether. Every culture has developed its own response to time. In a sequential approach, time moves forward in a straight line with one thing achieved at a time. Time commitments are a must and plans are rigid. In a synchronism approach, time moves round in cycles, with people doing several things at a time. Time is flexible and plans are easily changed to complete interactions satisfactorily. Promptness depends on the type of relationship (Trompenaars and Woolliams, 1999).

The third important study on culture was done by Schwartz (1999). Schwartz (1999) identified seven types of values, structured along three polar dimensions. These are;

- conservatism versus intellectual and affective autonomy,
- hierarchy versus egalitarianism,
- mastery versus harmony.

Conservatism was defined as a cultural emphasis on maintenance of the status, propriety, and restraint of actions and inclinations by Schwartz (1999). With

this definition one pole of the first dimension is related to the cultures in which the person is viewed as an entity that is embedded in the collectivity and find meanings through social relations. Autonomy in the first issue was defined as a cultural emphasis on the desirability of individuals independently pursuing their own ideas and intellectual directions by Schwartz (1999). The opposite pole in the first dimension is related to the cultures in which the person is viewed as an autonomous, bounded entity who finds the meaning in his or her own uniqueness. Hierarchy was defined as the cultural emphasis of the legitimacy of an unequal distribution of power, roles and resources by Schwartz (1999). The pole related to hierarchy uses power differences relying on hierarchical systems. On the other hand egalitarianism was defined as a cultural emphasis on transcendence of selfish interests in favour of voluntary commitment to promote the welfare of others by the same author. Opposite to hierarchy in egalitarianism basic interests and resources are shared. In mastery the aspiration to change the world through active self assertion rather than trying to fit as it was in harmony is the main issue (Schwartz, 1999).

The Global Leadership and Organizational Behaviour Effectiveness (GLOBE) research project focuses on relationships between societal culture, organizational culture and leadership (Hofstede, 2001). Power distance, uncertainty avoidance, social collectivism, in-group collectivism, gender egalitarianism, assertiveness, future orientation, performance orientation, and humane orientation are the nine dimensions that the project consists.

2.4.1 Organisational Culture

Culture within organizations is reflected in the way that people perform tasks, set objectives and administer the necessary resources to achieve objectives. Culture affects the way that people make decisions, think, feel and act in response to the opportunities and threats affecting the organisation (Thompson, 1993).

Hofstede and Hofstede (2005) indicated that organizational culture has become as fashionable a topic as organizational structure, strategy and control and added that most definitions related to that topic consisted of the issues as holistic (referring to a whole more than the sum of its parts), historically determined (reflecting the history of the organization), rituals, symbols, socially constructed

(created and preserved by the group of people who together form the organization), soft and difficult to change. With the help of these issues the authors defined organizational culture as the collective programming of the mind that distinguishes the members of one organization from another.

According to Hostede and Hofstede (2005) national cultures are part of the mental software we acquired during the first ten years of our lives, in the family, in the living environment, and at school. On the other hand they pointed out that the organizational cultures are acquired when we enter a work organization.

Every organization has its own culture or shared systems of meanings that differentiate its members from other organizations' members (Hofstede and Hofstede 2005). Hofstede *et al.*'s (1990) organizational culture dimensions are defined as follows (Hofstede, 1998):

1. Process-oriented versus results-oriented is related to the peoples' behaviour to risky situations. In process-oriented cultures the main aim is to avoid the risks but in result-oriented cultures, people perceived themselves as comfortable in unfamiliar situations and as putting in maximal effort;

2. Employee-oriented versus job-oriented culture is related to the value given to the employee. In employee-oriented cultures organizations took a responsibility for employee welfare. Oppositely in a job-oriented culture to complete the job is the first aim.

3. Professional versus parochial culture is about the level of members feeling of organization's norms covering their behaviour. Parochial culture member's behaviour usually covered with their organization's norms both at home and on the job. On the other hand professional culture members considered their private lives out of the job;

4. Open system versus closed system is about the openness of the organization to a new employee. Open system cultures help the new employee to feel at home but in closed system cultures the organization and its people are secretive, only very special people fitted into the organization;

5. The loose control versus tight control dimension refers to the tightness degree of the organization. In loose control units the thought of cost, meeting times were only kept approximately and jokes were frequently made. In tight control units the work is cost conscious, meeting times were kept punctually, and jokes were rare.

6. The normative versus pragmatic dimension deals with the popular notion of customer orientation. Pragmatic units were market-driven whereas for the normative units the major emphasis was on organizational procedures which were more important than results.

Cameron and Quinn (2005) determined four types of organizational culture based on two dimensions. The first dimension distinguishes effectiveness criteria that emphasises flexibility and dynamism from criteria that emphasise stability order and control. The other dimension differentiates effectiveness criteria that emphasise an internal orientation, integration and unity from criteria that emphasise an external orientation. Cameron and Quinn (2005) defined four clusters of criteria to make judgments about organisations. These are clan, adhocracy, hierarchy and market.

2.4.2 Culture in Construction

There is a growing interest in the studies on the culture of the construction industry, projects, and the effects of culture and cultural differences on construction. According to Harvey and Ashworth (1993) the construction industry has different from all other industries. The special characteristics that are seen in construction are listed below:

- the nature of the product done;
- make-to- order product;
- unique;
- temporary organisations;
- organisation structure and price determination in the industry.

Burthorpe, Duncan and Miller (2000) studied the subject of “culture” in literature, the construction industry culture view. The issues related to crisis, conflict, masculinity and embracing a casual approach to the work norms of punctuality, commitment and safety were come front for construction culture.

Architects, surveyors and clients were found to have significant roles in the culture of the construction industry.

Ngowi (2000) discussed the effects of cultural differences between the TQM approach and the cultural context at both industry and national levels. Botswana construction industry was analyzed to determine the implementation of TQM with cultural characteristics. At the end it was indicated that TQM implementations usually conflicts with the national culture.

Brockmann and Birkholz (1999) evaluated the professional culture of civil engineers and mechanical engineers and specified that two professional cultures are as distinctively different as their organization, their management and their technology. By the interviews administered with construction industry members and automobile industry members, the authors identified that there are significant differences between these two industries. The comparison done for two industries due to culture is shown below.

Table 2.1 Comparison of the cultures (construction industry and manufacturing industry)

Culture	
Construction industry	Manufacturing industry
Not well defined	Well defined
Highly communicative	Little communicative
Result oriented	Process oriented
Professional	Organizational
Pragmatic	Normative

Rahman, Kumaraswamy, Rowlinson and Sze (2003) indicated that improving internal critical success factors of construction companies provide harmonious work among parties in the chain and build required project cultures both for short term project success and for long term organizational and industry improvements. They specified the key requirements as the “flexible organizational cultures” of the involved organisations.

Ankrah (2007) developed a theoretical model including the relationship between organizational culture and performance of the construction industry.

Lorenz and Marosszeky (2007) addressed cultural issues in global construction sector and determined the differences in technical and cultural practices between markets, knowledge of local regulations and practices which are important for success of global construction businesses.

Ankrah and Proverbs (2008) analysed the impacts of factors on culture of a construction project organization through the data obtained from 64 questionnaires filled by the experienced practitioners in the construction industry in UK. Five principal cultural dimensions were developed. These dimensions were workforce orientation, performance orientation, team orientation, client orientation and project orientation. The results revealed that these five dimensions are associated with some project characteristics like project size, complexity, influence of participants like the quantity surveyor, client and main contractor, level of importance of cost, health and safety, location.

Yazıcı, Giritli, Oraz and Acar (2007) examined the cultural profile of construction organizations within the context of Turkish construction industry. The authors developed a questionnaire based on Organizational Culture Assessment Instrument (OCAI) which was developed by Cameron and Quin (1999) and collected data from 134 construction companies. The findings in this study revealed that the Turkish construction industry has been dominated by firms with a mixture of clan and hierarchy cultures. Moreover, the the results specified that type, size, age of the firm cause differences at organizational level.

Ozorhon, Arditi, Dikmen, Birgonul (2008) analyzed the effect of cultural similarity/difference for international joint ventures (IJV). The results of this study revealed that differences in organizational culture have an impact on IJV performance with the view point of national and organizational characteristics of partner companies.

Kıvrak (2010) investigated the effects of cultural differences on management practices of Turkish construction companies. By examining cross-cultural

knowledge management applications in these projects and observed that national culture differences have a direct affect on some project management practices like; knowledge management, time management, human resource management, negotiation and contract management.

In the scope of this study, culture is used for evaluation of the assessments of the projects. The effects of cultural related issues were not analysed for participants of supply chains in the previous studies. It was seen that the performance of participants in supply chains within the construction industry has not been analysed from the point of view of cultural aspects & attitudes. In this study the survey data was used to highlight culture in construction.

2.4.3 Culture and Supply Chain

McAfee, Glassman and Honeycut (2002) provided a guidance to effectively implement human resource management (HRM) policies that result in the desired logistical and supply chain strategies. To reach this aim cultural characteristics of the SC participants and their relationships were examined. The result of this study revealed that the internal consistency between culture and HRM policies is a pre-requisite for the conscious development of a successful supply chain strategy. Moreover they drew up the difficulties in providing consistency as follows:

- Shared attitudes, beliefs and patterns of behaviour develop over a long period of time and as a result don't change quickly.
- Some managers are less capable of implementing HRM policies to their companies.
- A firm's culture is effected from different factors (external pressures, internal potentials, responses to critical events).

Yunus and Tadisina (2010) proposed organizational culture as a potential determinant of supply chain integration effectiveness and investigated the impact of different types of organizational culture (group, developmental, hierarchical and rational) on supply chain integration. Flexibility-control orientation and internal-external focus were the dimensions of culture and logistics synchronization, information sharing, incentive alignment and collective learning were the

dimensions of supply chain integration used in study done by Yunus and Tadisina (2010). The results of study revealed that developmental culture is the most effective one in implementing supply chain integration.

Burtonshaw-Gunn and Ritche (2007) examined the impacts of cultural norms, behaviour and practices on supply chain management and propose actions to overcome barriers to successful implementation of supply chain management in construction industry.

2.5 Structural Equation Modeling

Ullman (1996) defined structural equation modeling (SEM) as follows:

“SEM is a collection of statistical techniques that allow a set of relationships between one or more independent variables, either continuous or discrete, and one or more dependent variables, either continuous or discrete, to be examined.”(Ullman, 1996)

Tabachnick and Fidell (1996) specified the advantages to use of SEM as examining the relationships among factors free of measurement error and examining complex relationships.

The differences between statistical data analysis techniques such as regression analysis, ANOVA, ANCOVA, time series analysis, panel data analysis, factor analysis, simultaneous equation systems, and SEM are the scales of dependent and independent variables and configurations of how they are organized to mimic the structure behind observed covariance (Tabachnick and Fidell, 1996). SEM deals with the covariance among the measured variables or observed sample covariance matrices. Hair *et al.* (1996) also specified that SEM could handle multiple hypothesized relationships simultaneously.

The measurement model and the structural model are the two components of structural equation modeling (Byrne, 1994). The measurement model is the component of the general model in which latent variables are prescribed It describes how well the observed variables serve as a measurement instrument for the latent

variables Confirmatory Factor Analysis (CFA) can be used for measurement models. There are straight arrows from the latent variables to their respective indicators and also straight arrows from the error and disturbance terms to their respective variables (Tabachnick and Fidell, 1996).

CFA used to determine if the number of factors and the loadings of the observed variables on them conform to what is hypothesized. In CFA, a certain number of factors are specified along with which factors are correlated, and which observed variables measure each factor (Schumacker and Lomax, 2004). The factor loadings are the correlation coefficients between the variables and factors. The squared factor loading is the percent of variance in that variable explained by the factor. Variance percentage in all the variables accounted by each factor can be found by adding the sum of the squared factor loadings and divide by the number of variables. This is the same as dividing the factor's eigenvalue by the number of variables.

The Cronbach's alpha value is used to test the extent to which multiple indicators for a latent variable belong together. The range for Cronbach's alpha is between 0 to 1. The minimum value recommended by Nunally (1978) for it is 0.70. A higher value indicates higher reliability of the scale used to measure the latent variable.

The structural model is the component of the general model that prescribes relations between latent variables and observed variables that are not indicators of latent variables (Hoyle, 1995). Direct and indirect relationships among latent variable that describe the amount of explained and unexplained variance can be seen in the structural model. Schumacker & Lomax (2004) pointed that the structural model is an indication of the extent to which hypothesized relationship is supported by the data.

LISREL, SAS CALIS, AMOS, and EQS are the software programs used for SEM. In this study LISREL was used. Tabachnick and Fidell (1996) specified LISREL as below:

“LISREL is a set of three programs; PRELIS, SIMPLIS and LISREL. Prelis pre-processes data, SIMPLIS allows models to be specified with equations and finally LISREL specifies SEM models with matrices. Some models become complicated to specify when using this method. LISREL offers residual diagnostics, several estimation methods, and many fit indices.” (Tabachnick and Fidell, 1996)

2.5.1 Definition of Terms

Some definitions about SEM and the analysis of SEM are given below for better understanding of related issues.

Path Diagram: “They are fundamental to SEM because they allow the researcher to diagram the hypothesized set of relationships. The diagrams are helpful in clarifying a researcher’s ideas about the relationships among variables and they can be directly translated into the equations needed for the analysis.” (Tabachnick and Fidell, 1996)

Observed Variables: “Observed variables also called measured variables, indicators, or manifest variables are represented by squares or rectangles.” (Tabachnick and Fidell, 1996)

Latent Variables: “Latent variables, constructs, or unobserved variables are the factors that have two or more indicators and represented by circles or ovals in path diagrams.” (Tabachnick and Fidell, 1996)

Latent Dependent Variables: Latent dependent variables are affected by other latent variables in the model and their measurement depends on the observed dependent variables (Schumacker & Lomax, 2004).

Latent Independent Variables: Latent independent variables are not affected by any other latent variables in the model and their measurements depend on the observed independent variables (Schumacker & Lomax, 2004).

Direct Effect: The direct effect is a directional relation between two variables that is the characterization of the relation between an independent and a dependent variable. The path coefficients, which represent the direct effects in the model, are the building blocks of the structural equation models (Schumacker & Lomax, 2004).

Indirect Effect: The indirect effect is the effect of an independent variable on dependent variable through one or more mediating variable (Hoyle, 1995).

Total Effect: The total effect is the sum of direct and indirect effects of an independent variable on a dependent variable (Schumacker & Lomax, 2004).

2.5.2 Steps of SEM

Model specification, identification, estimation, testing model fitness, and modification are the steps of SEM. In model specification step, hypothesis based on previous studies conducted. The second step, identification, is checked the completeness of information and/or constraints. The third step, estimation uses various estimation techniques to represent the relationship between the variables. The fourth step, model fitness, checks the performance of the model with numerous model fitness measures. It shows how well the model reproduces its data. The fifth step, modification, takes place if the parameter estimations may not meet the expectations. Misspecifications can be corrected or modification indexes, which are provided by the software, are used to change the parameter estimated.

2.5.3 The Goodness of fit Criteria for Structural Equation Modeling

Goodness of fit for the models of Structural Equation Modeling can be assessed by examining the results of some criteria. Interpretations of goodness-of-fit criteria are given below in detail:

Chi-Square (χ^2): Chi-square is a measure of overall fit of the model to the data (Jöreskog and Sörbom, 1993). In this view, it indicates that there is no significant discrepancy between the covariance matrix implied by the model and the population covariance matrix. A nonsignificant chi-square implies that the model fits the data; hence the population covariance matrix can be reproduced by the model (Kelloway, 1998). The chi-square is sensitive to sample size that it decreases as the sample size increases. In other words, the chi-square criterion tends to indicate a significant probability level when the sample increases, generally above 200 (Schumacker & Lomax, 2004).

Goodness of Fit Index (GFI): The GFI measures how much better the model fit as compared to no model at all (Jöreskog & Sörbom, 1989). It is based on a ratio of the sum of the squared discrepancies to the observed variances. Range of the values is between 0 (poor fit) and 1 (perfect fit).

Comparative Fit Index (CFI): It compares the model of interest with some alternative, such as the null or independence model. The CFI is also known as the Bentler Comparative Fit Index. Specifically, the CFI compares the fit of a target model to the fit of an independent model, which is a model in which the variables are assumed to be uncorrelated. In this context, fit refers to the difference between the observed and predicted covariance matrices, as represented by the chi-square index. In short, the CFI represents the ratio between the discrepancies of this target model to the discrepancy of the independence model. Roughly, the CFI thus represents the extent to which the model of interest is better than is the independence model. Values that approach 1 indicate acceptable fit. CFI is not too sensitive to sample size (Fan, Thompson, and Wang, 1999).

Normed Fit Index (NFI): The NFI equals the difference between the chi-square of the null model and the chi-square of target model, divided by the chi-square of the null model. In other words, an NFI of .90, for example, indicates the model of interest improves the fit by 90% relative to the null or independence model. When the samples are small, the fit is often underestimated (Schumacker & Lomax, 2004).

Root Mean Square Error of Approximation (RMSEA): It is a measure of discrepancy per degree of freedom. Values below 0.10 indicate a moderate fit to the data, values below 0.05 indicate a good fit to the data and values below 0.01 indicate an outstanding fit to the data (Schumacker & Lomax, 2004).

CHAPTER 3

MATERIAL AND METHOD

The two aspects of the study cited in this chapter title are presented here under discrete sections. The first covers succinct descriptions of the subject material-including criteria used in its selection and a detailed iteration of specific data derived there from. The second then gives an account of the operational procedures used for deriving the data in question as well as for its compilation and subsequent analysis.

3.1 Material

The study of factors impacting rbSC and project performance was based on face-to-face interviews and a questionnaire. Face-to-face interviews were carried out with three contractor companies. The questionnaire, which is given in Appendix A, was developed according to the information gathered from the informal face-to-face interviews and from the literature survey. The questionnaire was administered to 33 construction contractors, 20 AE companies, 16 sub-contractors and 9 suppliers. The software used for statistical analyses were LISREL and SPSS 17 for windows.

In order to determine the rebar supply chain with its sub factors, 3 contractor companies were visited and two technical staff members from two companies and the owner of the third company who knew the rebar procurement processes for their companies were interviewed. They were asked to comment on the rbSC process, the problems encountered during execution of the process, the response systems of the participants in the chain, and their interrelationships.

The questionnaire was prepared in accordance with an in depth literature review and the outcomes of the informal face-to-face interviews. Appendix A shows an example of a blank questionnaire. The questionnaire consists of three sections and a figure of framework. The first section was about the general information about the respondent companies and consists of seven questions. The first part of the

second section consists five questions about characteristics of projects' evaluated. The questions related to rbSC performance (four questions) and project performance (three questions) and factors impacting performance of rbSC(50 questions) in the second section and the third section of the questionnaire were evaluated in a Liker format that has 6 scale to prevent choosing the middle. These questions were evaluated under two headings. The first heading consisted of the importance evaluations starting from (1) Not at all important to (6) Very important. The second group heading consisted of project specific performance evaluations, ranging from (1) Unacceptable, (2) Low performance, (3) Needs improvement, (4) Satisfactory, (5) Good and finally, (6) Excellent. The third section was about the participant (contractor, AE company, sub-contractor, supplier) related factors and external factors (economic stability of the country, transportation cost, legal, client, environment, market related issues) that have impact on rbSC performance. At the end of the questionnaire a theoretical framework was also given to outline the relationships among the factors that were being investigated. This framework was used in the questionnaire to provide a better understanding of the questions by the respondents (rbSC participants). The questions in each section are described in detail as written below.

Section 1: The questions in this section give some information on participants' companies. The working area and size of the company, type of the projects that they construct, contract types they use are the main topics in this section. There are seven questions in this section.

Section 2: Concentrates on the characteristics of projects' evaluated (project type, project size due to its rebar need, project location, construction site distance from rebar supplier, the place where rebar prepared) and continued with rbSC and project performance related factors. Five questions for project characteristics, four questions for rbSC performance and three questions for project performance were used.

Section 3: Concentrates on the factors that are proposed to have impacts on the level of rbSC performance. The factors are grouped under five categories, which are; "contractor related factors", "sub-contractor related factors", "supplier related

factors”, “AE(Architectural/Engineering) company related factors” and “external factors”. There are 50 questions in this section.

3.2 Method

Face-to-face interviews were conducted with three contractors that were selected randomly from a list obtained from the Gaziantep Chamber of Commerce, in order to determine the rbSC process and factors affecting it in construction projects. The two technical staff that was interviewed was site managers and the owner interviewed was a civil engineer. During the interviews, technical staff / or the owner of the company were asked to describe the current process of preparing structural drawings, detailed cut and bent drawings, procuring process of rebar from the suppliers; and the process of placing cut and bent rebar in the formwork. In addition to these questions, the list of factors that can be seen in the fourth section of chapter four was prepared according to their orientations. The interviewees comment on the list of factors obtained from literature survey. Although the information obtained through interviewees were consistent with the one obtained through literature survey some exclusions were made due to the reasons described in the fourth section of chapter four. A list of these factors along with the reasons for inclusion or exclusion in the questionnaire is presented in Table 4.2.

A theoretical framework was developed based on the literature survey and informal face-to-face interviews to outline the relationships among the seven latent constructs namely, external factors, participant (contractor, sub-contractor, AE company, supplier) related factors, rbSC performance and project performance. The hypotheses, testing the impact of the factors on rbSC performance were based on this theoretical framework. The factors in this framework were measured by the sub-factors identified through literature survey and face-to-face interviews. These sub-factors constitute each question under the factors in the questionnaire developed. The questionnaire was used for the data collection.

In total the list of Gaziantep Chamber of Commerce consists of 313 contractor companies name. Fifty contractors were selected randomly and only 33 answered the

questionnaire. The respondents filled the questionnaire for 52 projects. These contractors were then asked to contact the other participants (AE company, sub-contractor, and supplier) with whom they had worked in rbSC process, for evaluating the same projects. Twenty AE companies filled the questionnaires for 30 projects, 16 sub-contractors filled the questionnaires for 21 projects, and 9 suppliers filled the questionnaires for 12 projects. Thus, 78 companies filled 115 questionnaires for 52 projects.

One of the objectives of this study was to conduct a comparative analysis for importance level and performance ratings of the determined sub-factors under seven factor constructs. To reach this objective, respondents were asked to evaluate each factor under two headings: importance and performance level. Under importance level respondents were asked to evaluate the importance of factors for his/her company. Under the performance level the respondents were asked to evaluate the achieved level of performance of each factor, for the project that was evaluated. The comparative analyses were carried out to determine whether the importance and performance levels are significantly different or not. The findings under this section can help companies to measure and improve their performance. t-test was applied for this group of hypotheses as this test is commonly used to evaluate the difference between two sets of data. The level of significance for t-test was accepted to be 0.05. The analyses were carried out using SPSS 17 software (for Windows).

The first five questions related to projects (project type, project location, projects' rebar need, construction site distance from rebar supplier, place where rebar were prepared) under section two were used to test whether these characteristics have an effect on rbSC performance, project performance and participant related factors (contractor, AE company, sub-contractor and supplier related factors). The one-way analysis of variance (ANOVA) was used to test differences caused by project characteristics. The level of significance for ANOVA was 0.05. For significant differences, a post hoc test (Games-Howell) was performed as a second stage of ANOVA test to determine specific groups that were different.

The main aim of this study was to determine the impacts of participant related factors and external factors on rbSC performance. The questions related to the

factors, were analyzed using Structural Equation Modeling (SEM) methodology to determine the relationships among external factors, participant related factors, rbSC performance and project performance. The questions of this section were grouped under seven constructs (latent variables) namely, rbSC performance related factors, project performance related factors, contractor related factors, AE company related factors, sub-contractor related factors, and supplier related factors and external factors. The hypotheses developed for each relationship were analyzed statistically to evaluate the magnitude and pattern of the impact. The general null hypothesis (Ho) for this section is; there is no impact on the determined factor and the alternative hypothesis, (Ha) states that there is an impact on the determined factor. The statistical analysis of these constructs was done by SEM. SEM is a statistical technique that combines confirmatory factor analysis and path analysis at same time. The capability of simultaneous analysis and showing all relationships between the factors in the same picture differs from SPSS program outputs. Firstly, confirmatory factor analysis for the latent variables was conducted to select the factors that have low loadings. t-values and goodness-of-fit indices gathered from the outputs of LISREL software were used. The critical value of 1.96, was the minimum t-value that we need for a significance at $p < 0.05$ level was used to test the relationship among the factors. The higher the t-value is the more likely the impact is significant. The GOF for each construct was analyzed through the goodness-of-fit index (GFI), the comparative index (CFI), Non-normed fit index (NNFI), the adjusted goodness-of-fit index (AGFI), the root mean square error of approximation (RMSEA) and the ratio for χ^2/df (degree of freedom). Number of factors determined in the questionnaire was 57 and it was decreased to 38 after confirmatory factor analysis. Then the developed framework outlining the relationships among the factors and rbSC performance was revised in order to reach the appropriate level of GOF measures. Parcelling and deleting the paths that showed a low relationship and had t-value lower than 1.96 were used to revise the framework. Purified factors under the constructs were parceled according to their conceptual relationships. The paths, which were not significant at $p < 0.05$ level were deleted. After these modifications a final model with appropriate GOF indices was developed. All the hypothesized relationships were tested at a time by SEM and the paths with t-values higher than

1.96 were accepted as significant at $p < 0.05$ level and the path coefficient of the path was used to evaluate the magnitude of the impact. Based on these results, a set of recommendations related to the factors affecting rbSC performance was formulated for rbSC participants.

At the end of the study the differences between assessments of participants for importance levels and performance ratings of the specified factors push us to analyze the reasons of the lower levels of performance. With this point of view comparison of assessments were done through the data obtained from the questionnaire.

The comparison of the assessment between the groups was performed through paired t-test and stacked charts drawn by Excel did evaluation of self-assessment. A checklist for participants of rbSC was developed according to the assessments and recommendations for rbSC participants were formulated to improve the rbSC process of SMEs.

3.2.1 Tests of Hypotheses

The hypotheses developed were a reflection of the statements in the proposed framework, which has been explained in Chapter 4 and given in Figure 4.2. Nine hypotheses were formulated in order to see whether there exists a relationship between the factors or not; these are:

H₀₁: External factors have no impact on AE company related factors

H₀₂: External factors have no impact on sub-contractor related factors

H₀₃: External factors have no impact on supplier related factors

H₀₄: External factors have no impact on contractor related factors

H₀₅: AE company related factors have no impact on contractor related factors

H₀₆: Sub-contractor related factors have no impact on contractor related factors

H₀₇: Supplier related factors have no impact on contractor related factors

H₀₈: Contractor related factors have no impact on rbSC performance

H₀₉: rbSC performance has no impact on project performance

CHAPTER 4

DATA COLLECTED

Data obtained through face-to-face interviews, roles of the rbSC participants, theoretical framework obtained, development of factors used in the questionnaire, the characteristics of projects evaluated and descriptive statistics are presented in this chapter.

4.1 Information obtained through face-to-face interviews

Informal face-to-face interviews were performed with three contractor companies whose main offices were in Gaziantep. The companies were small and medium sized limited or private contractor companies of Gaziantep.

The information provided from the staff was generally same for three companies as they use build and sell system mostly. Furthermore, these companies entered tenders opened by government and build for the private sector with lump sum contracts. As the main aim of the interviews was to identify the rbSC process for SMEs the questions related to factors impacting were asked. The current rbSC process can be summarized by the figure below.

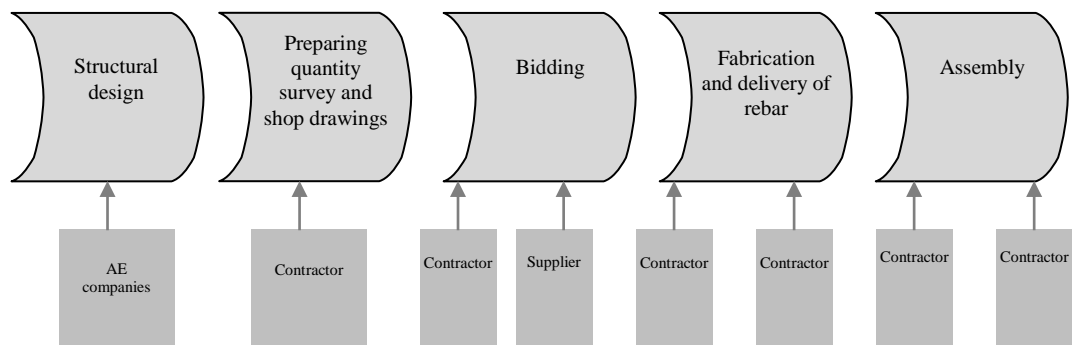


Figure 4.1. rbSC process and participants

- The engineers in the Architectural/Engineering or Engineering companies prepared structural design. In this step engineers prepared structural designs and details according to the architectural drawings and draw the details of the structural system showing the shapes and length of rebar used.
- Technical staff in the contractor companies prepared the quantity surveys according to the structural reinforcement drawings.
- The contractor companies use Bill of Quantities (BOQ) to obtain offers from minimum three rebar suppliers.
- After the negotiation with the suppliers the contractor approves the most appropriate bid, which is usually the lowest one.
- The projects with rebar need of up to 200 tons were evaluated as small, 201-500 tons were evaluated as medium and more than 500 tons were evaluated as large projects.
- If the offer was for cut and bent rebar the suppliers delivered the required material of the project (usually from Iskenderun). The rebar cut and bend division of the supplier or the second tier supplier produces steel reinforcement bars and stirrups in the required lengths and bent shapes for use in reinforced concrete structures and then deliver it to the site. The production process is automated through the use of specialized machinery to enable high volume production. If it was supplied in bars it was transported with 2-3 ton packages to the site again from the steel mills Iskenderun or from the distributors located in Gaziantep city.
- The rebar delivered in bars to the site were cut & bent according to the projects by sub-contractor (cut and bent labor).
- SC ends before assembly as other actors (formwork sub-contractor) enter the scene.

4.2 Roles of the rbSC participants

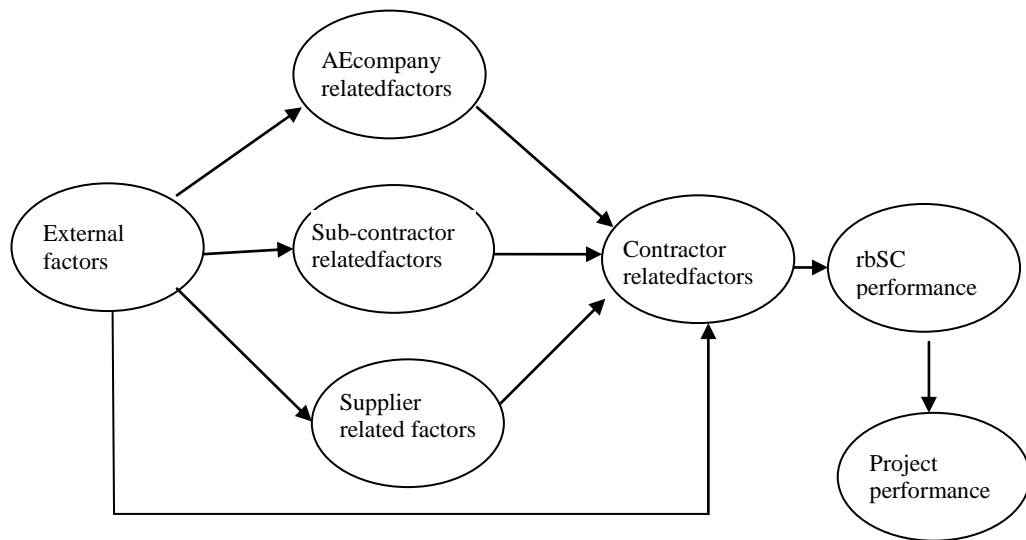
According to the information gathered through face-to-face interviews roles of the participants can be listed as below (Table 4.1):

Table 4.1 Roles of rbSC participants

Participant	Roles
Contractor	<ul style="list-style-type: none"> • Plan and program the rbSC process • Preparing bidding documents for AE services • Preparing BOQ (Bid of Quantity), • Preparing the order process of rebar, • Negotiating with the rebar supplier, • Finalizing the procurement process, • Managing the financial issues related to AE company, sub-contractor and supplier. • Negotiating with the rebar sub-contractor (steel worker), • Controlling the delivered rebar, • Controlling the assembled rebar.
AE Company	<ul style="list-style-type: none"> • Analyzing the clients requirements, • Preparing preliminary design, • Preparing shop drawings, • Designing the structure of the project, • Preparing detailed drawings, • Preparing change order drawings.
Sub-contractor (steel work, labor)	<ul style="list-style-type: none"> • Preparing the production area, • Cutting and bending the rebar according to the structural drawings, • Transporting the rebar to site, • Placing the cut and bent rebar in formwork.
Supplier	<ul style="list-style-type: none"> • Supplying the rebar according to specifications to the site.

4.3 Theoretical framework developed

The importance of rbSC for the building industry was deduced from the literature review. As the aim of the study was to find the impacts of factors on rbSC, identifying the factors was the first step. rbSC was analyzed with its participants in this study. The relationships of rbSC participants and their evaluation in the supply chain were analyzed and theoretical framework was developed (Fig. 4.2) based on the literature review literature survey and informal face-to-face interviews. This framework outlined the relationships among the contractor related factors, AE company related factors, sub-contractor related factors, and supplier related factors, external factors, rbSC performance and project performance.



Legend

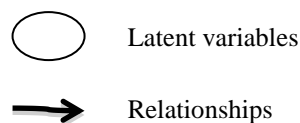


Figure 4.2. Framework developed for defining the relationships between the various participants related factors and their influence on the performance of rbSC and overall project success

4.4 Development of factors used in the questionnaire

The interviews were intended to classify the factors of the framework used to measure the impacts of participant related factors on rbSC performance through a questionnaire survey. According to the responses of interviewees the classification of the factors was changed for the one in literature for some factors. For example under financial issues financial stability is considered to be an impact factor for the suppliers because if he does not have finances he cannot purchase the material from the producer. However this factor is not seen as an important impact factor for the contractor because though he may be financially stable, he may not make payments in time to the supplier or the other participants. Therefore, cash flow was more important as a contractor related factor. Although the findings from the interviews were consistent with what obtained in the literature survey, a few modifications were done according to the data obtained from industry practitioners. The factors used in literature were determined in Table 4.2 below. Table 4.2 was prepared to specify the factors included and excluded for this study. The decision of including and excluding the factors was given according to the face-to face interviews and it was explained in the third column of the table.

Some studies have used the term ‘variables’ and others ‘factors’ for issues that impact SC performance. In this study both have been referred to as ‘factors’ and so both have been listed as such in Table 4.2.

Table 4.2 Factors studied in literature

Researcher	Study Name	Factors Studied	Reason for inclusion or exclusion
Palaneeswaran <i>et al.</i> (2001)	“Reforging construction supply chains: a source selection perspective”	<p>Past experience</p> <p>Past performance</p> <p>Finance</p> <p>Organization and management system</p> <p>Team relationships</p> <p>Human resources</p> <p>Disputes/claims history</p> <p>Current workload</p>	<ul style="list-style-type: none"> • This was included only for contractors because the contractor companies interviewed mentioned that the number of contractors worked with municipalities and government is high for Gaziantep city. The contracts of these works were usually lump sum and the project designs were prepared before the bid and it was difficult to reach design teams. • This was excluded because it depends on profits/loss in the past and this data was not available for all the projects that the companies investigated. • Finance related issues are included for contractor and supplier related factors. The contractors constitute the main participant of the chain and the flow of money pass through them. It is worthwhile to search the impact of the cash flow efficiency of the contractors. For suppliers, finance related issues were analyzed according to its stability because since they get the money from the contractor and it is important for contractors to make themselves sure on the reliability of the company. • This was included. The organization and the management related issues for contractors were searched. Materials management, site management, project management, organization structure and culture, communication systems were the questions related to this issue. • The inter group relationships were analyzed for contractor and structural designer, contractor and supplier, contractor and sub-contractor. The inner relationships were analyzed for sub-contractors because everyone saw their work on site and the team relationships. • This was included. Participants’ skills related issues were provided by the sub factors under human resources. • This was excluded because none of the interviewees declared the absence of such claims (legal actions) with their current partners. • This was excluded because this study focused on past/completed projects hence the impact of current workload was irrelevant.

Table 4.2 Factors studied in literature (continued)

Researcher	Study Name	Factors Studied	Reason for inclusion or exclusion
		Environmental concerns Technology Insurance cover Equipment Partnering Location of head office	<ul style="list-style-type: none"> • This was included under external factors and project characteristics related questions because the supply chain deals with a process with its environmental issues that affects the performance. • This was included. According to the contractors interviewed technology for contractors was important in the area of communication and equipment used. For AE companies it comes front with the Internet technology name, consisting the communication system of the AE companies and design information flow tool for the AE companies. • This was included under contractor related factors because site, material and worker insurance were the duty of the contractors. • This was included with the name of operating and machinery under contractor related factors. The equipment used for the construction was provided by the contractors in most of the construction supply chains. • The main aim of the supply chain is to increase the level of relations between the participants. Relationships between the participants were analysed with the questions in this study. • This was excluded since the limitation of this study is determined as the companies, which were located in the city of Gaziantep.
Briscoe et al. (2001)	“Construction supply chain partnerships: skills, knowledge and attitudinal requirements”	Writing/reading skills and Numeric/financial skills Client/contractor relationships Design communications Supplier communications Teamwork Planning and problem solving Manual skills	<ul style="list-style-type: none"> • This was included for the sub-contractor and supplier related factors due to the orientation of the contractors interviewed. According to the contractors, these skills are problematic usually for sub-contractors and suppliers. • The relationships between the participants were included for every relational part as told above. • The design information flow was included for AE related factors because AE companies design the structural project. • Product knowledge of the supplier was included under this variable as the researcher specified. • This was included. The details for teamwork and team relationships were given above. • This was included under contractor related factors since the contractors prepared the main plan and programs for the rebar supply chain process. • Operating and machinery skills were included. Usually the contractors provided the equipment's in the chain.

Table 4.2 Factors studied in literature (continued)

Researcher	Study Name	Factors Studied	Reason for inclusion or exclusion
Castro-Lacouture (2003)	“B2B e-work intranet solution design for rebar supply interactions”	<p>Internet technology</p> <p>CAD software usages</p> <p>Standardization of rebar shapes/components</p> <p>Ability to exchange/share rebar information</p> <p>Ability to reduce total rebar workflow duration</p>	<ul style="list-style-type: none"> • This was included under AE company related factors due to the information gathered through the contractors interviewed. In rebar supply chain, Internet was seen as a communication tool used by the AE companies. • CAD related issues were included under AE company related factors only because the contractor, sub-contractor used hard copies and the supplier used BOQ only. • This was included under AE companies to evaluate their success in structural design. Also included under sub-contractor related factors because the level of standardization affects the performance of sub-contractors. • The information flow capability was included under AE company related factors because the information was gathered through the structural design and this information flow was for AE companies only while the other participants were on the receiving. • The factors affecting rebar workflow duration were analysed on the basis of standardization of rebar shapes/components for AE companies and sub-contractors, processing and storage area capacity of site for sub-contractors only because the workflow duration was important only for sub-contractor related factors. Ability of reading and writing skills were analysed for sub-contractors since usually they were low educated.
Chan <i>et al.</i> (2004)	“Factors affecting the success of a construction project”	<p>Project-related factors</p> <p>Project procedures</p> <p>Project management actions</p> <p>Human - related factors</p> <p>External environment</p>	<ul style="list-style-type: none"> • This was included because the evaluations were done on the basis of the projects constructed. Project characteristics affecting rebar supply chain was included. These are project type, size, and location and rebar cutting and bending place. • Procurement and tendering related issues were included under general information on companies. • Management related issues were included under contractor related factors because the contractors did the project management. Materials management, site management, project management, communication system, organization structure, organization culture, insurance cover, control and interaction of the participants were the factors defined under the critical factors. • This was included by the ability related factors as defined above. • This was included as a separate construct that impacts rebar supply chain performance with the sub-factors specified by the researcher.

The factors in the theoretical framework can be classified as contractor related factors, AE company related factors, sub-contractor related factors, and supplier related factors and external factors. All these topics can be defined with tangible and intangible sub factors. External factors were listed in Table 4.3 below, rbSC performance and project performance related factors consisting of four and three sub items are listed in Table 4.4 and participant related factors are listed in Table 4.5.

Table 4.3 External factors

External factors
EXT1 Economic stability in the country
EXT2 Transportation cost
EXT3 Taxes
EXT4 Legal conditions
EXT5 Client characteristics
EXT6 Environmental factors

Table 4.4 rbSC and project performance related factors

rbSC performance (rbSCperf)
rbSCperf1 Missing/wrong/damaged/defective product/production
rbSCperf2 Responsiveness to customers
rbSCperf3 Supply chain flexibility
rbSCperf4 rbSC integration
Project performance (PROJperf)
PROJperf1 Project profitability
PROJperf2 Schedule performance
PROJperf3 Satisfaction of the customer

Table4.5Participant related factors

Contractor related factors	AE company related factors	Sub-contractor related factors	Supplier related factors
CONT1 Materials management competency	AE1 Design information flow	SUBCONT1 Improved communication and learning skills	SUP1 Delivery speed dependability
CONT2 Site management competency	AE2 Design integration	SUBCONT2 Labor utilization (planned, weekly working)	SUP2 Delivery reliability performance
CONT3 Project management competency	AE3 Design changes	SUBCONT3 Accommodation conditions on site	SUP3 Supplier responsiveness
CONT4 Organization culture of the contractor	AE4 Standardization of rebar shapes, components	SUBCONT4 Education level of the workers	SUP4 Price of the material
CONT5 Organization structure of the contractor	AE5 Delay in design definitions and approval	SUBCONT5 Ability of reading technical drawing	SUP5 Location of the supplier
CONT6 Insurance cover	AE6 Internet technologies	SUBCONT6 Standardization of rebar shapes, components	SUP6 Financial stability
CONT7 Past experience of the contractor	AE7 CAD software usages	SUBCONT7 Grouping the cut rebar in respect of length and size	SUP7 Writing and reading skills of contract and tech. doc.
CONT8 Operating and machinery		SUBCONT8 Processing area on site	SUP8 Supplier/contractor relationships
CONT9 Trouble shooting and problem solving		SUBCONT9 Storage area on site	SUP9 Number of faultless delivery
CONT10 Communication system of the contractor		SUBCONT10 Team relationships	SUP10 Quality of the material
CONT11 Interaction between structural designer and jobsite		SUBCONT11 Transportation of material on site	SUP11 Warranties given by the supplier
CONT12 Efficiency of cash flow method		SUBCONT12 Percentage of defects	SUP12 Product knowledge
		SUBCONT13 Cutting rebar in required length	

4.5 Evaluated project characteristics

Five criteria were determined to check if these criteria have an effect on rbSC performance, project performance and participant related factors. These are:

1. *Project type*: The type of structure, processes and similar supply chain structure depends on the type of project. It should be noted that 45.2% of the data collected was small residential projects where the type of the structures are not repeated many times.
2. *Location*: The location of the project is important for procuring rebar, storing and preparing on site. The projects for which data were collected were mostly located in low-density urban area (40.9%) and in suburban area (33%).
3. *Project rebar requirement*: Some materials are highly prone to risk. The contractors should focus on the procurement of the rebar, as it was one of the risky materials in the construction industry. The amount of rebar need is important for decreasing the transportation cost and procurement cost. To evaluate the rbSC performance according to the rebar requirement, projects are categorized due to its rebar need 12.2% of the projects evaluated were small-size, 53% of them were medium and 34.8% of them were big size. The amount of steel required affects the supply chain inversely.
4. *Construction site distance from rebar supplier*: As the transportation cost for rebar constitutes a high percentage of total rebar related works, the distance of the supplier from site is important. 43.5% of the construction sites were 10-30km away from the rebar supplier and 30.4% of them 0-10km away and 23.5% of them 30-50 km away from the rebar supplier.
5. *Preparation of rebar*: The usage of on-site and offsite cut and bend rebar has an impact and total time and cost. As the labor cost is cheap in Turkey most of the projects used on-site cut and bend rebar (73.9%).

4.6 Descriptive Statistics

The respondents characteristics and information related to their companies were analysed using descriptive statistics.

The legal status of the surveyed companies was tabulated as (Table B.1); 70.51% limited company, 3.85% corporation and 25.64% individual proprietorship.

As shown in Table B.2, 42.3% of the companies are contractors, 25.6% of them are AE companies and 20.5% of them are sub-contractors and the remaining (11.5%) belong to suppliers.

Within the companies, the individuals who filled out the questionnaires hold a variety of responsibilities. 48.71% of them were the owners, 43.59% were technical staff, 6.41% were sales staff and 1.28% were worker (Table B.3).

60.25% of the companies had been operating for more than 10 years. 11.54% of companies had been operating for 5 and less than 5 years. And 28.21% of the companies had been operating for 6-10 years (Table B.4).

The companies undertook construction jobs of various types. The expertise areas are residential, commercial, educational, hospitals and other (social centres, infrastructure) for all types of companies (Table B.5).

A majority of companies (30.77%) have annual volume between 2-5 billion TL. 25.64% of the companies have annual volume between 0-1 billion TL, most of whom are subcontractors (Table B.6).

CHAPTER 5

RESULTS AND DISCUSSION

In this chapter are presented the results of the various analyses of the data collected. The data were compared using t-test, anova test, post hoc test conducted in SPSS. Confirmatory factor analysis and structural analysis of the developed framework were conducted in Lisrel and the results were used in hypotheses testing.

5.1 Comparative Statistics

The data were compared using t-test, excel charts and ANOVA test then the results obtained from these comparisons were discussed.

5.1.1 T-test

Mean values and standard deviations of observed variables are reported in the tables below to check if there is any significant difference between the means of importance level and performance level of the variables.

The means of all rbSC performance related factors are significantly different at $p < .05$ levels. Moreover, results revealed that the means of importance level were higher than the performance ratings (Table 5.1). The results indicated that realized efficiency and effectiveness of the supply chain is lower than the desired situation. The factors related to the result of the process, “Missing/wrong/damaged/defective product/construction” (rbSCperf1) and “Responsiveness to customers” (rbSCperf2) had higher means both for importance level and ratings. As the term supply chain was new for the respondents, factors consisting this term were found to be less important and the realized performance for these factors was low. The main reason for these results was the industry level culture. Construction industry is result-oriented rather than process-oriented the reached success is the most important issue that the companies considered.

Table 5.1 Importance and performance levels for rbSC performance related factors

		N	Mean	Sd	df	t	p
rbSCperf1 (Missing/wrong/damaged/defective product/construction)	Imp.	115	5.13	0.82	114	5.97	0.000
	Perf.	115	4.69	0.74			
rbSCperf2 (Responsiveness to customers)	Imp.	115	4.92	1.01	114	5.01	0.000
	Perf.	115	4.62	0.95			
rbSCperf3 (Supply chain flexibility)	Imp.	115	4.46	1.16	114	3.85	0.000
	Perf.	115	4.1	1.12			
rbSCperf4 (rbSC integration)	Imp.	115	4.43	1.1	114	3.88	0.000
	Perf.	115	4.09	1.05			

Results indicated that the means of the “project profitability”(PROJperf1) for company’s importance weight and rating for project performance are not significantly different ($p < .14$) at $p < .05$ levels “Project profitability” was found to be the least important project performance related factor and the realized performance was higher than the importance level. “Satisfaction of the customer” (PROJperf3) and “schedule performance” (PROJperf2) was perceived as the prime measures for company success. Providing to their customer with quality services and products on time with consistency were the main aims of the companies. The realized performance and the importance levels for the main aims (schedule performance and satisfaction of the customer) of the companies were significantly different at $p < .05$ level (Table 5.2) indicating low level of achievement for these factors. These results show the pragmatic characteristic of the industry culture rather than normative.

Table 5.2 Importance and performance levels for project performance related factors

		N	Mean	Sd	df	t	p
PROJperf1 (Project profitability)	Imp.	115	4.45	0.91	114	1.49	0.140
	Perf.	115	4.58	0.87			
PROJperf2 (Schedule performance)	Imp.	115	5.12	0.73	114	5.22	0.000
	Perf.	115	4.77	0.76			
PROJperf3 (Satisfaction of the customer)	Imp.	115	5.17	0.87	114	3.46	0.001
	Perf.	115	4.95	0.86			

Results for contractor related factors revealed that only the means of “materials management competency” (CONT1), “site management competency” (CONT2), “Project management competency” (CONT3), “Organization culture of contractor” (CONT4) and “trouble shooting and problem solving ability of contractor”(CONT9) companies for importance levels and performance ratings are significantly different at $p < .05$ level. Management related issues were found to be as important factors but the realized performance for these factors was still lower than the desired ones. This was a realistic result since the adopting new management technique is more difficult for construction industry than the manufacturing industry. The result for “trouble shooting and problem solving”(CONT9) factor indicated that the importance of capturing the problems causing failed process has not perceived by the rbSC participants and as a result the performance for this factor is low. There is no significant difference between the remaining seven determinants of contractor related factors (Table 5.3). Since the contractors constitute the main construct of the chain, it was observed that attributes related to past experience like, technical skill, size, reputation of the contractor companies had the highest mean.

Table 5.3 Importance and performance levels for contractor related factors

		N	Mean	Sd	df	t	p
CONT1 (Materials management competency)	Imp.	115	4.74	0.8	114	4.07	0.000
	Perf.	115	4.39	1.01			
CONT2 (Site management competency)	Imp.	115	4.86	0.77	114	4.07	0.000
	Perf.	115	4.5	1.06			
CONT3 (Project management competency)	Imp.	115	4.83	0.91	113	4.97	0.000
	Perf.	115	4.43	0.93			
CONT4 (Organization culture of the contractor)	Imp.	115	4.9	0.78	114	5.03	0.000
	Perf.	115	4.47	0.85			
CONT5 (Organization structure of the contractor)	Imp.	115	4.07	1.49	114	0.17	0.866
	Perf.	115	4.06	1.19			
CONT6 (Insurance cover)	Imp.	115	4.16	1.52	114	0.93	0.354
	Perf.	115	4.06	1.19			
CONT7 (Past experience of the contractor)	Imp.	115	5.14	1	113	2.34	0.210
	Perf.	115	5.31	0.8			
CONT8 (Operating and machinery)	Imp.	115	5.13	0.8	114	1.93	0.056
	Perf.	115	5.01	0.83			
CONT9 (Trouble shooting and problem solving)	Imp.	115	4.35	1.46	113	4.57	0.000
	Perf.	115	4	1.36			
CONT10 (Communication system of the contractor)	Imp.	115	4	1.26	114	0.24	0.806
	Perf.	115	3.97	1.15			
CONT11 (Interaction between structural designer and jobsite)	Imp.	115	4.18	1.19	113	0.1	0.920
	Perf.	115	4.17	1			
CONT12 (Efficiency of cash flow method)	Imp.	115	5.04	0.86	114	1.84	0.068
	Perf.	115	4.9	0.86			

The means of importance level and performance ratings were significantly different at $p < .05$ levels for all AE company related factors except for “internet technologies” (AE6), which had p value of 0.245 (Table 5.4). All ratings were around moderate levels, indicating problematic view of AE companies within the chain. Furthermore AE companies realized performance levels were lower than these moderate level importance levels.

The level of technology and Internet usages in AE companies is high.

Connecting to Internet with high speed is possible for almost all AE companies. As a result the realized performance is higher than the importance level. High level of Internet technology used by design companies provides a low cost network for business-to-business transactions. The control, improvement and changes in designs can be done and seen by the participants by using same software. Internet technologies provide solutions that enhance the overall value of the supply chain. Real-time communication among supply chain participants reduces cost of waiting. rbSC participants believed that “Standardization of rebar shapes, components” (AE4) and “Delay in design definitions and approval” (AE5) were the more important items under AE company related factors (Table 5.4). Standardization of rebar shapes and components can be provided by construction knowledge and experience of AE companies in planning and engineering.

Table 5.4 Importance and performance levels for AE company related factors

		N	Mean	Sd	df	t	p
AE1 (Design information flow)	Imp.	114	4.44	0.8	113	4.5	0.000
	Perf.	114	3.99	1.01			
AE2 (Design integration)	Imp.	114	4.34	0.77	113	3.55	0.001
	Perf.	114	4	1.06			
AE3 (Design changes)	Imp.	114	4.32	0.91	113	2.62	0.010
	Perf.	114	4.07	0.93			
AE4 (Standardization of rebar shapes, components)	Imp.	114	4.64	0.78	113	3.53	0.001
	Perf.	114	4.34	0.85			
AE5 (Delay in design definitions and approval)	Imp.	114	4.62	1.49	113	4.12	0.000
	Perf.	114	4.24	1.19			
AE6 (Internet technologies)	Imp.	114	3.96	1.52	113	1.17	0.245
	Perf.	114	4.09	1.19			
AE7 (CAD software usages)	Imp.	114	4.26	1	113	3.19	0.002
	Perf.	114	4.61	0.8			

Table 5.5 revealed four significant differences between importance levels and performance ratings of sub-contractor related factors. The importance level means for “Improved communication and learning skills” (SUBCONT1), “Labor utilization (planned, weekly working schedules)” (SUBCONT2), “Ability of reading technical drawings” (SUBCONT5) and “Percentage of defects” (SUBCONT12) were significantly higher than the means of performance ratings of these factors. The results drawn from the Table 5.5 indicated that the source of the problems was mostly related to the sub-contractor skills. Workforce characteristics of sub-contractors by means of education level, ability of reading technical drawings, team relationships were deduced as significant factors that influenced rbSC performance. Working period of labor per week is very important for the productivity level at the construction site. As the education level of workers in the construction industry is very low, big problems related to this issue encountered during the construction process. Quality problems related to the works, ability of understanding technical drawings are some of the results of the low education level. Moreover, “Grouping the cut rebar in respect of length and size” (SUBCONT7), “Percentage of defects” (SUBCONT12) and “Cutting rebar in required length” (SUBCONT13) were found to be more important both for importance level and performance ratings. All ratings when compared to those of the other constructs factors were low, indicating that sub-contractors were not the key element of the chain. Some issues related to sub-contractors had the lowest means both for importance level and performance ratings espoused the weakness of the sub-contractors in the chain.

Table 5.5 Importance and performance levels for sub-contractor related factors

		N	Mean	Sd	df	t	p																																																																																																																																												
SUBCONT1 (Improved communication and learning skills)	Imp.	114	4.09	1.18	113	2.19	0.031																																																																																																																																												
	Perf.	114	3.9	1.2				SUBCONT2 (Labor utilization (planned, weekly working schedules))	Imp.	114	4.34	1.1	112	3.14	0.002	Perf.	114	4.07	1.14	SUBCONT3 (Accommodation conditions on site)	Imp.	114	3.55	1.53	113	0.70	0.485	Perf.	114	3.48	1.42	SUBCONT4 (Education level of the workers)	Imp.	114	3.07	1.28	113	0.01	0.365	Perf.	114	2.97	1.22	SUBCONT5 (Ability of reading technical drawings)	Imp.	114	3.77	1.46	113	2.60	0.011	Perf.	114	3.5	1.34	SUBCONT6 (Standardization of rebar shapes, components)	Imp.	114	4.55	0.94	113	0.84	0.402	Perf.	114	4.49	0.93	SUBCONT7 (Grouping the cut rebar in respect of length and size)	Imp.	114	4.68	0.81	113	0.98	0.329	Perf.	114	4.62	0.87	SUBCONT8 (Processing area on site)	Imp.	114	4.54	0.81	113	1.30	0.197	Perf.	114	4.43	0.95	SUBCONT9 (Storage area on site)	Imp.	114	4.5	0.87	113	0.99	0.323	Perf.	114	4.39	1.14	SUBCONT10 (Team relationships)	Imp.	114	3.97	1.22	113	0.00	1.000	Perf.	114	3.97	1	SUBCONT11 (Transportation of material on site)	Imp.	113	4.26	1	112	0.24	0.812	Perf.	113	4.27	0.97	SUBCONT12 (Percentage of defects)	Imp.	114	4.68	0.82	113	2.90	0.040	Perf.	114	4.48	0.8	SUBCONT13 (Cutting rebar in required length)	Imp.	114	4.73	0.81	113	0.73	0.468
SUBCONT2 (Labor utilization (planned, weekly working schedules))	Imp.	114	4.34	1.1	112	3.14	0.002																																																																																																																																												
	Perf.	114	4.07	1.14				SUBCONT3 (Accommodation conditions on site)	Imp.	114	3.55	1.53	113	0.70	0.485	Perf.	114	3.48	1.42	SUBCONT4 (Education level of the workers)	Imp.	114	3.07	1.28	113	0.01	0.365	Perf.	114	2.97	1.22	SUBCONT5 (Ability of reading technical drawings)	Imp.	114	3.77	1.46	113	2.60	0.011	Perf.	114	3.5	1.34	SUBCONT6 (Standardization of rebar shapes, components)	Imp.	114	4.55	0.94	113	0.84	0.402	Perf.	114	4.49	0.93	SUBCONT7 (Grouping the cut rebar in respect of length and size)	Imp.	114	4.68	0.81	113	0.98	0.329	Perf.	114	4.62	0.87	SUBCONT8 (Processing area on site)	Imp.	114	4.54	0.81	113	1.30	0.197	Perf.	114	4.43	0.95	SUBCONT9 (Storage area on site)	Imp.	114	4.5	0.87	113	0.99	0.323	Perf.	114	4.39	1.14	SUBCONT10 (Team relationships)	Imp.	114	3.97	1.22	113	0.00	1.000	Perf.	114	3.97	1	SUBCONT11 (Transportation of material on site)	Imp.	113	4.26	1	112	0.24	0.812	Perf.	113	4.27	0.97	SUBCONT12 (Percentage of defects)	Imp.	114	4.68	0.82	113	2.90	0.040	Perf.	114	4.48	0.8	SUBCONT13 (Cutting rebar in required length)	Imp.	114	4.73	0.81	113	0.73	0.468	Perf.	114	4.68	0.77								
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	Perf.	114	3.48	1.42				SUBCONT4 (Education level of the workers)	Imp.	114	3.07	1.28	113	0.01	0.365	Perf.	114	2.97	1.22	SUBCONT5 (Ability of reading technical drawings)	Imp.	114	3.77	1.46	113	2.60	0.011	Perf.	114	3.5	1.34	SUBCONT6 (Standardization of rebar shapes, components)	Imp.	114	4.55	0.94	113	0.84	0.402	Perf.	114	4.49	0.93	SUBCONT7 (Grouping the cut rebar in respect of length and size)	Imp.	114	4.68	0.81	113	0.98	0.329	Perf.	114	4.62	0.87	SUBCONT8 (Processing area on site)	Imp.	114	4.54	0.81	113	1.30	0.197	Perf.	114	4.43	0.95	SUBCONT9 (Storage area on site)	Imp.	114	4.5	0.87	113	0.99	0.323	Perf.	114	4.39	1.14	SUBCONT10 (Team relationships)	Imp.	114	3.97	1.22	113	0.00	1.000	Perf.	114	3.97	1	SUBCONT11 (Transportation of material on site)	Imp.	113	4.26	1	112	0.24	0.812	Perf.	113	4.27	0.97	SUBCONT12 (Percentage of defects)	Imp.	114	4.68	0.82	113	2.90	0.040	Perf.	114	4.48	0.8	SUBCONT13 (Cutting rebar in required length)	Imp.	114	4.73	0.81	113	0.73	0.468	Perf.	114	4.68	0.77																				
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Results indicated that the means of the “price of the material” (SUP4), “financial stability” (SUP6), “supplier/contractor relationships” (SUP8) for importance level and rating for project performance are not significantly different at $p < .05$ levels the contractor use a negotiated process with the distributor or manufacturer and the price they buy the rebar does not differs too much. On the other hand mean values of the other variables for performance ratings are lower than the mean values of importance weights (Table 5.6).

Table 5.6 Importance and performance levels for supplier related factors

		N	Mean	Sd	df	t	p
SUP1 (Delivery speed dependability)	Imp.	115	5.31	0.73	114	6.40	0.000
	Perf.	115	4.81	0.91			
SUP2 (Delivery reliability performance)	Imp.	115	5.31	0.6	114	4.82	0.000
	Perf.	115	4.94	0.82			
SUP3 (Supplier responsiveness)	Imp.	115	5.24	0.68	114	5.56	0.000
	Perf.	115	4.82	0.92			
SUP4 (Price of the material)	Imp.	115	5.07	1	114	0.50	0.622
	Perf.	115	5.02	0.99			
SUP5 (Location of the supplier)	Imp.	115	5	0.86	114	3.13	0.002
	Perf.	115	4.7	0.89			
SUP6 (Financial stability)	Imp.	115	5.07	0.99	114	0.34	0.734
	Perf.	115	5.04	0.75			
SUP7 (Writing and reading skills of contract and technical documents)	Imp.	115	4.07	1.3	114	1.74	0.084
	Perf.	115	4.22	1.26			
SUP8 (Supplier/contractor relationships)	Imp.	115	4.34	1.34	114	0.20	0.839
	Perf.	115	4.37	1.12			
SUP9 (Number of faultless delivery)	Imp.	115	5.15	0.79	114	2.45	0.016
	Perf.	115	4.98	0.75			
SUP10 (Quality of the material)	Imp.	115	5.07	0.73	114	2.31	0.023
	Perf.	115	5.21	0.72			
SUP11 (Warranties given by the supplier)	Imp.	115	4.45	1.22	114	3.65	0.000
	Perf.	115	4.75	0.94			
SUP12 (Product knowledge)	Imp.	115	4.58	1.24	114	2.96	0.004
	Perf.	115	4.82	0.92			

“Economic stability in the country” (EXT1) and “Transportation cost” (EXT2) were the most important dimensions of external factors both with importance weights and performance ratings. The means of importance level and performance ratings were significantly different except for “Environmental factors” (EXT6) at $p < .05$ level (Table 5.7). Economic stability in the country is important because of the fluctuations in the price of rebar. The price of rebar is determined world-widely, but the country economy, supply and demand conditions of the material affected the price. Transportation cost is important because in Turkey, rebar transportation cost accounts a high percentage in the material cost.

Table 5.7 Importance and performance levels for external factors

		N	Mean	Sd	df	t	p
EXT1 (Economic stability in the country)	Imp.	115	4.91	1.03	114	2.73	0.007
	Perf.	115	4.75	0.96			
EXT2 (Transportation cost)	Imp.	115	5.07	0.79	114	3.35	0.001
	Perf.	115	4.74	1.08			
EXT3 (Taxes)	Imp.	115	3.90	1.43	114	2.10	0.038
	Perf.	115	3.75	1.29			
EXT4 (Legal conditions)	Imp.	115	3.85	1.52	114	2.26	0.026
	Perf.	115	3.66	1.3			
EXT5 (Client characteristics)	Imp.	115	3.70	0.87	114	2.33	0.021
	Perf.	115	4.50	1			
EXT6 (Environmental factors)	Imp.	115	4.00	1.57	114	0.40	0.694
	Perf.	115	4.03	1.34			

5.1.2 Comparison of the assessments of performance

rbSC participants are required to assess their performance against the factors related to their companies role in the supply chain and assess other participants in the supply chain. For each factor, the companies rate themselves and the others at one of the six levels, as illustrated below.

<u>Likert Scale</u>	<u>Description</u>
1	Unacceptable
2	Low performance
3	Needs improvement
4	Satisfactory
5	Good
6	Excellent

In essence there are three levels of satisfaction, 1 and 2 are the lower side, 3 and 4 are average while 5 and 6 are high. In this case, 1 to 3 should be regarded as unacceptable while 4 to 6 are preferable.

The self-assessment provides the participants an opportunity to reflect its management practices related to supply chain and identify areas where it is doing well and areas where it needs to improve. The companies identify its strengths and weaknesses for continuous improvement. For rbSC the evaluation of participants self-assessments and others assessments help us to find the problematic link in the chain and the problem areas for this link.

During the analyses it was felt that there exist a difference between the performance ratings obtained by self assessment of a participant and those obtained through assessment done by the others. This difference indicated that each participant considered high own performance to be better than the others. This is seen as a cultural issue. Hence, the literature review was extended to include topics on construction culture. Thereafter, the same data was analyzed further by separating performance ratings to the self-assessment and those obtained through assessment by the others. These ratings are presented side by side in comparison charts for each participant and separately (Figure 5.1-5.4).

This data was then analyzed statistically for significant differences in assessments for each participant related factor. A chart was prepared for each participant where their performance ratings are compared in two groups; *i.e.*, the ratings obtained through self-assessment by the participant himself and those that were obtained by aggregating the ratings for his performance by the other

participants. During the analysis, if the total percentage of the performance ratings for the unacceptable, low performance and needs improvement is higher than 20%, this was taken as a factor that has problems in the SC.

Figure 5.1 shows the self-assessment of contractors and others' (AE companies, subcontractor, and supplier) assessments of contractor related factors. Only two of the factors are statistically different for the groups at $p < .05$ level. These factors are CONT7perf (past experience of the contractor) and CONT12perf (efficiency of cash flow method). The contractors assessments for themselves and the others assessments for the performance of contractors for the other 10 factors are not significantly different at $p < .05$ level.

77% of the contractors assessed their performance as good and excellent and 21% of contractors assessed their performance as satisfactory with efficiency cash flow method. The reason for the statistical difference in the performance assessments of cash flow was the absence of the strict articles related to cash flow in contracts. This result indicated that the other participants believe that the level of consistency in cash flow is lower for contractors than the contractors perceived. Mobilisation of resources (labour, workforce), materials and machineries depends on fund. The material suppliers did not give the most competitive rates if the contractors don't have consistent cash flow.

Past experience is an area of concern as 88% of contractor's performance is good or excellent with the requirements. The performance ratings for this factor are almost excellent for all of the rbSC participants. Although performance assessment level of other participants for this factor is high, the reason for the difference encountered between the groups for this factor is inadequate information about the contractors. In summary, the contractor culture in the area studied was seen to be lacking in the right attitude towards management related issues. Hence there is a need to change this attitude and truly understand the importance of management procedure and techniques in supply chain.

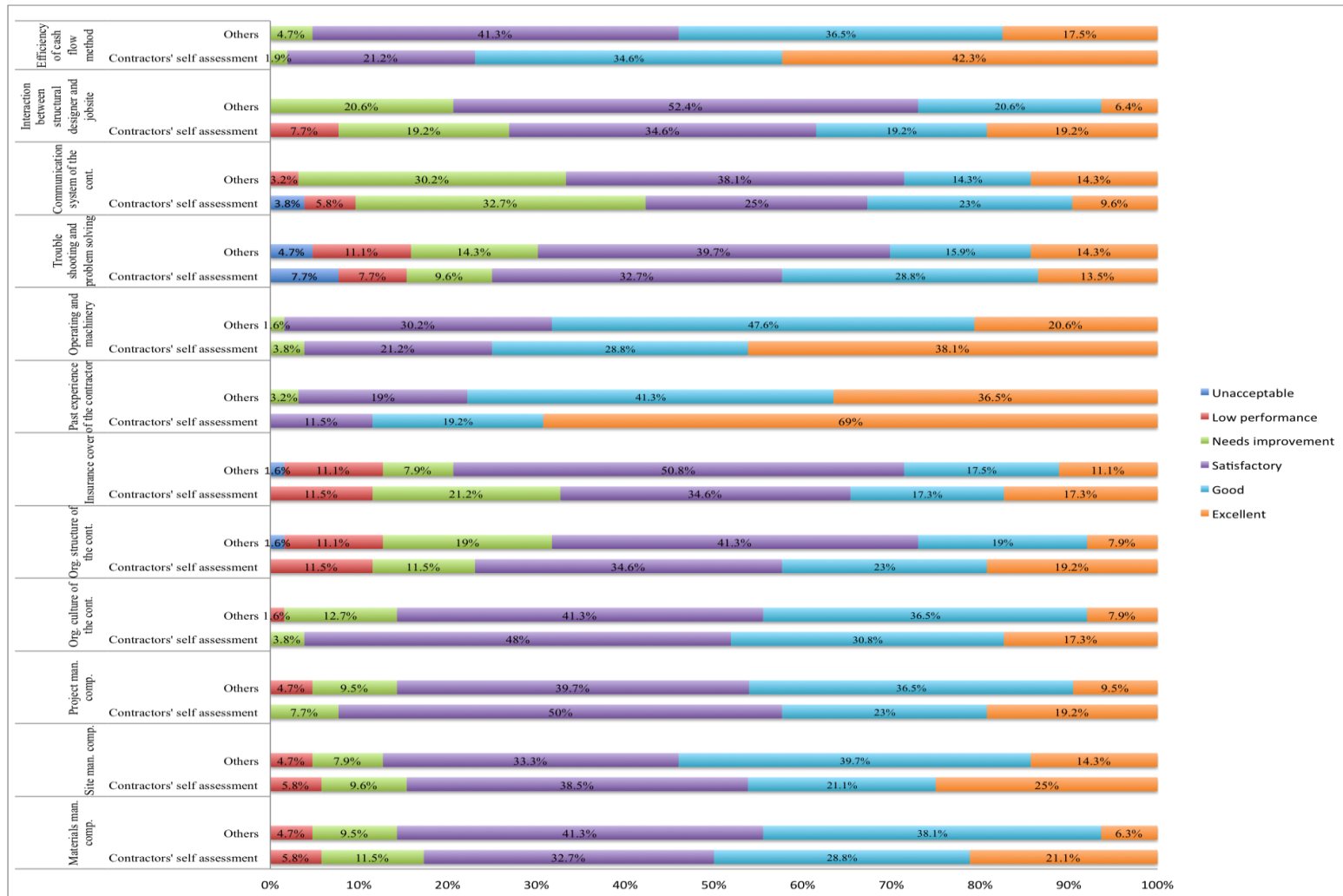


Figure 5.1 Performance assessments of contractor related factors

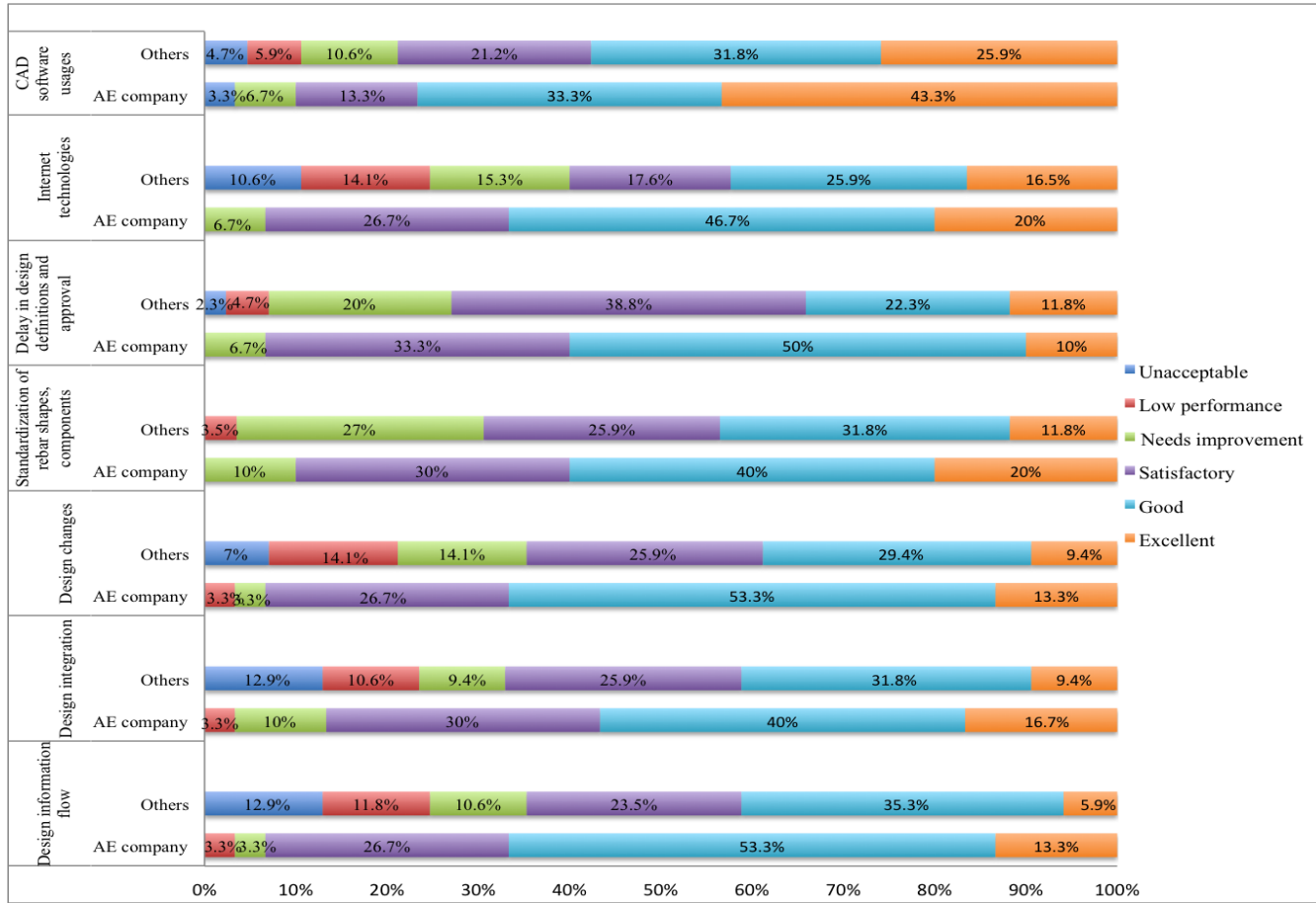


Figure 5.2 Performance assessments of AE company related factors

Figure 5.2 shows the evaluation of AE company related factors by AE companies and by the other rbSC participants (contractor, subcontractor, and supplier). AE companies see themselves as performing very well for all issues, with almost 60% of the companies rating themselves as very good and 30% of the remaining AE companies considering themselves to be satisfactory.

On the other hand, the evaluation of the other participants are significantly different for all AE company related factors at $p < .05$ level. The main reason for this result is the inadequate recording of the works done by AE companies. The contractor companies did not document the current operating system, tools, resources and costs of AE company related factors and did not create a value stream map to visualize how processes function and where the opportunities are. This shows the importance of communication at the front of the process, involving all the participants. Controlling the participants from the beginning is better than trusting them %100 percent. Even when parties know each other well, still a risk of changing behaviour according to the situations is remaining. Too much control can frustrate the parties involved but there is a need for a good balance between trust and control for AE companies in rbSC which can be achieved through a good contract which includes clause related to additional works and work changes and their related sub-issues like payments, duration and penalties.

The other participants' performance assessments of AE company related factors are lower than the self assessments for all issues because other participants encountered problems related to design issues on site and delivery delays of the production drawing.

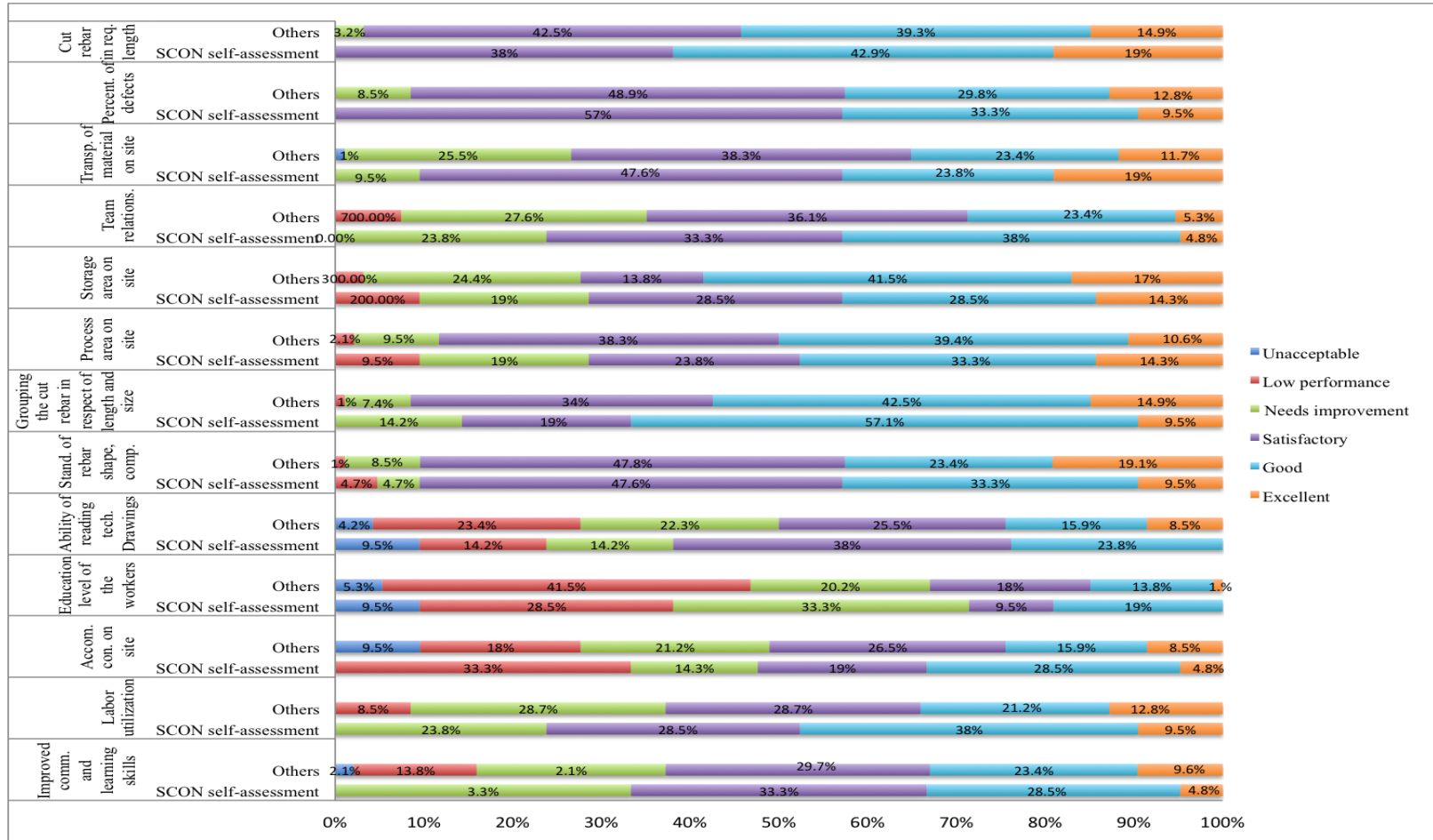


Figure 5.3 Performance assessments of sub-contractor related factors

As shown in Figure 5.3, subcontractors and the other participants (contractors, AE companies, and suppliers) assess subcontractor's performance as generally acceptable. The self-assessments and others assessments are not significantly different for subcontractor related factors at $p < .05$ level. The reasons for these are the tangible records (the works done) related to the subcontractor related factors performance. Subcontractors play a vital role in construction process and are directly related to project quality, time and cost. The control mechanisms on the works done by subcontractors are more than the other participants in the supply chain because there are clauses in their contracts regarding the amount of work, costs, duration and penalties. The most important reason for the medium levels of performance, for almost all factors is the subcontractor selection criteria. The subcontractor selection criteria mostly used by contractors are the tender price and employee competency. "Lowest price" is more important than quality based "value" in subcontractor selection criteria for SMEs. This shows the problems related to vision statements. Companies with developed long term missions and visions do not take decisions just for the short term profit. To avoid the risks like project quality non-compliance, project delays, delayed project payments and reach the planned level of success, the contractors pay more attention to the works done by subcontractors and strictly programme labor working schedules and put penalty clauses in the contracts prepared for the subcontractors.

Contracts done with subcontractors are not enough to realize the projects. Contractors do not pay attention to the weak signals of the parties involved, during the negotiation process or during the signing the contract. The works done by subcontractors are completely based on people and the results cannot be guaranteed by contracts. Moreover, usually subcontractors do not pay attention to the signs and what they expected. Mutual trust between the contractors and subcontractors as a result of culture is good but it is logical to add the signatures to this mutual trust.

Subcontractors assessed themselves better for all factors except the ones related to the other participants (SUBCONTperf6- Standardization of rebar shapes, components, SUBCONT8perf- Processing area on site, and SUBCONTperf9- Storage area on site). Subcontractor's performance is affected by these factors but the decisions about these factors are given by contractors and AE companies. Accordingly, the results for these factors are acceptable.

The highest self-assessment scores are for the factors SUBCONTperf2 (labor utilization), SUBCONTperf7 (grouping the cut rebar in respect of length and size) and SUBCONTperf13 (cutting rebar in required length).

For the suppliers (Figure 5.4), the significant differences between the self-assessments and others (contractor, AE companies, and subcontractors) assessments can be seen from the figure. Suppliers assessed themselves as almost excellent for all supplier related factors, e.g. SUPperf4 (price of the material), SUPperf5 (location of the supplier), SUPperf9 (number of faultless delivery) the difference between the assessments are not significant at $p < .05$ level. These factors are the ones that are documented strictly. Price of the material and the number of the faultless delivery can easily be seen from the bills. The performance related to distance is also not significant here because it is more or less the same and does not change according to the evaluator. For the supply of rebar, there are few reliable companies in the market. The suppliers have developed their own rules for the supply of rebar. As a result of polychromic culture of rebar suppliers, they handled many tasks simultaneously. Time is thought of being cyclical and it is not very important to be punctual for suppliers. Culturally the suppliers are lack of time and resource management.

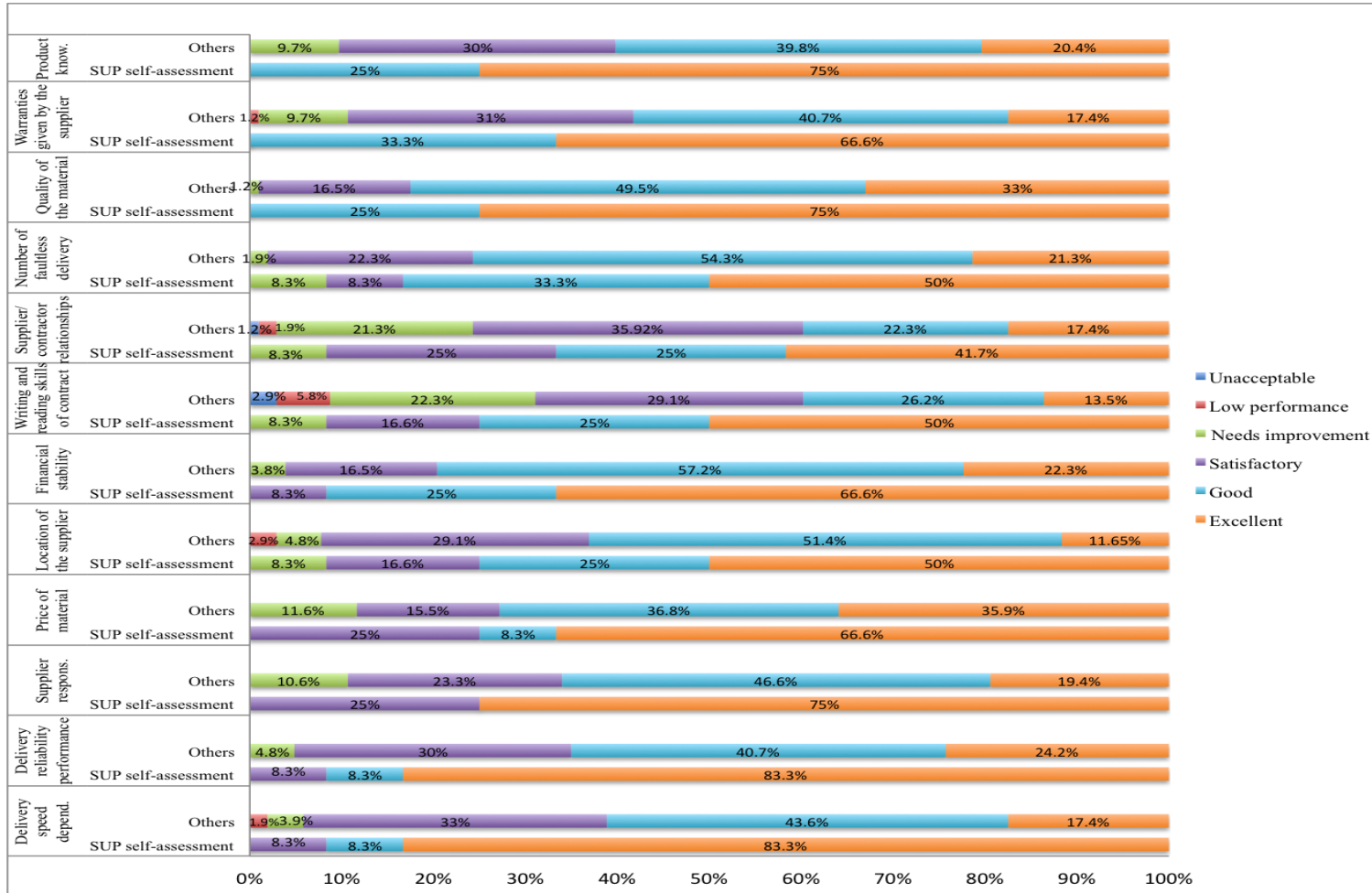


Figure 5.4 Performance assessments of supplier related factors

In this study 52 projects were evaluated by different contractors, AE companies, sub-contractors and suppliers; which meant that not every project was evaluated by all four participants except for three projects. However, this data is not significant to run a statistical test. The data for these three projects were evaluated according to their mean values (Table 5.8 – 5.10). For example, contractors scored their performance as 4.61/6.00 whereas the other three participants gave them a score of 4.34/6.00, which is slightly less than the self-assessment mean. The AE companies self-assessment score was 4.43/6.00 and the other participants score for AE companies was 4.17/6.00 which is relatively lower. For sub-contractors self-assessment score was 4.36/6.00. Sub-contractors got the lowest score from the others assessment and it was 3.93/6.00. The highest score for self-assessment was given by the suppliers. They gave themselves 5.19/6.00. Moreover, the others score for suppliers was 4.25/6.00. The self-assessment scores and those given by the other participants are almost the same for contractors, AE companies and sub-contractors. However there is a significant difference between the scores for the suppliers. On the other hand the lowest performance scores as given by the other three participants can be seen for sub-contractors which mean that the low performance of projects is usually attributed to the low performance of the sub-contractors.

Table 5.8 Performance assessments of projects evaluated by all participants (Contractor and AE company assessments)

	Akasya Houses		Hisar Residence		Gorkem Apt.		Assessments for all 3 projects	
	Self Assessment	Mean of others assessment	Self Assessment	Mean of others assessment	Self Assessment	Mean of others assessment	Mean of self-assessments	Mean of others assessments
CONT1 Materials management competency	4.00	4.33	5.00	4.67	5.00	4.33	4.67	4.44
CONT2 Site management competency	4.00	4.67	5.00	5.00	5.00	4.33	4.67	4.67
CONT3 Project management competency	5.00	5.00	4.00	4.33	5.00	4.33	4.67	4.55
CONT4 Organization culture of the contractor	5.00	4.00	4.00	4.33	5.00	4.33	4.67	4.22
CONT5 Organization structure of the contractor	5.00	4.00	4.00	4.33	5.00	4.00	4.67	4.11
CONT6 Insurance cover	4.00	4.33	4.00	4.33	5.00	4.00	4.33	4.22
CONT7 Past experience of the contractor	6.00	4.67	5.00	5.33	6.00	5.00	5.67	5.00
CONT8 Operating and machinery	5.00	3.67	5.00	5.33	5.00	4.67	5.00	4.56
CONT9 Trouble shooting and problem solving	5.00	4.00	5.00	5.00	2.00	1.67	4.00	3.56
CONT10 Communication system of the contractor	5.00	5.33	4.00	4.67	3.00	2.67	4.00	4.22
CONT11 Interaction between structural designer and jobsite	4.00	4.67	4.00	4.67	4.00	3.00	4.00	4.11
CONT12 Efficiency of cash flow method	5.00	4.33	5.00	5.33	5.00	3.67	5.00	4.44
Mean scores for contractors	4.75	4.42	4.50	4.78	4.58	3.83	4.61	4.34
AE1 Design information flow	4.00	4.33	5.00	4.67	4.00	3.67	4.33	4.22
AE2 Design integration	4.00	4.00	5.00	4.67	4.00	3.67	4.33	4.11
AE3 Design changes	5.00	4.33	5.00	4.33	4.00	3.67	4.67	4.11
AE4 Standardization of rebar shapes, components	4.00	4.33	5.00	4.67	4.00	3.67	4.33	4.22
AE5 Delay in design definitions and approval	5.00	4.33	5.00	4.33	4.00	4.00	4.67	4.22
AE6 Internet technologies	5.00	4.00	4.00	4.33	4.00	3.33	4.33	3.89
AE7 CAD software usages	5.00	4.67	4.00	4.67	4.00	4.00	4.33	4.45
Mean scores for AE companies	4.57	4.28	4.71	4.52	4.00	3.72	4.43	4.17

Table 5.9 Performance assessments of projects evaluated by all participants (Sub-contractor assessments)

	Akasya Houses		Hisar Residence		Gorkem Apt.		Assessments for all 3 projects	
	Self Assessment	Mean of others assessment	Self Assessment	Mean of others assessment	Self Assessment	Mean of others assessment	Mean of self-assessments	Mean of others assessments
SUBCONT1 Improved communication and learning skills	3.00	4.67	6.00	4.00	3.00	2.33	4.00	3.67
SUBCONT2 Labor utilization (planned, weekly working schedules)	5.00	5.00	5.00	4.33	5.00	2.67	5.00	4.00
SUBCONT3 Accommodation conditions on site	5.00	4.67	5.00	3.33	2.00	1.67	4.00	3.22
SUBCONT4 Education level of the workers	3.00	4.67	5.00	3.33	3.00	2.00	3.67	3.33
SUBCONT5 Ability of reading technical drawing	5.00	4.00	4.00	3.33	4.00	2.00	4.33	3.11
SUBCONT6 Standardization of rebar shapes, components	5.00	4.00	5.00	5.33	4.00	3.33	4.67	4.22
SUBCONT7 Grouping the cut rebar in respect of length and size	5.00	4.33	5.00	5.33	4.00	3.00	4.67	4.22
SUBCONT8 Processing area on site	4.00	4.33	5.00	5.33	4.00	2.67	4.33	4.11
SUBCONT9 Storage area on site	5.00	4.67	5.00	5.33	2.00	3.00	4.00	4.33
SUBCONT10 Team relationships	4.00	4.67	5.00	4.33	4.00	2.67	4.33	3.89
SUBCONT11 Transportation of material on site	4.00	3.67	5.00	5.00	4.00	3.33	4.33	4.00
SUBCONT12 Percentage of defects	4.00	4.33	5.00	5.00	5.00	4.00	4.67	4.44
SUBCONT13 Cutting rebar in required length	4.00	4.67	5.00	5.00	5.00	4.00	4.67	4.56
Mean scores for sub-contractors	4.31	4.44	5.00	4.54	3.77	2.82	4.36	3.93

Table 5.10 Performance assessments of projects evaluated by all participants (Supplier assessments)

	Akasya Houses		Hisar Residence		Gorkem Apt.		Assessments for all 3 projects	
	Self Assessment	Mean of others assessment	Self Assessment	Mean of others assessment	Self Assessment	Mean of others assessment	Mean of 3 projects	Mean of others assessments
SUP1 Delivery speed dependability	4.00	4.00	6.00	4.33	6.00	4.33	5.33	4.22
SUP2 Delivery reliability performance	5.00	4.67	6.00	4.33	6.00	4.33	5.67	4.44
SUP3 Supplier responsiveness	4.00	4.33	6.00	4.33	6.00	4.33	5.33	4.33
SUP4 Price of the material	4.00	4.00	6.00	4.67	4.00	3.33	4.67	4.00
SUP5 Location of the supplier	4.00	4.33	6.00	4.67	5.00	4.33	5.00	4.44
SUP6 Financial stability	6.00	4.00	6.00	4.67	5.00	4.67	5.67	4.45
SUP7 Writing and reading skills of contract and tech. doc.	4.00	4.00	6.00	4.00	5.00	4.00	5.00	4.00
SUP8 Supplier/contractor relationships	5.00	3.33	4.00	3.67	4.00	4.00	4.33	3.67
SUP9 Number of faultless delivery	3.00	3.67	5.00	4.33	6.00	4.67	4.67	4.22
SUP10 Quality of the material	5.00	4.00	6.00	4.33	6.00	5.00	5.67	4.44
SUP11 Warranties given by the supplier	5.00	4.67	6.00	4.33	5.00	3.67	5.33	4.22
SUP12 Product knowledge	5.00	4.67	6.00	4.67	6.00	4.33	5.67	4.56
Mean scores for suppliers	4.50	4.14	5.75	4.36	5.33	4.25	5.19	4.25

5.1.3 Basic Difference Statistics for Three or More Groups (ANOVA)

This section consisted of ANOVA tests carried out for project related questions (project type, project location, projects' rebar need, construction site distance from rebar supplier and place of rebar preparation) under the second section of the questionnaire. ANOVA was used to test whether these characteristics have an effect on rbSC performance, project performance related factors and rbSC participant related factors. ANOVA test was applied to each project characteristic and the results were presented below.

A. rbSC performance related factors impact by project characteristics

Table 5.11 revealed the results for the rbSC performance related factors by project characteristics. Table 5.11 was composed of two parts: one part describes results from the ANOVA and provides total number of the sample (N), mean value for each group and p-value. The other part of Table 5.11 summarized the post hoc test indicating the group for which the mean rbSC performance related factors was significantly from those other groups within each category.

In the project type group category, the highest mean of rbSC performance related factors (4.61) was calculated for residential and the lowest for education buildings (4.23) but the means of the groups were not significantly difference at $p < .05$ level. For the location of project the mean for rbSC performance related factors for the projects located in a low density urban area was significantly higher than the projects those located in a high density urban area and suburban area. The lowest mean for rbSC related factors was calculated for medium size projects (4.33) due to its rebar need and the highest mean was calculated for big size projects (4.70). These are significantly different at $p < .05$ level. However the mean for small size project due to projects' rebar need had the mean of 4.36, that was very closed to the medium size mean (4.36), this finding lacked statistical significance because this was based on a small sample of 14. rbSC performance related factors affected due to the construction site distance from rebar supplier. The highest mean of rbSC performance related factors was calculated for the projects those sites' located 10-

30km away from the rebar supplier (4.61) and the lowest mean was calculated for the projects those sites located more than 50 km away from the rebar supplier (4.11), however this was again based on small sample of 3. The significant difference for this characteristic was reported for 10-30km projects and 30-50km projects at 95% confidence interval according to Games-Howell test results. rbSC performance related factors don't affected from the place of fabrication and assembly of rebar (p-value =0.984).

Table 5.11 rbSC performance impact by project characteristics

Project characteristics	rbSC performance related factors					
	ANOVA test (p< .05)			Post Hoc (CI=95%)		
	N	Mean	p-value	High	Low	
Project type	Residential	52	4.61	0.244	No significant differences	
	Commercial	18	4.43			
	Education	25	4.23			
	Health	7	4.62			
	Other	13	4.31			
Project location	high density urban area	35	4.15	0.000	Low density urban area	High density urban area
	low density urban area	47	4.79		Low density urban area	Suburban area
	suburban area	33	4.32			
Project rebar requirement	small	14	4.36	0.043	big	medium
	medium	61	4.33		big	medium
	big	40	4.70			
Construction site distance from rebar supplier	0-10 km	35	4.50	0.090	10-30 km	30-50 km
	10-30 km	50	4.61			
	30-50 km	27	4.19			
	>50 km	3	4.11			
Place of rebar preparation	on-site cut and bend	85	4.47	0.984	No significant differences	
	off-site cut and bend	5	4.46			
	both	25	4.44			

B. Project performance related factors impact by project characteristics

Table 5.12 summarized the analysis results for projects performance related factors by project characteristics. When projects were sorted by project type, residential projects had the highest project performance ratings at 4.94 and the lowest mean was recorded for education projects (4.49). The difference is statistically significant (p-value=0.041). Mean of project performance related factors was significantly high for the projects constructed at a low density urban area than the projects located at a high density urban area and suburban area (p-value=0.005). Projects performance related factors don't change according to projects rebar need (p-value = 0.567), construction site distance from rebar supplier (p-value = 0.320) and place of rebar preparation (p-value = 0.344).

Table 5.12 Project performance impact by project characteristics

Project characteristics	Project performance related factors					
	ANOVA test (p< .05)			Post Hoc (CI=95%)		
	N	Mean	p-value	High	Low	
Project type	Residential	52	4.94	0.041	Residential	Education
	Commercial	18	4.72			
	Education	25	4.49			
	Health	7	4.62			
	Other	13	4.74			
Project location	high density urban area	35	4.59	0.005	Low density urban area	High density urban area
	low density urban area	47	4.99		Low density urban area	Suburban area
	suburban area	33	4.65			
Projects' rebar need	small	14	4.69	0.567	No significant differences	
	medium	61	4.73			
	big	40	4.85			
Construction site distance from rebar supplier	0-10 km	35	4.79	0.320	No significant differences	
	10-30 km	50	4.85			
	30-50 km	27	4.64			
	>50 km	3	4.33			
Place of rebar preparation	on-site cut and bend	85	4.77	0.344	No significant differences	
	off-site cut and bend	5	4.40			
	both	25	4.84			

C. Contractor related factors impact by project characteristics

Table 5.13 showed contractor related factors impact by project characteristics. Contractor related factors were impacted by project type. The mean for residential projects were significantly higher than the mean for health projects (p-value = 0.002). The highest mean value of 4.90 for health projects was lack of significance due to number of small sample size. Based on the location of the project, the mean contractor related factors for low density urban area constructed projects was

significantly higher than those projects constructed in a high density urban area (p-value = 0.000). According to Games-Howell test results, there is a significant difference for contractor related factors performance between medium size and large size projects due to projects rebar need at 95% confidence interval (p-value = 0.004). Moreover, contractor related factors don't affected from construction site distance from rebar supplier (p-value = 0.188) and place of rebar preparation (p-value = 0.495).

Table 5.13 Contractor related factors performance impact by project characteristics

Project characteristics	Contractor related factors					
	ANOVA test (p< .05)			Post Hoc (CI=95%)		
	N	Mean	p-value	High	Low	
Project type	Residential	52	4.82	0.002	Residential	Education
	Commercial	18	4.47			
	Education	25	4.25			
	Health	7	4.90			
	Other	13	4.51			
Project location	high density urban area	35	4.28	0.000	Low density urban area	High density urban area
	low density urban area	47	4.87			
	suburban area	33	4.57			
Projects' rebar need	small	14	4.42	0.004	big	medium
	medium	61	4.48			
	big	40	4.88			
Construction site distance from rebar supplier	0-10 km	35	4.58	0.188	No significant differences	
	10-30 km	50	4.71			
	30-50 km	27	4.49			
	>50 km	3	4.00			
Place of rebar preparation	on-site cut and bend	85	4.61	0.495	No significant differences	
	off-site cut and bend	5	4.27			
	both	25	4.64			

D. AE company related factors impact by project characteristics

The mean value of AE company related factors for education projects was 3.06, indicating AE company related factors performance was statistically different for education projects than residential, commercial and health projects (p-value = 0.000). Moreover, the performance of AE company related factors was statistically different for residential and other projects according to Games-Howell test results. Mean of AE company related factors was significantly high for the projects constructed at a low density urban area than the projects located at a high density urban area and suburban area (p-value=0.000). The lowest mean value for small projects was lack of significance due to the sample number of 14. AE company related factors performance differed according to the construction site difference from rebar supplier. The mean value for 10-30km was significantly different from the mean value of 0-10km and >50 km at p<.05 level. In addition, the performance level of AE company related factors of 30-50km projects are significantly higher than the projects those located >50 km away from rebar supplier (p-value = 0.000). When the category of rebar preparation place was considered, the mean AE company related factors for on-site cut and bend was higher than that of off-site cut and bend, but this result was not significant as indicated by the p-value of 0.076 in Table 5.14

Table 5.14 AE company related factors performance impact by project characteristics

Project characteristics		AE company related factors				
		ANOVA test (p< .05)			Post Hoc (CI=95%)	
		N	Mean	p-value	High	Low
Project type	Residential	52	4.82	0.000	Residential	Education
	Commercial	18	4.17		Commercial	Education
	Education	25	3.06		Health	Education
	Health	7	4.71		Residential	Other
	Other	13	3.59			
Project location	high density urban area	35	3.51	0.000	Low density urban area	High density urban area
	low density urban area	47	4.70			
	suburban area	33	4.18			
Projects' rebar need	small	14	3.86	0.001	big	medium
	medium	61	3.94			
	big	40	4.70			
Construction site distance from rebar supplier	0-10 km	35	3.81	0.000	10-30 km	0-10 km
	10-30 km	50	4.63		10-30 km	>50 km
	30-50 km	27	4.07		30-50km	>50 km
	>50 km	3	2.33			
Place of rebar preparation	on-site cut and bend	85	4.30	0.076	No significant differences	
	off-site cut and bend	5	3.23			
	both	25	4.03			

E. Sub-contractor related factors impact by project characteristics

Table 5.15 showed sub-contractor related factors impact by project characteristics. The mean values of sub-contractor related factors performance for some project types were significantly different (p-value = 0.003). The sub-contractor related factors performance had the highest mean value for health projects and this value was significantly different from the mean value of commercial and other

building types. Moreover, mean sub-contractor related factors performance for residential buildings is significantly higher than the mean for commercial buildings at $p < .05$ level. For the location of project the mean for sub-contractor related factors for the projects located in a low density urban area was significantly higher than the projects those located in a high density urban area at $p < .05$ level. There is no significant differences in sub-contractor related factors performance due to projects' rebar need, construction site distance from rebar supplier and preparation place of rebar at $p < .05$ level.

Table 5.15 Sub-contractor related factors performance impact by project characteristics

Project characteristics		Sub-contractor related factors				
		ANOVA test ($p < .05$)			Post Hoc (CI=95%)	
		N	Mean	p-value	High	Low
Project type	Residential	52	4.14	0.003	Health	Commercial
	Commercial	18	3.50		Residential	Commercial
	Education	25	3.71		Health	Other
	Health	7	4.50			
	Other	13	3.50			
Project location	high density urban area	35	3.37	0.000	Low density urban area	High density urban area
	low density urban area	47	4.30			
	suburban area	33	3.38			
Projects' rebar need	small	14	3.76	0.222	No significant differences	
	medium	61	3.81			
	big	40	4.08			
Construction site distance from rebar supplier	0-10 km	35	3.77	0.158	No significant differences	
	10-30 km	50	4.06			
	30-50 km	27	3.84			
	>50 km	3	3.13			
Place of rebar preparation	on-site cut and bend	85	3.88	0.559	No significant differences	
	off-site cut and bend	5	4.30			
	both	25	3.88			

F. Supplier related factors performance impact by project characteristics

Table 5.16 presented that performance level of supplier related factors were not significantly different for different project types at $p < .05$ level. The mean value of supplier related factors performance for the projects those located in a low density urban area was significantly higher than the projects located in a high density urban area. Projects' rebar need had an effect on supplier related factors performance. The performance for big projects is significantly higher than the performance of small and medium size for suppliers. Although the mean values of supplier related factors were different for different construction site distances and different place for preparation the results lacked of significance according to Games-Howell test results.

Table 5.16 Supplier related factors performance impact by project characteristics

Project characteristics	Supplier related factors				
	ANOVA test ($p < .05$)			Post Hoc (CI=95%)	
	N	Mean	p-value	High	Low
Project type	Residential	52	4.95	0.383	No significant differences
	Commercial	18	4.91		
	Education	25	4.74		
	Health	7	5.25		
	Other	13	4.97		
Project location	high density	35	4.71	0.003	Low density urban area
	low density	47	5.14		High density urban area
	suburban	33	4.81		
Projects' rebar need	small	14	4.64	0.00	big
	medium	61	4.78		small
	big	40	5.23		big
Construction site distance from	0-10 km	35	4.80	0.006	No significant differences
	10-30 km	50	5.03		
	30-50 km	27	4.99		
	>50 km	3	3.83		
Place of rebar preparation	on-site cut	85	4.96	0.037	No significant differences
	off-site cut	5	4.23		
	both	25	4.92		

5.2 Confirmatory factor analyses of the measurement models

Confirmatory factor analyses with the data of the main study were conducted to select the observed factors(sub-factors) with low loadings in structural equation modeling. rbSC performance model was represented by contractor related factors (CONT-12 observed factors), AE company related factors (AE-7 observed factors), sub-contractor related factors (SUBCONT-13 observed factors), supplier related factors (SUP-12 observed factors), External factors (EXT-6 observed factors), rbSC performance (RBperf-4 observed factors) and project performance (PROJperf-3 observed factors).

To verify the factor structure of contractor related factors scale, a confirmatory factor analysis using Lisrel 8.51 was conducted. Factor analysis for the latent variable of contractor related factors was performed through 12 items (Figure 5.5). For purifying and reaching to fit indices for this construct items CONT2, CONT5, CONT6, CONT9, CONT11, CONT12 were dropped for further analysis (Figure 5.6). Confirmatory factor analysis for the remaining factors yielded acceptable fit of the confirmatory model in the data [$\chi^2 = 2.55$, $p < .001$, RMSEA = .106, GFI = .94, AGFI = .87, CFI = .96, NNFI = .93] (Table 5.17).

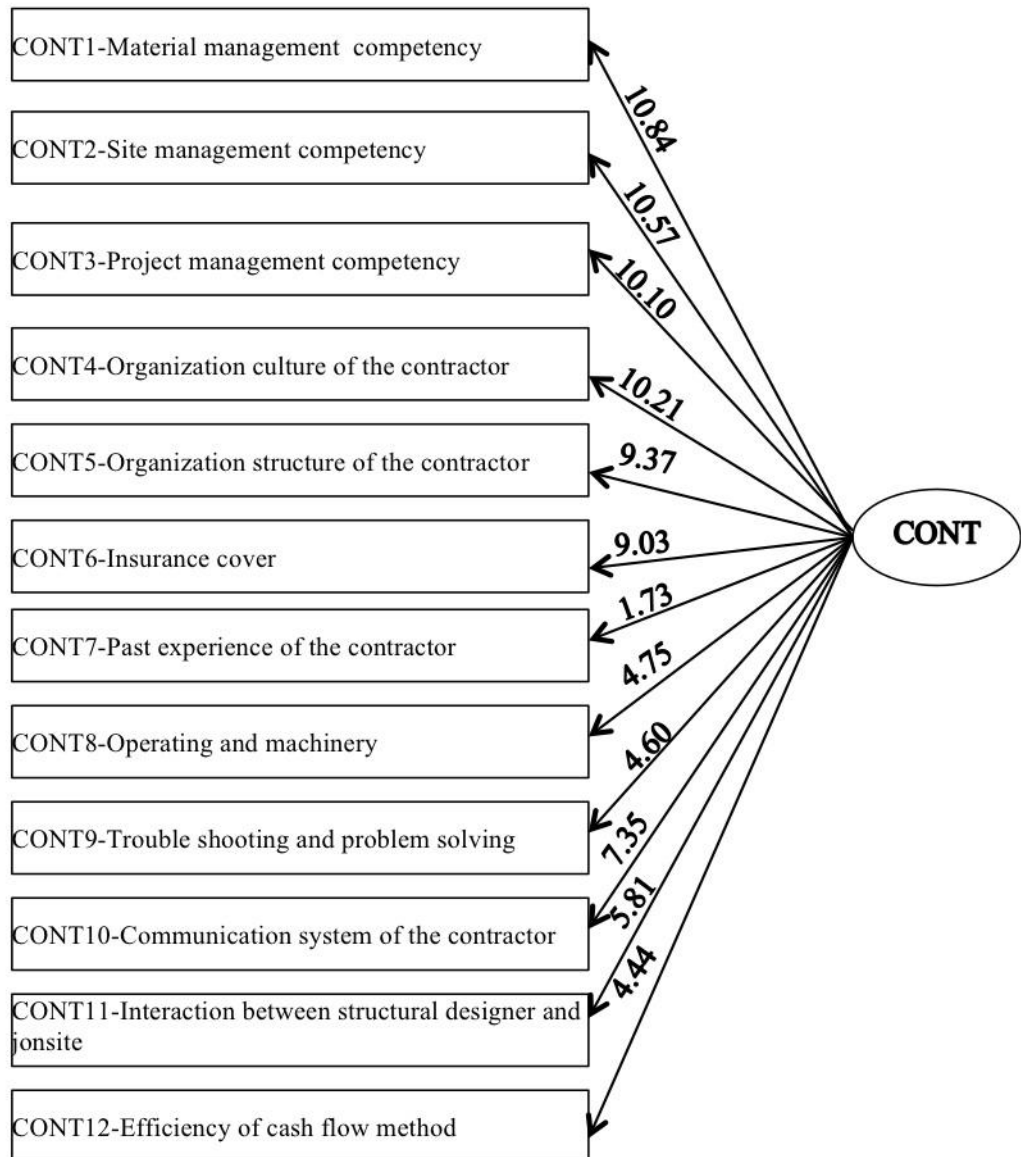


Figure 5.5 Impacts of sub-factors on contractor related factors with t-values (before confirmatory factor analysis)

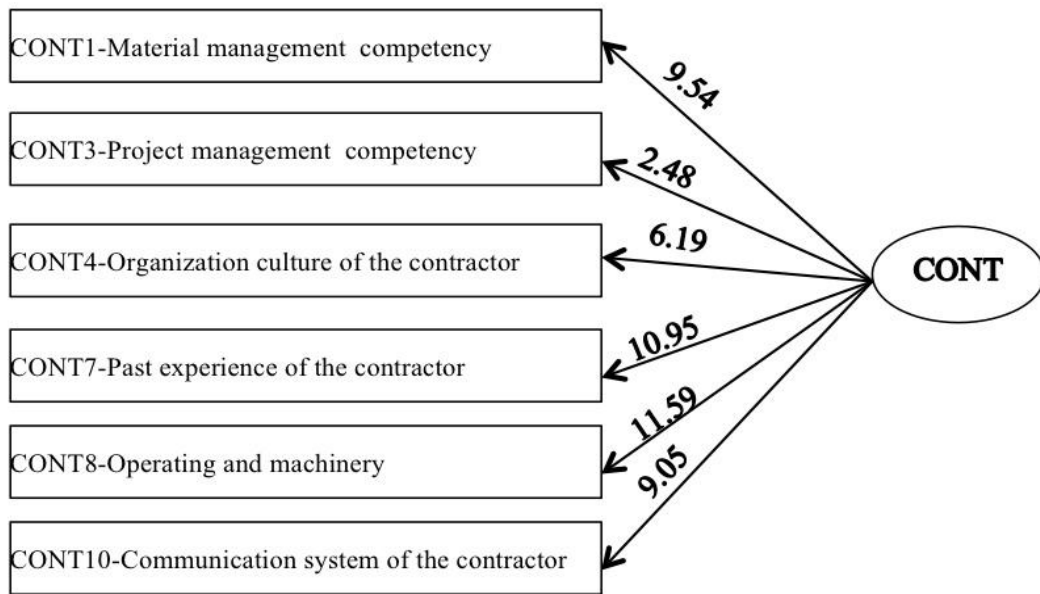


Figure 5.6 Impacts of sub-factors on contractor related factors with t-values (after confirmatory factor analysis)

Table 5.17 Fit indices for contractor related factors

Goodness-of-fit measure	Allowable range of GOF measure	Proposed	Final
χ^2/dof	< 3	3.462	2.283
RMSEA	< .01	0.147	0.106
GFI	0 (No fit) – 1(Perfect fit)	0.785	0.943
AGFI	0 (No fit) – 1(Perfect fit)	0.690	0.868
CFI	0 (No fit) – 1(Perfect fit)	0.830	0.956
NNFI	0 (No fit) – 1(Perfect fit)	0.792	0.927

Factor analysis for the subscale of AE company related factors was performed through 7 items (Figure 5.7). For purifying and reaching to fit indices for this construct items a parcel named AE8 was constructed with the mean of items AE1, AE2, AE3. The answers given to these three items show that they are parallel in logic. Confirmatory factor analysis for the new construct yielded acceptable fit of the confirmatory model in the data [$\chi^2 = 77.15, p < .001, RMSEA = .00, GFI = .99, AGFI = .95, CFI = 1.00, NNFI = 1.00$] (Table 5.18). All items had loadings above than .30, minimum loading was .49 and the maximum loading was 0.87 (Figure 5.8).

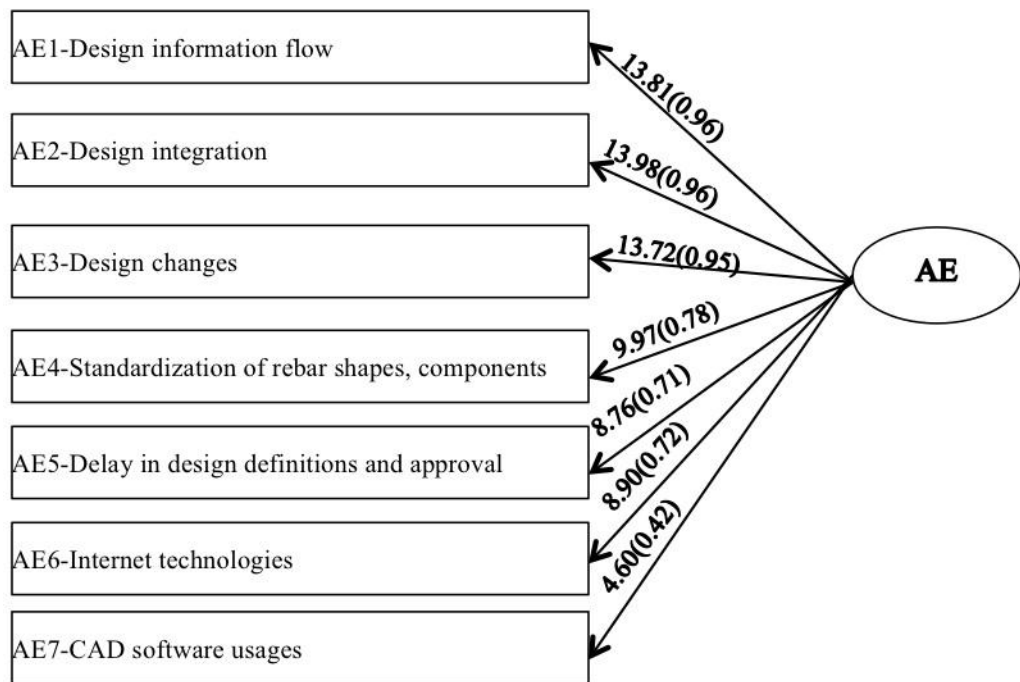


Figure 5.7 Impacts of sub-factors on AE company related factors with t-values and path coefficients in brackets (before confirmatory factor analysis)

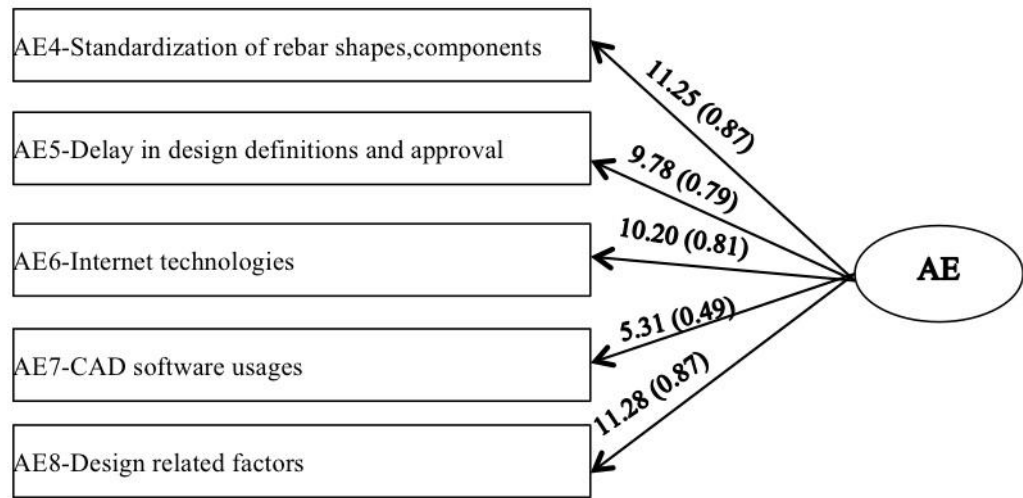


Figure 5.8 Impacts of sub-factors on AE company related factors with t-values and path coefficients in brackets (after confirmatory factor analysis)

Table 5.18 Fit indices for AE company related factors

Goodness-of-fit	Allowable range of GOF	Proposed	Final
χ^2/dof	< 3	5.10	0.979
RMSEA	< .01	0.199	0.0
GFI	0 (No fit) – 1(Perfect fit)	0.838	0.987
AGFI	0 (No fit) – 1(Perfect fit)	0.676	0.950
CFI	0 (No fit) – 1(Perfect fit)	0.930	1.00
NNFI	0 (No fit) – 1(Perfect fit)	0.896	1.00

Factor analysis for the latent variable of sub-contractor related factors was performed through 13 items (Figure 5.9). For purifying and reaching to fit indices for this construct items SUBCONT1, SUBCONT7, SUBCONT9, SUBCONT12, SUBCONT13 were dropped for further analysis (Figure 5.10). Confirmatory factor analysis for the remaining factors yielded acceptable fit of the confirmatory model in the data [$\chi^2 = 36.76$, $p < .001$, RMSEA = .09, GFI = .93, AGFI = .87, CFI = .98,

NNFI = .94] (Table 5.19). All items had loadings above than .30, minimum loading was .52 and the maximum loading was 0.82.

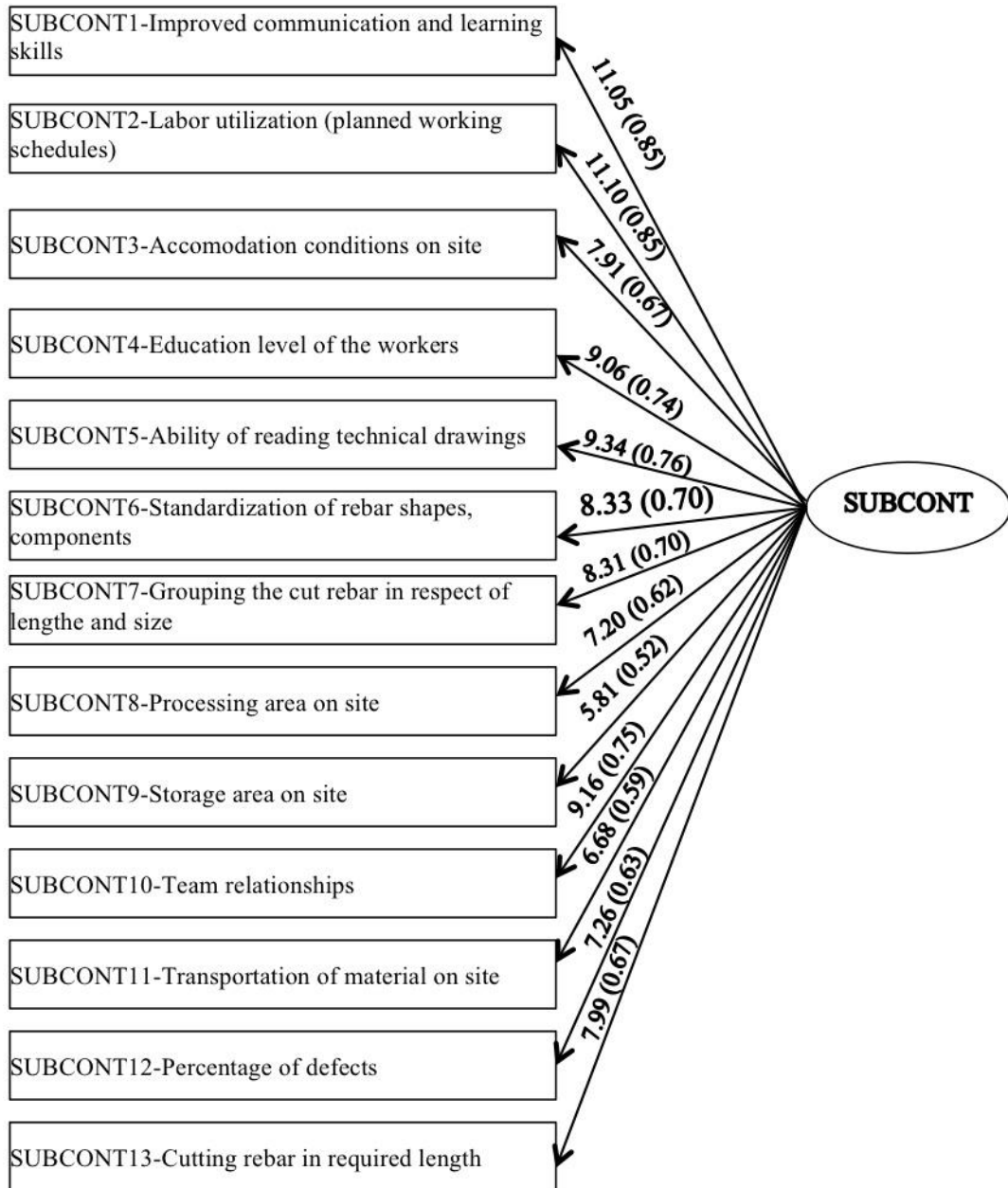


Figure 5.9 Impacts of sub-factors on sub-contractor related factors with t-values and path coefficients in brackets (before confirmatory factor analysis)

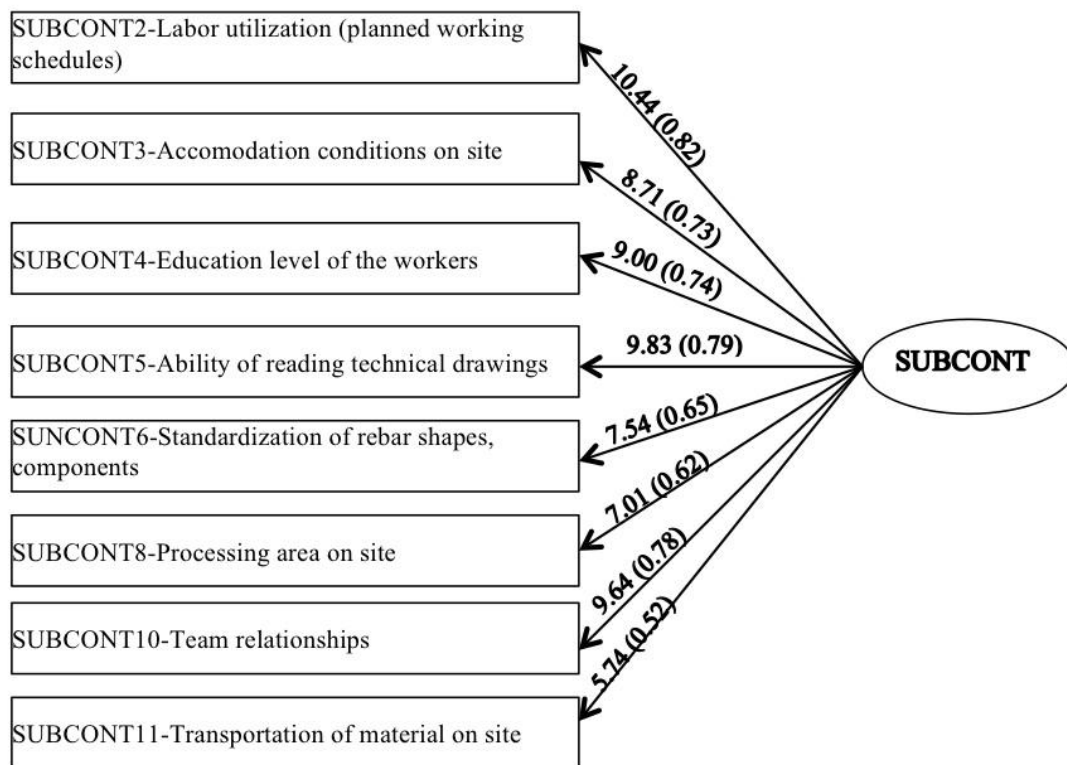


Figure 5.10 Impacts of sub-factors on sub-contractor related factors with t-values and path coefficients in brackets (after confirmatory factor analysis)

Table 5.19 Fit indices for sub-contractor related factors

Goodness-of-fit measure	Allowable range of GOF measure	Proposed	Final
χ^2/dof	< 3	4.898	1.888
RMSEA	< .01	0.185	0.086
GFI	0 (No fit) – 1 (Perfect fit)	0.699	0.925
AGFI	0 (No fit) – 1 (Perfect fit)	0.579	0.866
CFI	0 (No fit) – 1 (Perfect fit)	0.764	0.957
NNFI	0 (No fit) – 1 (Perfect fit)	0.717	0.940

Factor analysis for the latent variable of supplier related factors was performed through 12 items (Figure 5.11). For purifying and reaching to fit indices for this

construct items SUP2, SUP7, SUP8, SUP12 were dropped for further analysis (Figure 5.12). Confirmatory factor analysis for the remaining factors yielded acceptable fit of the confirmatory model in the data [$\chi^2 = 31.69, p < .001, RMSEA = .07, GFI = .94, AGFI = .88, CFI = .96, NNFI = .94$] (Table 5.20). All items had loadings above than .30, minimum loading was .53 and the maximum loading was .81.

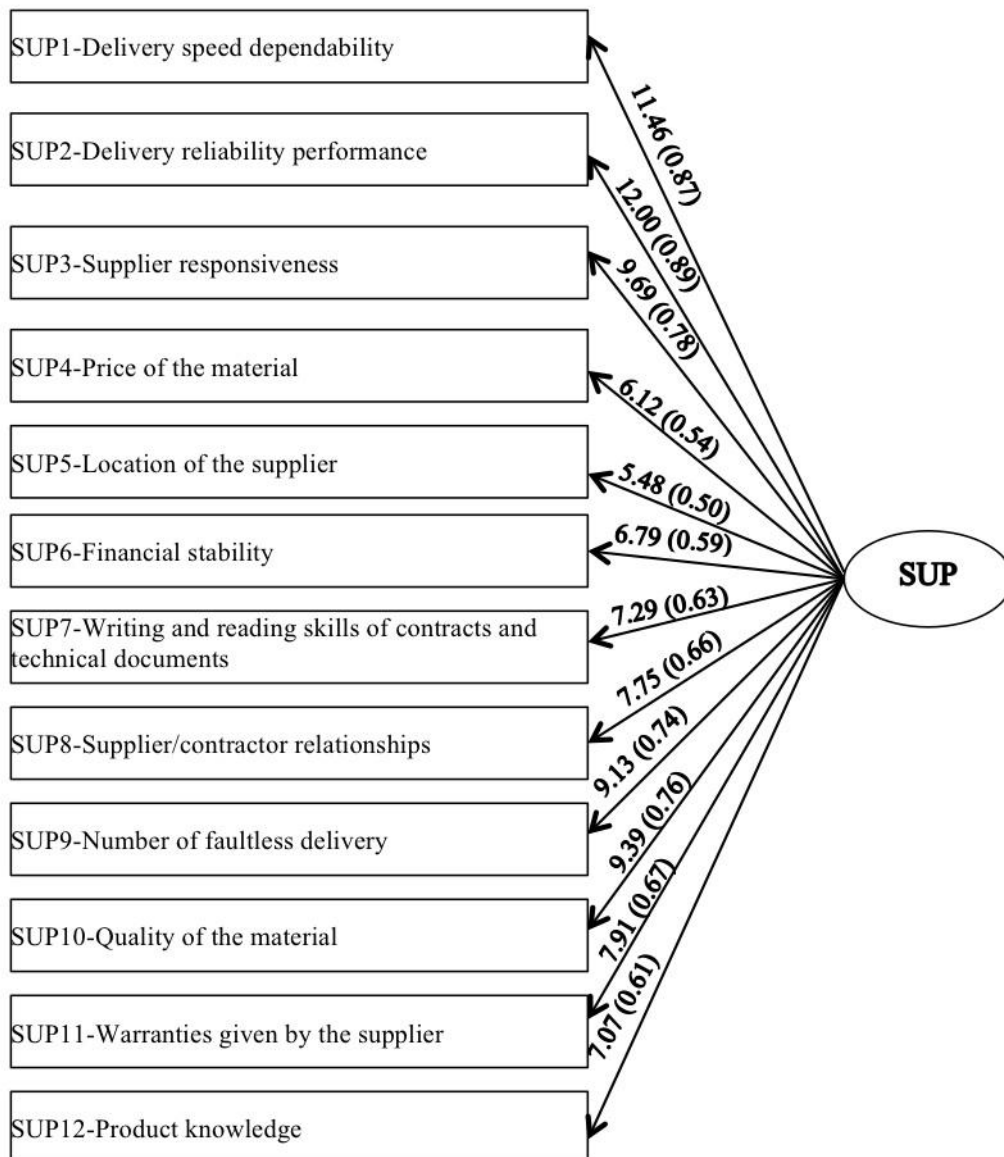


Figure 5.11 Impacts of sub-factors on supplier related factors with t-values and path coefficients in brackets (before confirmatory factor analysis)

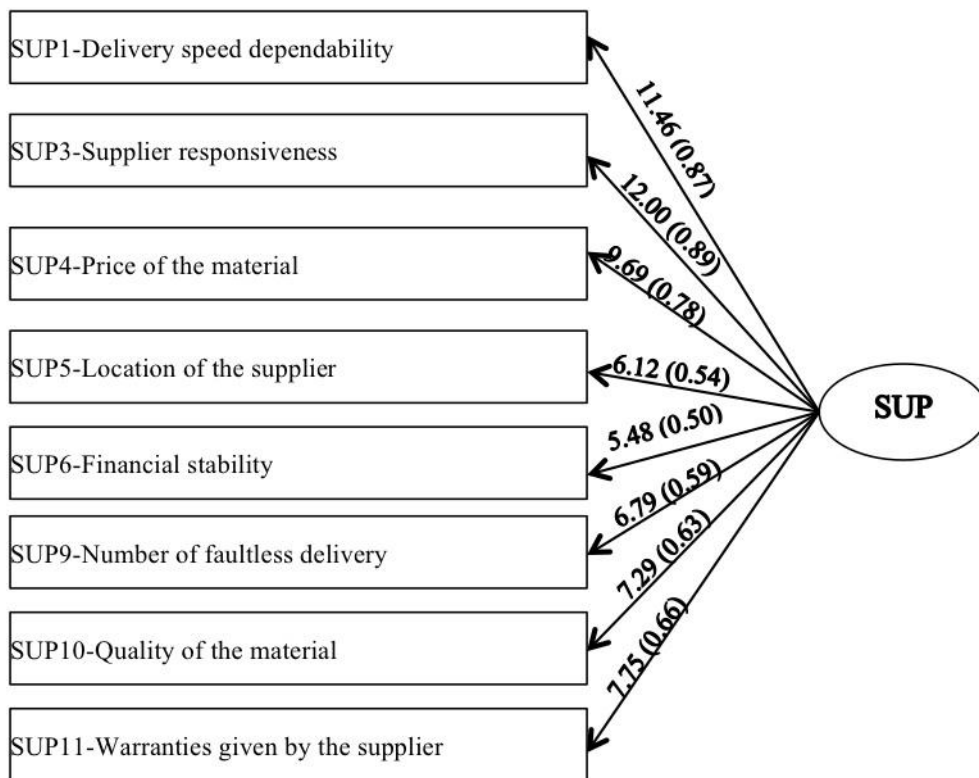


Figure 5.12 Impacts of sub-factors on supplier related factors (after confirmatory factor analysis)

Table 5.20 Fit indices for supplier related factors

Goodness-of-fit measure	Allowable range of GOF measure	Proposed	Final
χ^2/dof	< 3	6.97	1.58
RMSEA	< .01	0.229	0.072
GFI	0 (No fit) – 1 (Perfect fit)	0.645	0.935
AGFI	0 (No fit) – 1 (Perfect fit)	0.487	0.883
CFI	0 (No fit) – 1 (Perfect fit)	0.698	0.960
NNFI	0 (No fit) – 1 (Perfect fit)	0.631	0.943

Factor analysis for the latent variable of external factors was performed through 6 items (Figure 5.13). For purifying and reaching to fit indices for this

construct sub-factors EXT3 was dropped for further analysis (Figure 5.14). Confirmatory factor analysis for the remaining factors yielded acceptable fit of the confirmatory model in the data [$\chi^2 = 3.85$, $p < .001$, RMSEA = .00, GFI = .99, AGFI = .95, CFI = 1.00, NNFI = 1.00] (Table 5.21). All items had loadings above than .30, minimum loading was .37 and the maximum loading was .63.

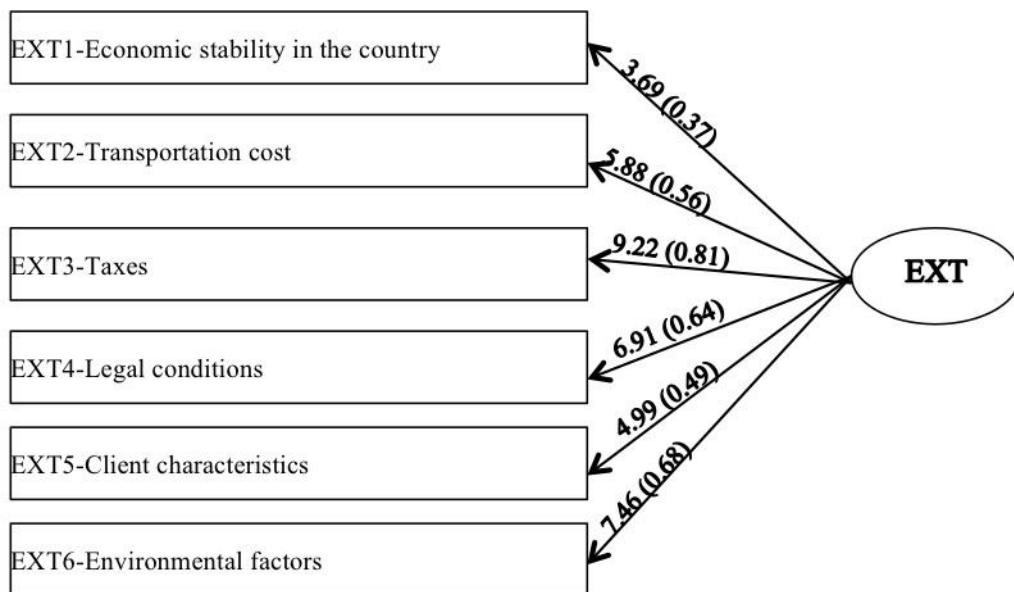


Figure 5.13 Impacts of sub-factors on external factors with t-values and path coefficients in brackets (before confirmatory factor analysis)

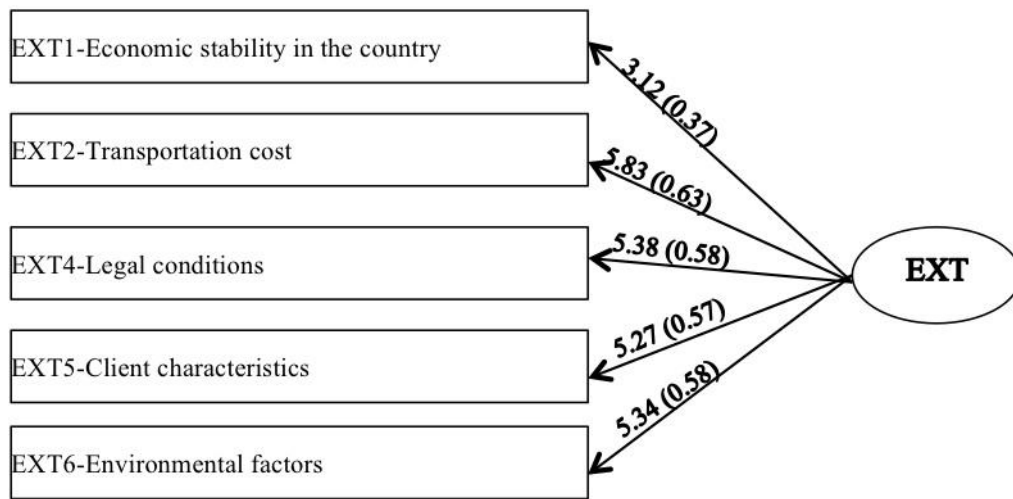


Figure 5.14 Impacts of sub-factors on external factors with t-values and path coefficients in brackets (after confirmatory factor analysis)

Table 5.21 Fit indices for external factors

Goodness-of-fit	Allowable range of GOF measure	Proposed	Final
χ^2/dof	< 3	5.176	0.963
RMSEA	< .01	0.191	0.00
GFI	0 (No fit) – 1(Perfect fit)	0.880	0.987
AGFI	0 (No fit) – 1(Perfect fit)	0.720	0.950
CFI	0 (No fit) – 1(Perfect fit)	0.799	1.00
NNFI	0 (No fit) – 1(Perfect fit)	0.665	1.00

Factor analysis for the latent variable of rbSC performance was performed through 4 items (Figure 5.15). For purifying and reaching to fit indices for this construct sub-factors RBperf3 was dropped for further analysis (Figure 5.16). Confirmatory factor analysis for the remaining factors yielded acceptable fit of the confirmatory model in the data [$\chi^2 = 0.00$, $p < .001$, RMSEA = .00, GFI = 1.00, AGFI = 1.00, CFI = 1.00, NNFI = 1.00] (Table 5.22). All items had loadings above than .30, minimum loading was .53 and the maximum loading was .80.

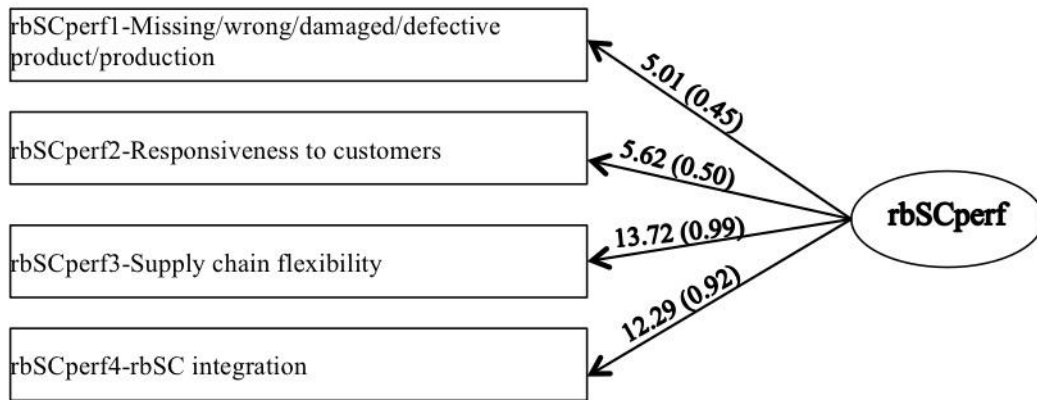


Figure 5.15 Impacts of sub-factors on rbSC performance with t-values and path coefficients in brackets (before confirmatory factor analysis)

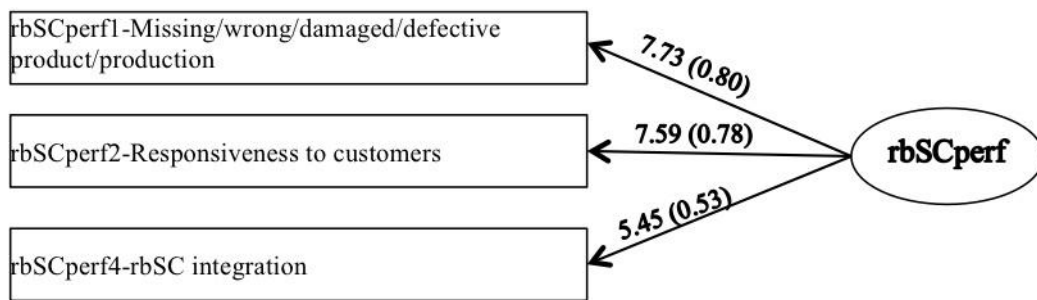


Figure 5.16 Impacts of sub-factors on rbSC performance with t-values and path coefficients in brackets (after confirmatory factor analysis)

Table 5.22 Fit indices for rbSC performance factors

Goodness-of-fit measure	Allowable range of GOF measure	Proposed	Final
χ^2/dof	< 3	16.45	0.00
RMSEA	< .01	0.368	0.00
GFI	0 (No fit) – 1 (Perfect fit)	0.874	1.00
AGFI	0 (No fit) – 1 (Perfect fit)	0.370	1.00
CFI	0 (No fit) – 1 (Perfect fit)	0.873	1.00
NNFI	0 (No fit) – 1 (Perfect fit)	0.619	1.00

Factor analysis for the latent variable of project performance was performed through 3 items (Figure 5.17). Because of having good fit indices any sub-factor was dropped for further analysis. Confirmatory factor analysis for the factors yielded acceptable fit of the confirmatory model in the data [$\chi^2 = 0.00$, $p < .001$, RMSEA = .00, GFI = 1.00, AGFI = 1.00, CFI = 1.00, NNFI = 1.00] (Table 5.23). All items had loadings above than .30, minimum loading was .45 and the maximum loading was .63.

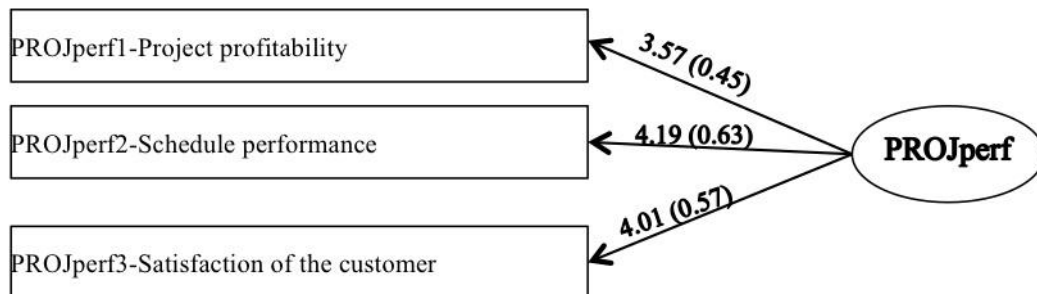


Figure 5.17 Impacts of sub-factors on project performance with t-values and path coefficients in brackets (before confirmatory factor analysis)

Table 5.23 Fit indices for project performance related factors

Goodness-of-fit measure	Allowable range of GOF measure	Proposed	Final (not modified)
χ^2/dof	< 3	0.00	0.00
RMSEA	< .01	0.00	0.00
GFI	0 (No fit) – 1 (Perfect fit)	1.00	1.00
AGFI	0 (No fit) – 1 (Perfect fit)	1.00	1.00
CFI	0 (No fit) – 1 (Perfect fit)	1.00	1.00
NNFI	0 (No fit) – 1 (Perfect fit)	1.00	1.00

5.3 Analysis of Structural Model

Using LISREL, the relationships were examined between the factor, rbSC performance (a latent variable with four sub-factors) and project performance (a latent variable with three sub-factors), and four participant related factors, namely contractor related factors (a latent variable with twelve sub-factors), AE company related factors (a latent variable with seven sub-factors), sub-contractor related factors (a latent variable with thirteen sub-factors), supplier related factors (a latent variable with twelve sub-factors) and finally external factors (a latent variable with six sub-factors). The hypothesized model after confirmatory factor analysis is presented in Figure 5.18 where ovals represent latent factors, and rectangles represent measured factors.

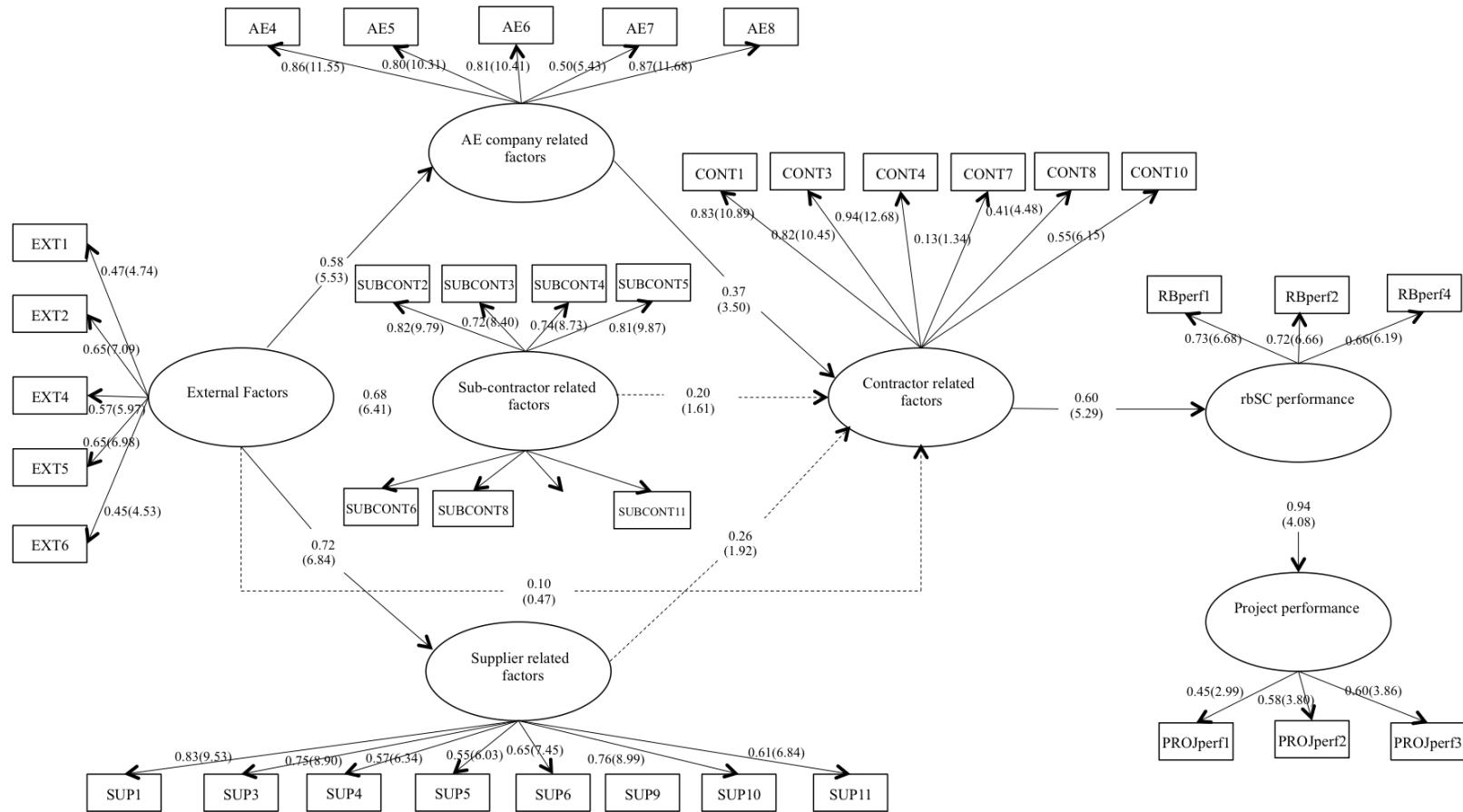
To specify the model in the study, the first step was to test the measurement model, providing evidence for how well the latent variables were measured by predefined sub-factors. Unidimensionality of the latent variables was assessed using confirmatory factor analysis. It was necessary to re-specify the rbSC performance, contractor related factors, AE company related factors, sub-contractor related factors, supplier related factors and external factors as latent variables to achieve sufficient unidimensionality. rbSC performance construct was reduced to 3 sub-factors, contractor related factors construct was reduced to 6 sub-factors, AE company related factors construct was reduced to 5 sub-factors, sub-contractor related factors construct was reduced to 8 sub-factors, supplier related factors was reduced to 8 sub-factors and finally external factors construct was reduced to 5 sub-factors. After reaching goodness of fit indices within allowable ranges for each construct, each measurement construct was considered sufficiently unidimensional, reliable and valid to support further assessment of the structural model.

Since each construct was validated and checked for reliability, the next step was about testing the relationships between the variables within the structural model. The developed structural model is depicted in Figure 5.18. The numbers on the arrows in Figure 5.18 originating from the latent variables represent path

coefficients. All links were statistically significant at $p < 0.05$ level, since their t-value were higher than 1.96, except the relationships between external factors and contractor related factors, supplier related factors and contractor related factors and sub-contractor related factors and contractor related factors. The goodness-of-fit results for the proposed structural model were presented in Table 5.24. The results indicated that the model needs improvement to reach goodness-of-fit results within the allowable range.

Table 5.24 Fit indices for developed structural model

Goodness-of-fit measure	Allowable range of GOF measure	Fit indices
χ^2/dof	< 3	2.15
RMSEA	< .01	0.100
GFI	0 (No fit) – 1 (Perfect fit)	0.606
AGFI	0 (No fit) – 1 (Perfect fit)	0.554
CFI	0 (No fit) – 1 (Perfect fit)	0.689
NNFI	0 (No fit) – 1 (Perfect fit)	0.666



Legend ○ Latent variable □ Observed variable → Existence of relationship - - - -> Absence of relationship

Figure 5.18 Developed structural model with path coefficients and t-values (brackets). (Solid lines refer to significant relations, dashed lines refer to insignificant relations at $p < 0.05$ level)

In the study of finding the impacts of factors on rbSC performance to reach the fit indices within the allowable range, the sub-factors were parceled according to their conceptual relations. For contractor related factors, sub-factors CONT1, CONT3, CONT4 were summed to create a total scale score for a new item called CONA and CONT7, CONT8, CONT10 were summed to create a total scale score for a new item called CONB. AE company related factors parceled into three sub-factors called AEA (created by summing up AE1, AE2, AE3), AEB (created by summing up AE4, AE5), AEC (create by summing up AE6, AE7). SUBCONT3, SUBCONT6, SUBCONT8, SUBCONT11 as the sub-factors related to sub-contractors were summed up to create a total score for a new sub-factor called SUBCONTA and SUBCONT2, SUBCONT4, SUBCONT5, SUBCONT10 were summed up to create a total score for the second new sub-factor for sub-contractor related factor with the name of SUBCONTB. Supplier related factors parceled into two, due to the logical relations between the items. For this reason SUP1, SUP3, SUP6, SUP9, SUP11 were summed up to create SUPA and only SUP4 and SUP10 were summed to create SUPB. All remaining external factors were summed up to create EXT. As it is described above there were two parcels created for each participant except AE company related factors which had three parcels and one parcel was created for external factors.

The path coefficients and t-values in the parceled model were presented in Figure 5.16. Path coefficients and t-values were statistically significant at $p < 0.05$, except for the relationship between EXT (external factors) and CONT (contractor related factors). The goodness-of-fit results of the parceled model were presented in Table 5.25. The results indicated better fit indices than the proposed model but still did not reach to the best fit indices.

“Contractor related factors” latent variable was found to have an impact on rbSC performance. Since the contractors positioned as a mediator in the framework with the factors parceled under CONTA and CONTB, they have power to impact rbSC performance level. Production performance in the construction industry cannot

be separated from contractor's productivity. For the defined factors under this construct, factor loading were found to be 0.82 for the contractor companies management and culture related factors (CONT1, CONT3, CONT4), 0.56 for contractor's resource and capability related factors (CONT7, CONT8, CONT10). These findings show that new management philosophies play important role for all sized contractors including small and medium sized. Materials management competency and project management competency can make a significant contribution to the cost effectiveness of a construction project. To reach the level of manufacturing industry in applying the new management philosophies, it is the first step to be aware of them.

“AE company related factors” were found to be most influential on “contractor related factors”. AE companies are the key companies as they start and manage the design process. Designers play a very important role as their work involves from inception to completion of a project. “Delay in design definitions and approval” and “standardization of rebar shapes, components” were found to be having the highest factor loading with a value of 0.95, under this construct. Managing design process is a core activity for the continuity of the chain. “Standardization of rebar shapes, components” is important for all rbSC participants to save time and decrease the percentages of wrong products. Design related factors have a loading of 0.84 and technology and CAD usages related factors have relatively lower loading of 0.75

The skill levels of the labor in “reading technical drawings” and in handling the cutting, bending and assembling operations with close relationships were found to be most important indicators for sub-contractor related factors. Also utilization of the team by their team leader and education level of the workers has impacts on sub-contractor related factors. As a second group, availability of the good conditions and characteristics not only for working sites but also for the constructed projects has an impact on sub-contractor related factors with a loading of 0.81.

“Supplier related factors” were found to be having the lowest factor loading with a value of 0.31 under the main construct. Delivery speed dependability, supplier

responsiveness, financial stability, number of faultless delivery and warranties given by the supplier were the factors that have the highest factor loading of 0.95 under supplier related factors. Price and quality of the materials also found to be important in accordance with the issues described above. As it is seen, right delivery is the key issue in this construct. Right delivery means that delivering the right material, at the right time, to the right place with the best price.

“External factors” did not affected by the other factors but they had impacts on the other latent factors as they were used as independent latent variable in the proposed model. According to the results “external factors” have an impact on “AE company related factors” with a factor loading of 0.52, on “sub-contractor related factors” with a factor loading of 0.64, on “supplier related factors” with a factor loading of 0.72. As most of the external related factors were related to economy and cost, “supplier related factors” were influenced more than the other participants. Economic stability in the country, transportation cost has the potential to affect the supplier’s price and their position in the chain. The factors used under “external factors” construct have a high factor loading with a value of 0.89.

Table 5.25 Fit indices for the parceled model

Goodness-of-fit measure	Allowable range of GOF measure	Fit indices
χ^2/dof	< 3	2.20
RMSEA	< .01	0.104
GFI	0 (No fit) – 1 (Perfect fit)	0.811
AGFI	0 (No fit) – 1 (Perfect fit)	0.736
CFI	0 (No fit) – 1 (Perfect fit)	0.842
NNFI	0 (No fit) – 1 (Perfect fit)	0.805

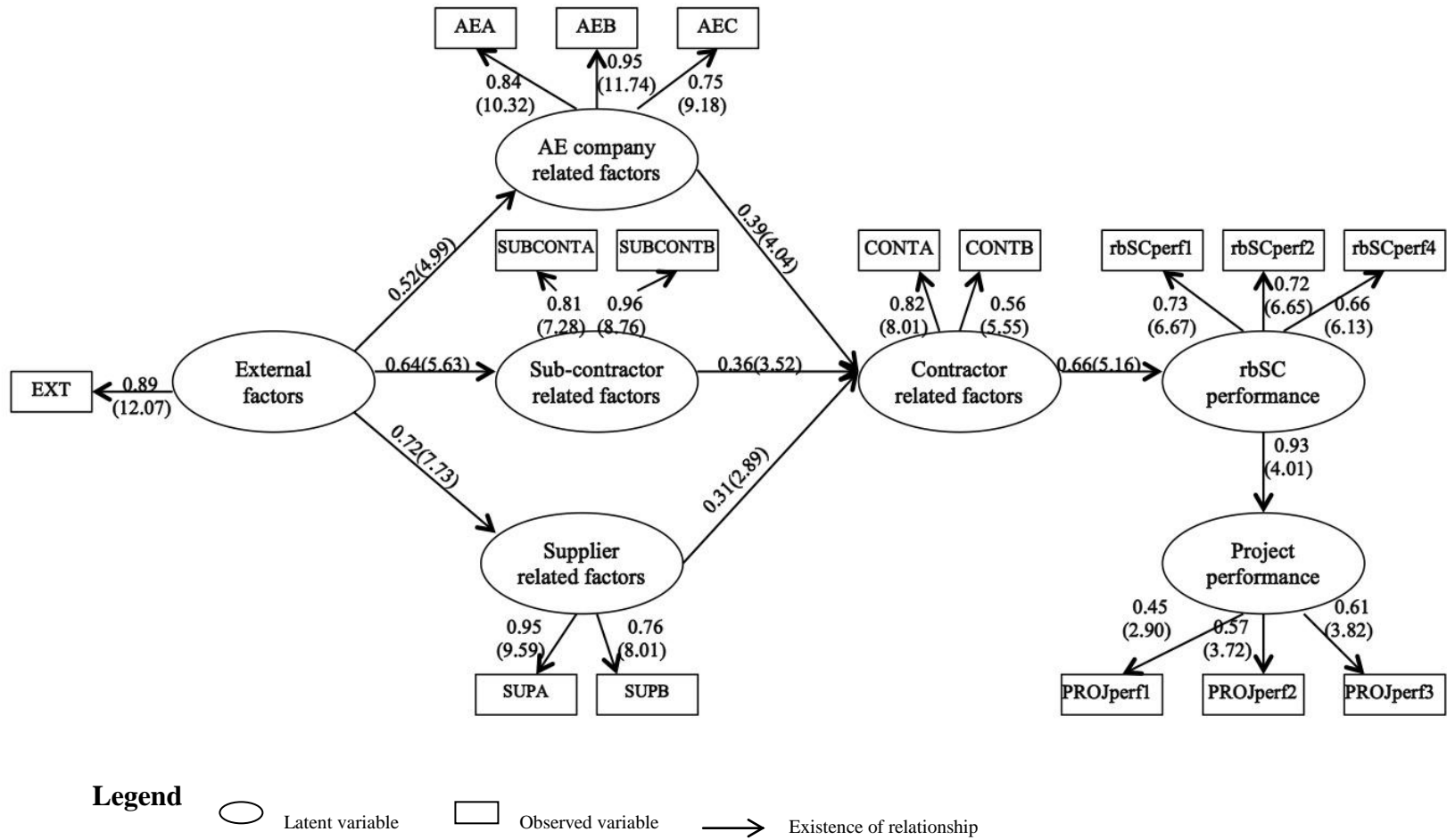
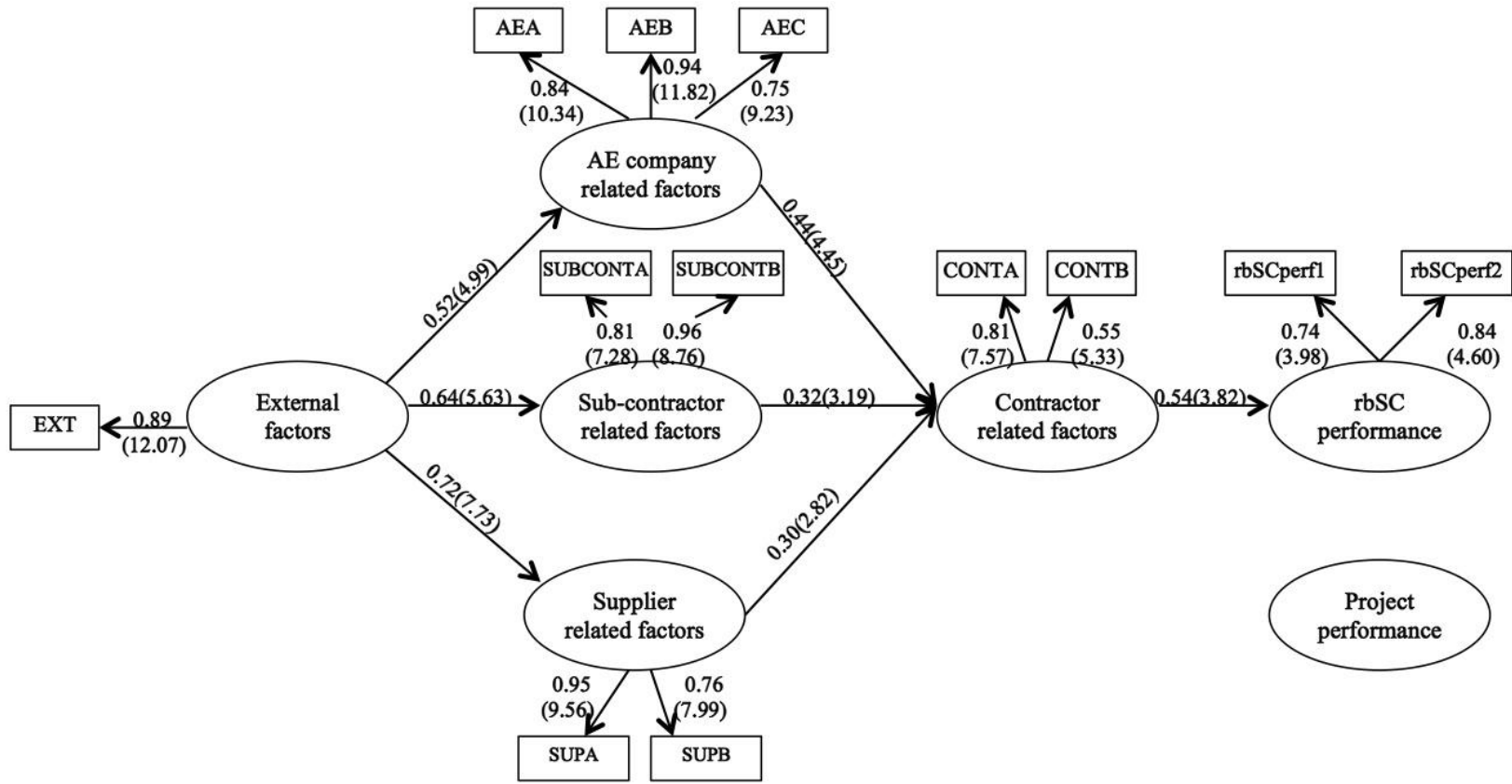


Figure 5.19 Parceled model with path coefficients and t-values (brackets)

Finally, the relationships were tested by removing the link between rbSC performance and project performance for the proposed model. Path coefficients and t-values were statistically significant at $p < 0.05$ (Figure 5.17). Removing the link between two factors improved the goodness-of-fit indices obtained in the previous parceled model. Table 5.26 presented the comparison of the goodness-of-fit indices obtained in the proposed model, parceled model and the final model and Table 5.27 presented the factor loadings (path coefficients) of the sub-factors in the final model.

Table 5.26 Comparison of the fit indices for models

Goodness-of-fit measure	Allowable range of GOF measure	Proposed Model	Parceled model	Final model
χ^2/dof	< 3	2.15	2.20	2.04
RMSEA	< .01	0.100	0.104	0.096
GFI	0 (No fit) – 1 (Perfect fit)	0.606	0.811	0.876
AGFI	0 (No fit) – 1 (Perfect fit)	0.554	0.736	0.798
CFI	0 (No fit) – 1 (Perfect fit)	0.689	0.842	0.926
NNFI	0 (No fit) – 1 (Perfect fit)	0.666	0.805	0.898



Legend ○ Latent variable □ Observed variable → Existence of relationship

Figure 5.20 Final model with path coefficients and t-values (brackets)

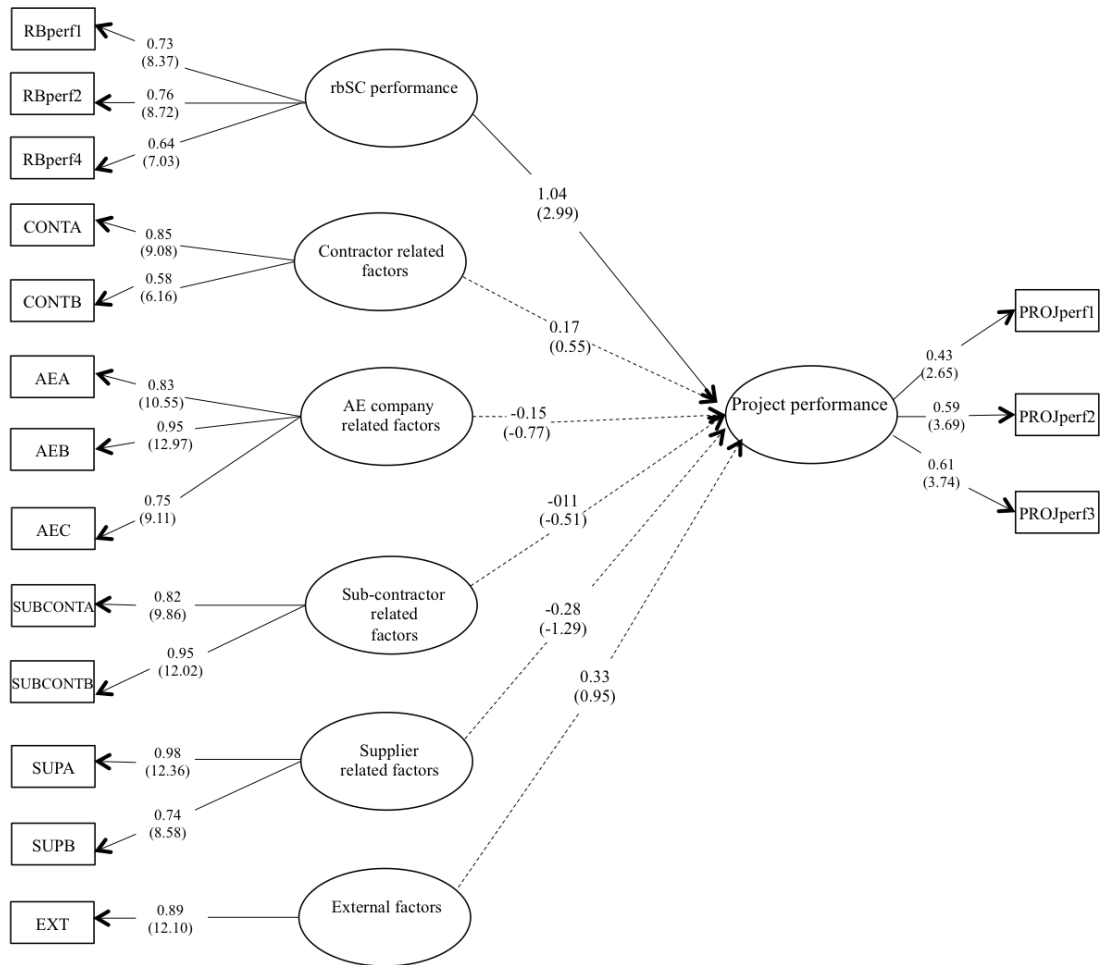
Table 5.27 Factor loadings of the sub-factors for the final model

Factors		Factor Loading
Contractor related factors		
CONTA	CONT1 Materials management competency	0.81
	CONT3 Project management competency	0.81
	CONT4 Organization culture of the contractor	0.81
CONTB	CONT7 Past experience of the contractor	0.55
	CONT8 Operating and machinery	0.55
	CONT10 Communication system of the contractor	0.55
AE company related factors		
AEA	AE1 Design information flow	0.84
	AE2 Design integration	0.84
	AE3 Design changes	0.84
AEB	AE4 Standardization of rebar shapes, components	0.94
	AE 5 Delay in design definitions and approval	0.94
AEC	AE6 Internet technologies	0.75
	AE7 CAD software usages	0.75
Sub-contractor related factors		
SUBCONTA	SUBCONT3 Accommodation conditions on site	0.81
	SUBCONT6 Standardization of rebar shapes, components	0.81
	SUBCONT8 Processing area on site	0.81
	SUBCONT11 Transportation of material on site	0.81
SUBCONTB	SUBCONT2 Labor utilization	0.96
	SUBCONT4 Education level of the workers	0.96
	SUBCONT5 Ability of reading technical drawing	0.96
	SUBCONT10 Team relationships	0.96
Supplier related factors		
SUPA	SUP1 Delivery speed dependability	0.95
	SUP3 Supplier responsiveness	0.95
	SUP6 Financial stability	0.95
	SUP9 Number of faultless delivery	0.95
	SUP11 Warranties given by the supplier	0.95
SUPB	SUP4 Price of the material	0.76
	SUP10 Quality of the material	0.76
External factors		
EXT	EXT1 Economic stability in the country	0.89
	EXT2 Transportation cost	0.89
	EXT4 Legal conditions	0.89
	EXT5 Client characteristics	0.89
	EXT6 Environmental factors	0.89

To determine the relationships between the “project performance” and the other latent variables an IV (Independent Variable) model was tested (Figure 5.21). The goodness-of-fit indices for this model presented in Table 5.28. As it was described the “project performance” related factors were selected through a literature survey as “project profitability”, “schedule performance” and “satisfaction of the customer”. The results indicate that all sub-factors were significant at $p < 0.05$ level. Factor loadings for the project performance related factors range between 0.43 and 0.61, with the highest factor loading for “satisfaction of the customer”. It is known from the literature survey that to complete the projects regarded to the users’ expectations and satisfaction is essential. The results indicate that the companies believe that if customers are satisfied, the project can be considered as successful. “Project profitability” has the lowest factor loading in this construct. As “project profitability” can be considered as “business benefit” the results revealed that the companies gave more importance to the “customer benefits” than their “business benefits”. “Schedule performance” is an indicator related to the duration of completing the project. It can be considered as an indicator that shows the effectiveness of the project. “Schedule performance” is not only important for project profitability but also for the satisfaction of the customer.

It was also observed that “contractor related factors”, “AE company related factors”, “sub-contractor related factors”, “supplier related factors” and “external factors” did not have an impact on project performance directly. T-values for these latent variables were not significant at $p < 0.05$ level (Figure 5.21). Only “rbSC performance” was found to be having an impact on “project performance”. In other words, the higher the “rbSC performance” was, the higher level for “project performance” was reached. The factor loading for this impact was 1.04. In the IV model “missing / wrong / damaged / defective product /production”, “responsiveness to customers” and “rbSC integration” were found to be indicators that measure the “rbSC performance” with factor loadings of 0.73, 0.76 and 0.64 respectively. In addition to the first two indicators “rbSC integration” was found to be significant in the construct. As it was described in chapter 2, to increase the profitability of the project, the amount of “missing / wrong / damaged / defective product /production” should be low. “Responsiveness to customers” is important for customer satisfaction

and schedule performance of the project. “rbSC integration” is important for the collaboration of the participants.



Legend

○ Latent variable □ Observed variable → Existence of - - - → Absence of

Figure 5.21 Independent variable model with path coefficients and t values (in brackets)

Table 5.28 Fit indices for IV (Independent variable) model

Goodness-of-fit measure	Allowable range of GOF measure	IV model
χ^2/dof	< 3	2.12
RMSEA	< .01	0.099
GFI	0 (No fit) – 1 (Perfect fit)	0.836
AGFI	0 (No fit) – 1 (Perfect fit)	0.735
CFI	0 (No fit) – 1 (Perfect fit)	0.866
NNFI	0 (No fit) – 1 (Perfect fit)	0.808

5.4 Test of Hypotheses

The hypotheses defined in chapter 3, were tested statistically by using LISREL program. Path coefficients of the structural model and t-values of the factors were used to check the statistical results and observe the relations between the construct components having p value more than 0.05 (Figure 5.22 and Figure 5.23).

Hypothesis 1

H_{01} : External factors have no impact on AE company related factors

Hypothesis 1 was formulated to analyze the impacts of external factors on AE company related factors. For the analysis, t-value of the link from external factors to AE company related factors and path coefficient (standardized estimates) of the link were used. As t-value of the link was 4.99 and significant at $p < 0.05$ level (higher than 1.96) hypothesis 1 was rejected. This means external factors have an impact on AE company related factors. The path coefficient of 0.52 indicated a moderate positive impact.

External factors were presented by all sub-factors defined in the proposed construct for EXT latent variable except EXT3(Taxes). The sub-factor of EXT loaded significantly on its latent variable (factor). The value of the loading was 0.89. Additionally three sub-factors under AE company related factors loaded significantly (t-value for AEA = 10.34, t-value for AEB = 11.74, t-value for AEC = 9.18) at $p < 0.05$ level. For AE company related factors the parcel created by AE4

(standardization of rebar shapes, components) and AE5 (delay in design definitions and approval) were found to be the most important factors with a path coefficient of 0.94. Design related issues about AE company with AEA parcel name had a path coefficient of 0.84. The parcel created by summing up AE6 (internet technologies) and AE7 (CAD software usages) has moderately influenced AE related factors and its path coefficient was 0.75.

Hypothesis 2

H₀₂: External factors have no impact on sub-contractor related factors

The relationship between external factors and sub-contractor related factors (hypothesis 2) was significant at the 0.05 level with a path coefficient of 0.64 and t-value of 5.63. As a result hypothesis 2 was rejected.

External factors were presented by a parcel including all sub-factors except EXT3(Taxes). SCONT2 (labor utilization), SCONT4 (education level of the workers), SCONT5 (ability of reading technical drawings) and SCONT10 (team relationships) under the parcel SCONTB influenced sub-contractor related factors significantly (t-value = 8.76) at 0.05 level and had the highest path coefficient of 0.96. SCONT3 (accommodation conditions on site), SCONT6 (Standardization of rebar shapes, components), SCONT8 (processing area on site) and SCONT11 (transportation of materials on site) with the SCONTA parcel name had a significant impact (t-value = 7.11) on sub-contractor related factors with the path coefficient of 0.81.

Hypothesis 3

H₀₃: External factors have no impact on supplier related factors

The link from external factors to supplier related factors was found to be positive and significant. As a result hypothesis 3 was rejected at 0.05 level (t-value = 7.73) The value of the impact of external factors on supplier related factors was quite high with 0.72.

The sub-factor of EXT as it was told in the previous hypotheses was loaded significantly on its latent variable (factor). The two parcels under supplier related factors (SUPA and SUPB) loaded significantly with t-value of 9.56 and 7.99 respectively. SUP1 (delivery speed dependability), SUP3 (supplier responsiveness), SUP6 (financial stability), SUP9 (number of faultless delivery) and SUP11 (warranties given by the supplier) with the parcel name of SUPA had a path coefficient of 0.95, meant that the level of impact was high. SUPB parcel created by summing up SUP4 (price of the material) and SUP10 (quality of the material) influenced supplier related factors with path coefficient of 0.76.

Hypothesis 4

H_{04} : External factors have no impact on contractor related factors

The relationship between external factors and contractor related factors (hypothesis 4) was not significant at 0.05 level with a t-value lower than 1.96. Hypothesis 4 was accepted. This meant contractor related factors did not related with external factors directly but they were related by the other latent factors between external and contractor related factors.

Hypothesis 5

H_{05} : AE company related factors have no impact on contractor related factors.

The relationship between AE company related factors and contractor related factors (hypothesis 5) was significant at 0.05 level with a t-value of 4.45 and path coefficient of 0.44. By the way, hypothesis 5 was rejected, meaning that AE company related factors have an impact on contractor related factors.

All the sub-factors under AE company related factors (AEA, AEB, AEC) loaded significantly as it was described in hypothesis 1. Both contractor related sub-factors, CONTA and CONTB were also loaded significantly with t-value of 7.57 and 5.33 respectively. CON1 (materials management competency), CON3 (project management competency) and CON4 (organization culture of the contractor) were the factors under CONA and has the path coefficient of 0.81. CON7 (past experience of the contractor), CON8 (operating and machinery), CON10 (communication

system of the contractor) under the parcel CONB were validated in the contractor related factors construct with a path coefficient of 0.55. This information about sub-factors of contractor related factors was true for all hypotheses consisting the contractor related factors.

Hypothesis 6

H₀₆: Sub-contractor related factors have no impact on contractor related factors.

Sub-contractor related factors with two sub-factors have a significant relationship with contractor related factors at the 0.05 level with a t-value of 3.19 and path coefficient of 0.32. As a result hypothesis six was rejected.

Significant sub-factors related to sub-contractors were described in hypothesis two and sub-factors related to contractors were described in the fifth hypothesis.

Hypothesis 7

H₀₇: Supplier related factors have no impact on contractor related factors.

The relationship between supplier related factors and contractor related factors (hypothesis 7) was significant at the 0.05 level with a t-value of 2.82 and path coefficient of 0.30. t-value higher than 1.96 indicated that the null hypothesis was rejected. Although the relationship between supplier related factors and contractor related factors was positive, the magnitude of the relationship was not high.

The two parcels under supplier related factors were loaded significantly as told in the third hypothesis. Contractor related factors also represented by CONA and CONB as described in the fifth hypothesis in detail.

Hypothesis 8

H₀₈: Contractor related factors have no impact on rbSC performance.

Hypothesis 8 was formulated to analyze the impacts of the contractor related factors on rbSC performance. The null hypothesis was rejected due to the t-value of 3.82 that was significant at 0.05 level. This means contractor related factors have an

impact on rbSC performance. The path coefficient for this relationship was calculated as 0.54, meaning a moderate impact.

rbSCperf1 and rbSCperf2 were the sub-factors loaded significantly at 0.05 level under rbSC performance factor with t-value of 3.98 and 4.60 respectively. rbSCperf2 (responsiveness to the customers) was found to have the highest path coefficient (0.84) and rbSCperf1 (missing / wrong / damaged / defective product / production) had a path coefficient of 0.74.

Hypothesis 9

H₀₉: rbSC performance has no impact on project performance.

Hypothesis 9 was rejected because t-value of the link between rbSC performance and project performance was 2.99 and it was significant at 0.05 level .

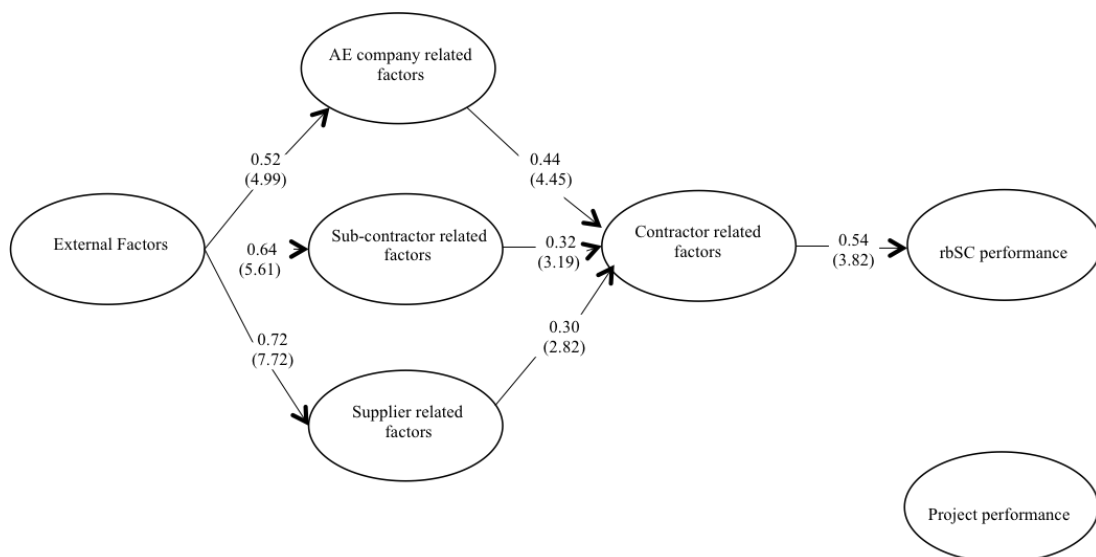


Figure 5.22 Hypothesized model with path coefficients and t values (in brackets)

CHAPTER 6

CONCLUSIONS AND RECOMMENDATIONS

This study focused on the supply chain of rebars which are one of the major and critical building materials used in contemporary construction projects. A theoretical framework consisting of factors that have impacts on rbSC performance and project performance was developed. The impacts were analyzed according to the outputs gathered from LISREL. On the other hand some specific issues elicited from the literature survey and informal face-to-face interviews were analyzed according to their affects on rbSC performance, project performance and the other defined factors. These were: projects location, projects rebar need, site distance from rebar supplier, rebar fabrication and assembly place of rebar. The following paragraphs present the conclusions, limitations and recommendations of this study.

6.1 Conclusions

In this study, face-to face interviews and data obtained from questionnaire revealed that rbSC performance was influenced by participant related factors and characteristics of the projects. Identification of the most important factors, problematic issues in the SC and their causes is important for SC participants to determine the strengths and weaknesses of these for continuous improvement.

Analysis done with LISREL according to the data obtained from respondents revealed the critical factors which need to be considered from the beginning of the process to increase the efficiency. These factors are given in the table below:

Table 6.1 Critical success factors for rbSC

Contractor related factors
CONT1 Materials management competency
CONT3 Project management competency
CONT4 Organization culture of the contractor
CONT7 Past experience of the contractor
CONT8 Operating and machinery
CONT10 Communication system of the contractor
AE company related factors
AE1 Design information flow
AE2 Design integration
AE3 Design changes
AE4 Standardization of rebar shapes, components
AE 5 Delay in design definitions and approval
AE6 Internet technologies
AE7 CAD software usages
Sub-contractor related factors
SUBCONT3 Accommodation conditions on site
SUBCONT6 Standardization of rebar shapes, components
SUBCONT8 Processing area on site
SUBCONT11 Transportation of material on site
SUBCONT2 Labor utilization
SUBCONT4 Education level of the workers
SUBCONT5 Ability of reading technical drawing
SUBCONT10 Team relationships
Supplier related factors
SUP1 Delivery speed dependability
SUP3 Supplier responsiveness
SUP6 Financial stability
SUP9 Number of faultless delivery
SUP11 Warranties given by the supplier
SUP4 Price of the material
SUP10 Quality of the material
External factors
EXT1 Economic stability in the country
EXT2 Transportation cost
EXT4 Legal conditions
EXT5 Client characteristics
EXT6 Environmental factors

Findings based on project related section of the questionnaire reflect the changes in rbSC and project performance and the factors due to project type, project location, project rebar requirement and site distance from rebar supplier. The relationships between rbSC indicators, determinants and project characteristics and site location are presented in Table 6.1.

Table 6.2 The relationships between factor groups, project characteristics and site location

	rbSC Performance	Project Performance	Contractor Related Factors	Sub- contractor Related Factors	Supplier Related Factors	AE Company Related Factors
Project type		√	√	√		√
Project location	√	√	√	√	√	√
Project rebar requirement	√		√		√	√
Site distance from rebar supplier	√					√

As explained in detail in Chapter 5, problem areas in managing rbSC and their reasons were identified according to the information gathered in section four of Chapter 2 which concerns culture related issues in workplace. The dimensions of culture studied by different authors were adapted to the study to determine the reasons of the problems occurred in rbSC. Definitions of culture dimensions were associated with the real world cases in this study. The reasons for the problematic issues in rbSC overlap with the cultural characteristics of the rbSC participants. These problems and their reasons for their occurrences are given in Tables 6.3 and 6.4.

Table 6.3 The relationships between main problem areas and their reasons for contractor and AE company related factors

Problematic participant related factors in rbSC	Common reasons for problems (determined in literature)
<p>Contractor related factors</p> <ul style="list-style-type: none"> • Organization structure of the contractor (CONT5) • Insurance cover (CONT6) • Trouble shooting and problem solving (CONT9) • Communication system of the contractor (CONT10) • Interaction between structural designer and job site (CONT11) 	<ul style="list-style-type: none"> • <i>The effects of hierarchical culture:</i> Leaders/owners see themselves as being highly capable coordinators and organizers. • <i>Job definitions are not specified</i> • <i>Individualism effects:</i> Weak relationships among company staff and with other participants. Not taking responsibility for problem solving. • <i>Result-oriented:</i> Less importance given to the process related issues. Solution alternatives for the problems and the responsibilities for solving the problems were not defined well. • <i>Poor communication:</i> About who is responsible for what, when and where) • <i>Short-term orientation:</i> Staff likely to complete works at the last minute; adhoc solutions adopted; long-term vision is lacking • <i>Loose-control organizations:</i> Meeting times are not kept punctually
<p>AE company related factors</p> <ul style="list-style-type: none"> • Design information flow (AE1) • Design integration (AE2) • Design changes (AE3) • Standardization of rebar shapes, components (AE4) • Delay in design definitions and approval (AE5) • Internet technologies (AE6) 	<ul style="list-style-type: none"> • <i>Result-oriented contracts:</i> The contracts between contractor and AE companies don't include clauses related to process -additional works, work changes, durations and penalties. • <i>Loose-control organizations:</i> Lack of consideration for costs duration and punctuality intervention. • <i>Inefficient use of technology:</i> Between different groups with different culture. • <i>Low communicative:</i> Barriers exist in the flow of information.

Table 6.4 The relationships between main problem areas and their reasons for sub-contractor and supplier related factors

Problematic participant related factors in rbSC	Common reasons for problems (determined in literature)
<p>Sub-contractor related factors</p> <ul style="list-style-type: none"> • Improved communication and learning skills (SUBCONT1) • Labor utilization (planned weekly, monthly working) (SUBCONT2) • Accommodation conditions on site (SUBCONT3) • Education level of the workers (SUBCONT4) • Ability to read technical drawing (SUBCONT5) • Processing area on site (SUBCONT6) • Storage area on site (SUBCONT9) • Team relationships (SUBCONT10) • Transportation of material on site (SUBCONT11) 	<ul style="list-style-type: none"> • <i>Uneducated sub-contractors:</i> Construction teams without qualification or training, lower the work quality cause reworks that increase the total cost. • <i>Result-oriented rather than process-oriented:</i> Tender price is the most important criterion for the contractors and quality is sometimes forgotten. • <i>Affective culture rather than neutral:</i> Level of expressing emotion is high. • <i>Job-oriented culture rather than employee oriented culture:</i> The value given to the sub-contractors are usually in low levels. Contractors do not concern about the accommodation and working conditions of sub-contractors, and their aim is just completing the job.
<p>Supplier related factors</p> <ul style="list-style-type: none"> • Writing and reading technical skills of contract and technical documents (SUP7) • Supplier-contractor relationships (SUP8) 	<ul style="list-style-type: none"> • Inadequate in adopting time and resource management techniques. • <i>Result oriented rather than process oriented:</i> The focus is just on the amount of sale. • <i>Pragmatic rather than normative:</i> Market driven.

6.2 Limitations

Firstly, the study was done at the company level and only one-person from each company answered the questionnaire. However, the most knowledgeable and educated person in the company was asked to respond to the questions. On the other hand the respondees were not always able to answer questions that were related to their field or company.

Since the study depended on data gathered from the companies located in Gaziantep city, the data is not representative of the whole country. The size of the city is not big and the volume of the construction is not comparable to cities like Istanbul and Ankara. Moreover, the organization culture and the practice of profession may be different in this region.

Finally, the sample size with 78 companies may not be sufficient to formulate a statistical model that consists of 4 groups of participants (contractors, AE companies, sub-contractors, suppliers).

6.3 Contribution of the Current Study

The following contributions have been achieved by this study.

Determination of the participant related factors with their impacts on rbSC performance: By using SEM the latent variables and their sub-factors were analyzed. The factors that should be considered for higher performance of rbSC in SMEs were identified.

Problematic issues based on self-assessment as well as other participants' assessments were determined: to show the current situation in the SMEs in the construction industry.

Factors performance was associated with the project characteristics: Project characteristics that have an effect on rbSC performance were determined.

6.4 Recommendations for Contractors

The main contractors need to:

- Take into consideration the effects of the project type, location, rebar requirement while preparing their bids, schedule and contracts.
- Adopt communitarism culture in their business activities rather than individualism culture for the overall good of SC.
- Change their workplace structure and decrease the effects of hierarchy in their organizations. The contractor companies need to work with qualified technical staff at different level of the organization.
- Provide long-term relation with all rbSC participants. Build up long-term visions rather than ad hoc solutions.
- Mobilize the communication system between the participants at the outset of the process. The flow of information and flow changes should be done systematically.
- Select the sub-contractors according to their skills. Just focusing on the tender price creates problems during the implementation of the project.
- Strive to be employee-oriented rather than job-oriented. Provide better working conditions for the sub-contractors to increase their performance in the long-term.
- Organize training programs for sub-contractors and work force to increase their skills.

6.5 Recommendations for AE companies

The AE companies need to:

- Be aware of the effects of project type, project location, rebar requirement of the project while giving their bids, preparing their programs and contracts.
- Provide higher degree of coordination and integration to decrease the amount of changes.

- Prepare contracts that include clauses related to additional works, work changes, durations and penalties.
- Use internet technology more efficiently in order to improve communication and documentation.
- Strive to standardize the rebar shapes and sizes.
- Avoid work changes and conflicts by integrating the design team at the outset of the project.

6.6 Recommendations for Sub-contractors

The sub-contractors need to:

- Attend the training programs to improve technical skills.
- Improve skills related to reading and understanding technical documents and numerical skills to give more realistic bids.
- Be aware of the penalties that they will encounter in case of inaccurate production.
- Add clear clauses related to site, equipments and machines they need on site and accommodation conditions in the contracts done with contractors.

6.7 Recommendations for Suppliers

The suppliers need to:

- Pay attention to time and resource management.
- Create long-term relationships with contractors to share risks and rewards.
- Provide the quality conditions both for sub-standard material and the employee worked in the company.

6.8 Recommendations for Future Works

The following recommendations would benefit future work on rbSC:

- The framework should be analyzed for large-scale projects and companies. The number of participants increases in large projects. Therefore, more complex frameworks with more sub-factors need to be developed.
- The sub-factors under latent variables would be changed and the impacts of the latent variables on rbSC performance might be analyzed for the new factors.
- This study was performed by collecting data related to the companies located in the South East Region of Turkey. It can be expanded to the Turkish construction companies working in other regions also where the importance levels of the factors may change according to the region conditions.

LITERATURE CITED

- Agus, A. 2011. Supply chain management, supply chain flexibility and business performance, in: *Journal of Global Strategic Management*, (p.134-145, 9).
- Akintoye, A., McIntosh, G. and Fitzgerald, E.2000. A survey of supply chain collaboration and management in the UK construction industry, in: *European Journal of Purchasing and Supply Management*, (p.159-168, 6).
- Ankrah, N. A. and Langford, D. A. 2005. Architects and Contractors: A comparative study of organizational cultures, in: *Construction Management and Economics*, 23(6), 595-607.
- Ankrah, N. A. 2007. *An investigation into the impact of culture on construction project performance*, Ph. D. Dissertation, Universty of Wolverhampton.
- Anson, M., Wang, S. Q. 1998. Performance of concrete placing in Hong Kong buildings, in: *Journal of Construction and Engineering Management*, (p.116-124, 124(2)).
- Ashton, D., Felstead, A. and Green, F. 2000. *Skills in the British' workplace, in Coffield Differing Visions of a Learning Society*, Bristol Policy Press.
- Atkinson, R. .1999. Project management: cost, time and quality, two best guesses and a phenomenon, its time to accept other success criteria, *International Journal of Project Management*, 17 (6), 337.
- Barthorpe, S., Duncan, R. and Miller, C. 2000. The pluralistic facets of culture and its impact on construction, in:*Property Management*, 18(5), 335-351.
- Baskerville, R. F. 2003. Hofstede never studied cultural accountings; in *Organizations and Society*, (p.1-14, Vol.28, No:1).
- Bertelsen, S., Nielsen, J.1997. Just in time logistics in the supply of building materials,*First International Conference on Construction Industry Development*, Singapore.
- Briscoe, G., Dainty, A. and Millet, S. 2001. Construction Supply Chain Partnerships: skills, knowledge and attitudinal requirements; in *European Journal of Purchasing & Supply Management*, (p.243-255, 7).

- Brockmann, C. and Birkholz, A. 1999. Industry culture in construction and manufacturing; in *European Journal of Management*, (p.155-165, 8 (1)).
- Bodley, J. H. 1994. An Anthropological Perspective, *Cultural Anthropology: Tribes, States, and the Global System*.
- Byrne, B. (1994). *Structural equation modeling with EQS and EQS / windows: Basic concepts, applications and programming*, Thousand Oaks CA, Sage.
- Cameron, K. and Quin R. E. (2005). *Diagnosing and changing organizational culture based on competing values framework*, John Willey and Sons Inc., USA.
- Carter, J. R., Smeltzer, L., Narasimhan, R. 1998. The role of buyer and supplier relationships in integrating TQM through the supply chain; in *European Journal of Purchasing & Supply Management*, (p.223-234, 4).
- Castro, D. L. 2003. *B2B e-work intranet solution design for rebar supply interactions*, Ph. D. Dissertation, Purdue University.
- Chan, A. P. C., Chan, A. P. L (2004). Key performance indicators for measuring construction success; in *Benchmarking: An International Journal*, (p.203-221, 11(2)).
- Chan, A. P. C., Scot, D. and Chan, A. P. I. 2004. Factors affecting the success of a construction project; in: *Journal of Construction Engineering and Management*, (p.153-155).
- Cheng, J. C. P., Law, K. H., Bjornson, H., Jones, A. and Sriram, R. D. 2010. A service oriented framework for construction supply chain integration; in *Automation in Construction*, in press.
- Dainty, A. R. J., Millett, S. J. and Briscoe, H. G. 2001. New perspectives on construction supply chain integration; in: *Supply Chain Management: An International Journal*, (p.163-173, Vol.6(4)).
- Douglas, E. E. (2009). Understanding Schedule change management; in : *AACE International Transactions*.
- Dubois, A., Gadde E. 2000. Supply Strategy and Network Effects: Purchasing behaviour in construction industry; in: *European Journal of Purchasing & Supply Management*, (p.207-215, 6).

Fotwe, F. T. E., Thorpe, A., McCaffer, R. 2001. Information procurement practices of key actors in construction supply chains; in: *European Journal of Purchasing and Supply Management*, (p.155-164, 7).

Ericsson, H. M. 2001. Managing the construction supply chain by simulation; in : *Construction Informatics Digital Library*, (http://itc.scix.net/paper_ecce-2001-8.content).

Fotwe, F. T. E., Thorpe, A., McCaffer, R. 2001. Information procurement practices of key actors in construction supply chains; in: *European Journal of Purchasing & Supply Management*}, (p.155-164, 7).

Fronlich, M. T., Westbrook, R., 2001. Arcs of integration: an international study of supply chain strategies; in: *Journal of Operations and Management*, (p.185-200, 19(2)).

Giritli, H., Yazıcı, E. O., Oraz, G. T. and Acar, E. 2006. Organizational culture: a comparative analysis from the Turkish construction industry, *The joint international conference a construction culture, innovation and management (CCIM)- Sustainable development through culture and innovation*, Dubai.

Gunasekaran, A., Patel, C., McGaughey, R. E. 2004. A framework for supply chain performance measurement; in : *International Journal of Production Economics*, (p.333-347, 87).

Hair, J., Black, W., Babin, B., Anderson, R., and Tatham, R. 2006. *Multivariate data analysis*, Sixth Edition, Pearson Education, Inc., Upper Saddle River, New Jersey.

Harvey, R. C. and Ashworth, A. 1993 *The Construction Industry of Great Britain*, Oxford.

Hamzeh, F. R. 2009. *Improving construction workflow, the role of production planning and control*, Ph. D. Dissertation, University of California, Berkeley.

Harbhajan, S. 2009. *Construction project management*, Abhishek Publications.

Hellman, L. J., Gadde, L. E. 1996. Information technology and the efficiency of materials supply: the implementation of EDI in the construction industry; *ISPERA Conference*, Eindhoven University of Technology, The Netherlands.

Hinze, J. W. 2008. *Construction planning and scheduling*, Pearson Prentice Hall, Upper saddle River, New Jersey.

- Hostede, G. 1998. Identifying organizational subcultures: An empirical approach; in: *Journal of Man. Stud.*,(p.1-12, 35(1)).
- Hofstede, G. (2001). *Culture consequences: comparing values, behaviours, institutions and organisations across cultures*, 2nd Edition, Sage Publications Inc., USA.
- Hofstede, G. and Hofstede, G. J.(2005). *Cultures and organizations: software of the mind*, 2nd Edition, McGraw-Hill, New York.
- Holt, G. D., Olomolaiye, P. O., and Harris, F. C. (1994). Factors influencing U.K. construction clients' choice of contractor; in : *Building and Environment*, (p.241-248, 29(2)).
- Hong-Minh, S. M., R., Barker, M. M., Naim. 2001. Identifying Supply Chain Solutions in the UK House Building Sector; in : *European Journal of Purchasing & Supply Management*, Vol.7, pp.49-59.
- Hoyle, R. H. 1995. *Structural equation modeling: concepts, issues and applications*, Thousand Oaks, CA : Sage.
- Huang, C. N. 2003. *Time study in two-echelon supply chain for steel framing construction: field investigation and networking model simulation*, Ph. D. Dissertation, University of Wisconsin, Madison.
- Issa, R R. A., Flood, I., and Caglasin, G. 2003. A survey of e-business implementation in the US construction industry; *ITcon*, 8.
- Joreskog, K. G. and Sorbom, D. 1993. *Lisrel 7 users reference guide*, IL: Scientific Software Inc., Chicago.
- Kıvrak, S. 2010. *Effects of cultural differences on management practices of Turkish construction companies and cross-cultural knowledge management in international construction projects*, Ph. D. Dissertation, Civil Engineering Program, Anadolu University, Eskisehir.
- Kline, R. B. 1998. *Principles and practice of structural equation modeling*, Guilford Press, New York, NY.
- Kog, Y. C. and Loh K. P. 2012. Developing CSFs for construction projects; in *Journal of Construction Engineering and Management*, ASCE 138: 520-528.
- Lee, H. L. 2000. Creating value through supply chain integration; in: *Supply Chain Management Review*, (p.30-36, 4(4)).

- McAfee, R. B., Glassman, M. and Honeycutt, E.D. 2002. The effects of culture and human resource management policies on supply chain management strategy; in : *Journal of Business Logistics*, (p.1-18, 23(1)).
- MacCallum, R. 1986. Quantitative methods in psychology; in : *Psychological Bulletin*, (p.107-120, 100(1)).
- Maloney, W. F. and Federle, M. O. 1993. Practical models for organizational assessment; in *Journal of Management Engineering*, 9 (1) 64-81.
- Meng, X. 2012. The effect of relationship management on project performance in construction strategy; in : *International Journal of Project Management*, (p.188-198, 30(2)).
- Min, J. U. and Bjornsson H. C. 2008. Agent-based construction supply chain simulator (CS2) for measuring the value of real-time information sharing in construction; in : *Journal of Management Engineering*, (p.245-254, 24(4)).
- Monezka, T., Trend, R., Handfield, R. 1998. *Purchasing and Supply Chain Management*, OH : South-Western College Publishing, Cincinnati.
- Navon, R. and Berkovich, O. 2005. Development and on site evaluation of an automated materials management and control model; in : *Journal of Construction Engineering and Management*, (p.1328-1336, 131(2)).
- Ngowi, A. B.2000. Impact of culture on the application of TQM in the construction industry in Botswana; in : *International Journal of Quality and Reliability Management*, (p.442-453, 17(4)).
- Nunally, J. (1978). *Psychometric theory*, McGraw-Hill, New York.
- O'Brien, W. J. 1998. *Capacity costing approaches for construction supply-chain management*, Ph. D. Dissertation, Stanford University.
- Ofori, G., 2000. Greening the construction supply chain in Singapore; in: *European Journal of Purchasing and Supply Management*, (p.195-206, 6).
- Othman, A. A. and Rahman S.A. 2010. Supply chain management in the building construction industry: Linking procurement process coordination, market, orientation and performance; in : *The Journal of Surveying, Construction & Property*, Vol.1, pp23-46.
- Ozorhon, B., Arditi, D., Dikmen, I. and Birgonul, M. T. 2008. Implications of culture in the performance of international construction joint ventures in : *The Journal of Construction Engineering and Management*, Vol.134, pp361-370.

Palaneeswaran, E. M. M., Kumaraswamy, X. Q., Zhang. 2001. Reforging Construction Supply Chains: A Source Selection Perspective; in : *The Journal of Purchasing and Supply Management*, Vol.7, pp165-178.

Parfitt, M. K. and Sanvido V. E. 1993. Checklist of critical success factors for building projects; in *Journal of Management in Engineering*, Vol.9, No.3. pp 243-249.

Polat, G. 2005. *A simulation-based decision support tool for economical materials management system in the construction industry*, Ph. D. Dissertation, Istanbul Technical University, Istanbul.

Perdomo-Rivera, J. L. 2004. *A framework for a decision support model for supply chain management in the construction industry*, Ph. D. Dissertation, Faculty of Virginia Polytechnic Institute and State University, Blacksburg, Virginia.

Proverbs, D. G. and Holt, G. D. 2000. Reducing Construction Costs: European Best Practice Supply Chain Implications; in: *European Journal of Purchasing and Supply Management*, (p.149-158, 6).

Pserng, H. P., Yin S.Y.L. and Li S. 2006. Developing a resource supply chain planning system for construction projects; in *Journal of Construction Engineering and Management*, ASCE 132(4): 393-407

Rahman, M. M. and Rowlinson, S. 2003. Professionalism in construction: Culture of High Performance, *Proceedings of CIB TG23 International Conference*, University of Hong Kong, Hong Kong.

Qrunfleh, S. M. 2010. *Alignment of information systems with supply chains: Impacts on supply chain performance and organizational performance*, Ph. D. Dissertation, University of Toledo, Toledo.

Schwartz, S. H. 1999. A theory of cultural values and some implications for work; in : *Applied Psychology: An International Review*, (p.23-47, 48(1)).

Shmanske, S. 2003. JIT and the complementary of buffers and lot size, in: *American Business Review*, (p.100-106, 21(1)).

Schumacker, R. E., Lomax, R. G. 2004. *A beginner's guide to structural equation modeling*, Lawrence Erlbaum Associates, Inc., Publishers, Manwah, New Jersey.

Tabannick, B. G., and Fidel, L. S. 1996. *Using Multivariate Statistics*, NY: Harpercollins College Publishers, New York.

- Tan, K. C., Kannan, V.R. 1998. Supply chain management: supplier performance and firm performance; in : *International Journal of Purchasing and Materials management*, (p.2-9, 34(3)).
- Thomas, H. R., Riley, D.R., and Messner, J. I. 2005. Fundamental principles of site material management; in : *Journal of Construction Engineering and Management*, (131(7)).
- Tommelein, I. D., Yi Li, A. E. 1999. Just-in-time concrete delivery: mapping alternatives for vertical supply chain integration, *Proceedings IGLC-7*, University of California, Berkeley, CA, USA.
- Trompenaars, F. 1993. *Riding the waves of culture- Understanding cultural diversity in business*, Nicholas Brealey Publishing, London.
- Trompenaars, F., and Woolliams, P. 1999. First-class accommodation, in: *People Management*, 5(8), 30-37.
- Xiao, H., Proverbs, D. 2003. Factors influencing contractor performance in an international investigation; in: *Engineering Construction and Architectural Management*, (p.322-332, 10).
- Xue, X., Wang, Y., Shen, Q. and Yu, X. 2007. Coordination mechanisms for construction supply chain management in the internet environment; in: *International Journal of Project Management*, (p.150-157, 10).
- Vrijhoef, R., Koskela, L. 1999. Roles of supply chain management in construction, *Proceedings IGLC-7*, University of California, Berkeley, CA, USA.
- Vrijhoef, R., Koskela, L. 2000. The Four Roles of supply chain management in construction; in : *European Journal of Purchasing and Supply Management*, (p.169-178, 6(3-4)).
- Vrijhoef, R., Koskela, L. 2005. Revisiting the three peculiarities of production in construction, in : *Proceedings IGLC-13, Lean Construction Theory*, Sydney, Australia.
- Yunus, E. and Tadisina, S. K. 2010. Organizational culture context, supply chain integration and performance, *POMS 21st Annual Conference*, Vancouver, Canada.
- Zhang, J. P., Ma, Z. Y., Cheng, P. 2001. 4D Visualization of construction site management; in : *Proceeding IV'01 Proceedings of the fifth International Conference on Information Visualization*, Washington, DC, USA.

Zhongli, K. Y. S., Nakagava, Y., Kensei, T. T. G. 2010. Cooperative software development and usability evaluation: a web-based work management system for construction sites; in : *Journal of software*, (p.259-268, 5(3)).

<http://www.supply-chain.org>

<http://www.oracle.com>

Turkish Statistics Agency (TUİK)

APPENDIX A1

QUESTIONNAIRE (ENGLISH)

QUESTIONNAIRE ABOUT THE ANALYSIS OF THE IMPACTS OF THE FACTORS ON rbSC PERFORMANCE

General Instructions and Information

- This survey is being conducted by Z. Banu Yavuz, a Ph. D. candidate at METU.
- This survey is done to analyse the impacts of factors on rbSC and project performance. The proposed framework located at the end of the questionnaire, represent the relationships between the factors and constitute the basement of this study.
- The questionnaire consists of 9 pages and it takes about 15 minutes to answer all questions.
- Please answer all questions. Importance level part aims to measure the importance level for you, and the performance want to evaluate the level of this factor for the real projects that your company took in. Answers are in a 6-scaled likert format. 1=Not at all important to 6= Very important.

I. GENERAL INFORMATION ABOUT THE COMPANY

1. The name and the address of your company:

.....
.....

2. What is your primary job responsibility?

- Contractor
- Architecture/Engineering company
- Sub-contractor (rebar labor)
- Supplier (rebar supplier)

3. With which contract type/s does your company work?

- Lump sum Unit price
- Cost+ percentage of cost Construct and sell
- Other (please specify).....

4. What is your primary job responsibility?

- Owner Technical staff (engineer/architect/technican)
- Sales staff Worker
- Other (please specify).....

5. How long has your company been in the construction sector?

- 1-5 years 6-10 years 11-15 years 16-20 year
- More

6. What are the prevailing type of construction projects?

(You may select more than one option)

Residential Commercial Education Health

Other (please specify).....

7. What is your firm's annual turnover volume?

1.000.000. TL 1.000.000 TL-2.000.000. TL 2.000.000.TL-
5.000.000.TL 5.000.000. TL -10.000.000.TL More

II. Rebar Supply Chain and Project Performance Related Factors

The performance factors of rbSC performance and project are listed below. In the importance level part evaluate what is the level of importance of these variables for your company on the performance of rbSC and project. In the performance level part, evaluate the realized performance of your company about the factors written below, according to the outputs of the projects that your company participated in the construction process of it. Before evaluating the indicators answer the questions about the projects that you choose to evaluate.

The evaluated projects’;

Type of the construction Residential Commercial Education Health
 Other(please specify).....

Size (Due to the rebar need) Small Medium Big

Location High density urban area Low density urban area
 Outside the city

Construction site distance 0-10km 10-30km 30-50km More than 50km

Rebar was cut and bend on site.
 off-site cut and bend.
 cut and bend on site and off-site.

Performance factors of rbSC	Importance	Performance level
Missing/ wrong/ damaged/ defective Product/construction.....	01 02 03 04 05 06	01 02 03 04 05 06
Responsiveness to the customers.....	01 02 03 04 05 06	01 02 03 04 05 06
Supply chain flexibility.....	01 02 03 04 05 06	01 02 03 04 05 06
rbSC integration.....	01 02 03 04 05 06	01 02 03 04 05 06

Performance factors of project performance	Importance	Performance level
Project profitability.....	01 02 03 04 05 06	01 02 03 04 05 06
Schedule performance.....	01 02 03 04 05 06	01 02 03 04 05 06
Satisfaction of the customer.....	01 02 03 04 05 06	01 02 03 04 05 06

III. The factors that have impacts on rbSC performance

The defined factors that have impacts on rbSC performance are listed below. In the importance level part evaluate the factors due to their impacts on rbSC performance level. In the performance level part, evaluate the realized performance of your company about the factors written below, according to the outputs of the projects that your company participated in the construction process of it.

Contractor related factors	Importance	Performance level
Materials management competency.....	01 02 03 04 05 06	01 02 03 04 05 06
Site management competency.....	01 02 03 04 05 06	01 02 03 04 05 06
Project management competency.....	01 02 03 04 05 06	01 02 03 04 05 06
Organization culture of the contractor.....	01 02 03 04 05 06	01 02 03 04 05 06
Organization structure of the contractor.....	01 02 03 04 05 06	01 02 03 04 05 06
Insurance cover	01 02 03 04 05 06	01 02 03 04 05 06
Past experience of the contractor.....	01 02 03 04 05 06	01 02 03 04 05 06
Operating and machinery.....	01 02 03 04 05 06	01 02 03 04 05 06
Trouble shooting and problem solving.....	01 02 03 04 05 06	01 02 03 04 05 06
Communication system of the contractor.....	01 02 03 04 05 06	01 02 03 04 05 06
Int. between structural designer and jobsite.....	01 02 03 04 05 06	01 02 03 04 05 06
Efficiency of cash flow method.....	01 02 03 04 05 06	01 02 03 04 05 06

AE company related factors	Importance	Performance level
Design information flow.....	01 02 03 04 05 06	01 02 03 04 05 06
Design integration.....	01 02 03 04 05 06	01 02 03 04 05 06
Design changes.....	01 02 03 04 05 06	01 02 03 04 05 06
Standardization of rebar shapes, components..	01 02 03 04 05 06	01 02 03 04 05 06
Delay in design definitions and approval.....	01 02 03 04 05 06	01 02 03 04 05 06
Internet technologies.....	01 02 03 04 05 06	01 02 03 04 05 06
CAD software usages.....	01 02 03 04 05 06	01 02 03 04 05 06

Sub-contractor-related factors	Importance	Performance level
Improved communication and learning skills	01 02 03 04 05 06	01 02 03 04 05 06
Labor utilization(planned,weekly working schedules, relaxation allowance).....	01 2 03 04 05 06	01 02 03 04 05 06
Accommodation conditions on site.....	01 02 03 04 05 06	01 02 03 04 05 06
Education level of the workers.....	01 02 03 04 05 06	01 02 03 04 05 06
Ability of reading technical drawings.....	01 02 03 04 05 06	01 02 03 04 05 06
Standardization of rebar shapes, components.....	01 02 03 04 05 06	01 02 03 04 05 06
Grouping the cut rebar in respect of length and size	01 02 03 04 05 06	01 02 03 04 05 06
Processing area on site.....	01 02 03 04 05 06	01 02 03 04 05 06
Storage area on site.....	01 02 03 04 05 06	01 02 03 04 05 06
Team relationships.....	01 02 03 04 05 06	01 02 03 04 05 06
Transportation of material on site.....	01 02 03 04 05 06	01 02 03 04 05 06

Percentage of defects.....	01 02 03 04 05 06	01 02 03 04 05 06
Cutting in required length.....	01 02 03 04 05 06	01 02 03 04 05 06
Supplier related factors	Importance	Performance level
Delivery speed dependability.....	01 02 03 04 05 06	01 02 03 04 05 06
Delivery reliability performance.....	01 02 03 04 05 06	01 02 03 04 05 06
Supplier responsiveness.....	01 02 03 04 05 06	01 02 03 04 05 06
Price of the material.....	01 02 03 04 05 06	01 02 03 04 05 06
Location of the supplier.....	01 02 03 04 05 06	01 02 03 04 05 06
Financial stability.....	01 02 03 04 05 06	01 02 03 04 05 06
Writing and reading skills of contract and technical document	01 02 03 04 05 06	01 02 03 04 05 06
Supplier/Contractor relationships.....	01 02 03 04 05 06	01 02 03 04 05 06
Number of faultless delivery.....	01 02 03 04 05 06	01 02 03 04 05 06
Quality of the material.....	01 02 03 04 05 06	01 02 03 04 05 06
Warranties given by the supplier.....	01 02 03 04 05 06	01 02 03 04 05 06
Product knowledge.....	01 02 03 04 05 06	01 02 03 04 05 06

External factors	Importance	Performance level
Economic stability in the country.....	01 02 03 04 05 06	01 02 03 04 05 06
Transportation cost.....	01 02 03 04 05 06	01 02 03 04 05 06
Legal conditions.....	01 02 03 04 05 06	01 02 03 04 05 06
Client characteristic.....	01 02 03 04 05 06	01 02 03 04 05 06
Environmental factors.....	01 02 03 04 05 06	01 02 03 04 05 06
Number of firms in the same market.....	01 02 03 04 05 06	01 02 03 04 05 06

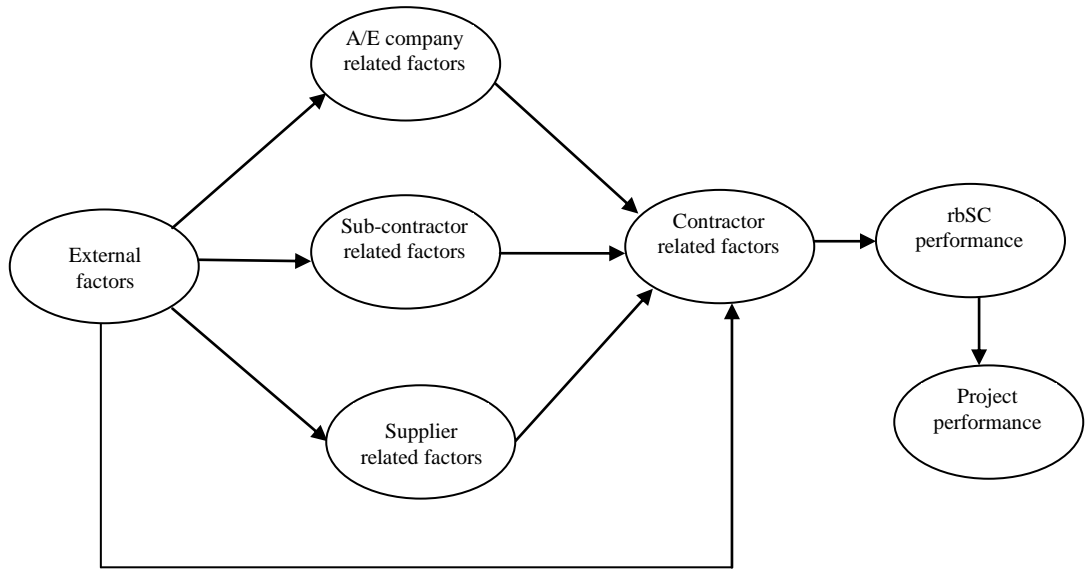


Figure A1.1. Theoretical framework that is proposed for rbSC.

APPENDIX A2

QUESTIONNAIRE (TURKISH)

İNŞAAT DEMİRİ TEDARİK ZİNCİRİ PERFORMANSINA ETKİ EDEN FAKTÖRLERİN ANALİZİ ANKETİ

İÇERİK

Anket ile ilgili genel açıklamalar:

- Bu anket çalışması ODTÜ Mimarlık Fakültesi'nde doktora çalışmalarına devam eden Z. Banu Yavuz Pelvan tarafından yürütülmektedir.
- Bu çalışma, inşaat demiri tedarik zinciri performansına etki eden faktörlerin analizini hedeflemektedir. Anketin sonunda inşaat demiri tedarik zinciri için ilişkileri gösteren ve anket sorularının temelini oluşturan kavramsal çerçeveyi görebilirsiniz.
- Bu anket 9(dokuz) sayfadan oluşmaktadır, ve cevaplama yaklaşık 15 dakika sürmektedir.
 - Lütfen tüm soruları cevaplayınız. Önem seviyesi başlığının altındaki kısma ilgili maddenin sizin için oluşturduğu önemi, performans kısmına ise uygulamış olduğunuz projelerde, ilgili maddeler için elde edilmiş performans düzeyi işaretlenmelidir. Cevaplar altılı likert ölçeğindedir. 1=Hiç önemli değil, 2=Biraz önemli, 3=Önemli, 4=Oldukça önemli, 5=Çok önemli, 6=Son derece önemli.

I. FİRMALAR HAKKINDA GENEL BİLGİ

1. Firmanızın adı ve adresi:

.....

.....2. Firmanızın çalışma alanı nedir?

- Yüklenici firma (inşaat müteahhiti)
- Mimarlık/mühendislik firması
- Alt yüklenici (inşaat demiri işçilik taşeronu)
- Tedarikçi (inşaat demiri tedarikçisi)

3. Firmanız hangi tür sözleşmelerle iş yapmaktadır?

- Götürü usul Birim fiyat
- Maliyet + belirlenen % kar Yap-sat
- Diğer (lütfen belirtiniz).....

4. Firmadaki asıl göreviniz nedir?

- İşyeri sahibi Teknik personel (mühendis/mimar/tekniker)
- Satış personeli İşçi
- Diğer (lütfen belirtiniz).....

5. Firmanız çalıştığı alanda kaç yıldır faaliyet göstermektedir?

- 1-5 yıl 6-10 yıl 11-15 yıl 16-20 yıl
- Daha fazla

6. Firmanızın ilgilendiği inşaat projesi türleri nelerdir?

(Birden çok seçenek işaretleyebilirsiniz)

Konut Ticaret Eğitim Sağlık
Diğer(belirtiniz).....

7. Firmanızın yıllık cirosu ne kadardır?

1.000.000. TL 1.000.000 TL-2.000.000. TL 2.000.000.TL-
5.000.000.TL 5.000.000. TL -10.000.000.TL Daha fazla

2. İnşaat Demiri Tedarik Zinciri ve Proje Performans Göstergeleri

Aşağıda inşaat demiri tedarik zinciri ve proje performans göstergeleri yer almaktadır. Önem kısmında, verilen göstergelerin inşaat demiri tedarik zinciri ve proje performansı için ne derece önemli olduğunu değerlendiriniz. Performans düzeyi kısmında ise, firmanızın yapmış olduğu bir projede (inşa edilmiş bir yapıda) belirtilen performans göstergelerine ne düzeyde ulaştığınızı işaretleyiniz. Performans göstergelerini değerlendirmeden önce, değerlendirmeye alacağınız proje ile ilgili aşağıdaki dört soruyu yanıtlayınız.

Değerlendirmeye alınacak projenin;

- Yapı tipi** Konut Ticaret Eğitim Sağlık
 Diğer(belirtiniz).....
- Boyutu (demir ihtiyacına göre)** Küçük Orta Büyük
- Konum** Şehir içinde sıkışık alanda Şehir içinde geniş alanda
 Şehir dışında
- Demirinin temin edildiği yerin şantiyeye olan uzaklığı** 0-10km 10-30km 30-50km >50km
- Demiri** Şantiyede kesilip büküldü.
 Hazır(kesilip, bükülmüş) olarak şantiyeye geldi.
 Hem hazır geldi hem şantiyede hazırlandı.

İnşaat demiri tedarik zinciri performans göstergeleri	Önem	Performans Düzeyi
Unutulan/yanlış/hatalı/bozuk ürün/üretim	01 02 03 04 05 06	01 02 03 04 05 06
Müşteriye hitap etme.....	01 02 03 04 05 06	01 02 03 04 05 06
Tedarik zinciri esnekliği.....	01 02 03 04 05 06	01 02 03 04 05 06
İnşaat demiri tedarik zinciri entegrasyonu....	01 02 03 04 05 06	01 02 03 04 05 06
Proje performans göstergeleri	Önem	Performans Düzeyi
Proje karlılığı	01 02 03 04 05 06	01 02 03 04 05 06
Çalışma programı performansı.....	01 02 03 04 05 06	01 02 03 04 05 06
Müşteri memnuniyeti.....	01 02 03 04 05 06	01 02 03 04 05 06

3. İnşaat Demiri Tedarik Zincirine Etki Eden Faktörler

Aşağıda inşaat demiri tedarik zinciri performansına etki eden faktörler yer almaktadır. Önem kısmında, verilen her faktör grubunun inşaat demiri tedarik zinciri ve proje performansı için ne derece önemli olduğunu değerlendiriniz. Performans düzeyi kısmında ise, firmanızın yapmış olduğu bir projede (inşa edilmiş bir yapıda) belirtilen faktörler için ne düzeyde performans gösterdiğini işaretleyiniz.

Yüklenici firma ile ilgili faktörler	Önem	Performans Düzeyi
Malzeme yönetimi yetkinliği.....	01 02 03 04 05 06	01 02 03 04 05 06
Şantiye yönetimi yetkinliği.....	01 02 03 04 05 06	01 02 03 04 05 06
Proje yönetimi yetkinliği.....	01 02 03 04 05 06	01 02 03 04 05 06
Yüklenici firma organizasyon yapı kültürü .	01 02 03 04 05 06	01 02 03 04 05 06
Yüklenici firma yapısı.....	01 02 03 04 05 06	01 02 03 04 05 06
Sigorta	01 02 03 04 05 06	01 02 03 04 05 06
Yüklenici firmanın tecrübesi.....	01 02 03 04 05 06	01 02 03 04 05 06
Makine ve ekipman parkı.....	01 02 03 04 05 06	01 02 03 04 05 06
Sorun yakalama ve problem çözme	01 02 03 04 05 06	01 02 03 04 05 06
Yüklenici firma iletişim sistemleri.....	01 02 03 04 05 06	01 02 03 04 05 06
Yapı strüktür tasarımcısı ve saha arasındaki etkileşim.....	01 02 03 04 05 06	01 02 03 04 05 06
Nakit akışı verimliliği.....	01 02 03 04 05 06	01 02 03 04 05 06

Mimarlık/Mühendislik firmaları ile ilgili faktörler	Önem	Performans Düzeyi
Tasarım bilgisi akışı.....	01 02 03 04 05 06	01 02 03 04 05 06
Tasarımda entegrasyon.....	01 02 03 04 05 06	01 02 03 04 05 06
Tasarım değişiklikleri.....	01 02 03 04 05 06	01 02 03 04 05 06
İnşaat demiri şekilleri ve yapı elemanlarında standardizasyon.....	01 02 03 04 05 06	01 02 03 04 05 06
Tasarım ve onaylarında yaşanan gecikmeler..	01 02 03 04 05 06	01 02 03 04 05 06
İnternet teknolojileri.....	01 02 03 04 05 06	01 02 03 04 05 06
CAD-çizim programları kullanımı	01 02 03 04 05 06	01 02 03 04 05 06
Alt-Yüklenici ile ilgili faktörler	Önem	Performans Düzeyi
Gelişmiş iletişim ve öğrenme becerileri.....	01 02 03 04 05 06	01 02 03 04 05 06
İşçi kullanımı(planlanan, haftalık çalışma programları, izinleri).....	01 02 03 04 05 06	01 02 03 04 05 06
Şantiyede konaklama koşulları.....	01 02 03 04 05 06	01 02 03 04 05 06
İşçilerin eğitim seviyesi.....	01 02 03 04 05 06	01 02 03 04 05 06
Teknik döküman okuma becerisi.....	01 02 03 04 05 06	01 02 03 04 05 06
İnşaat demiri şekilleri ve yapı elemanlarında standardizasyon.....	01 02 03 04 05 06	01 02 03 04 0506
Kesilmiş demirlerin boy ve ölçüye göre gruplandırılması.....	01 02 03 04 05 06	01 02 03 04 05 06
Şantiye sahasındaki çalışma alanı.....	01 02 03 04 05 06	01 02 03 04 05 06
Şantiye sahasındaki depolama alanları.....	01 02 03 04 05 06	01 02 03 04 05 06
Takım içi ilişkiler.....	01 02 03 04 05 06	01 02 03 04 05 06
Malzemenin sahada taşınması.....	01 02 03 04 05 06	01 02 03 04 05 06
Hatalı ürün oranı.....	01 02 03 04 05 06	01 02 03 04 05 06

Demiri istenen ölçülerdkesmek..... 01 02 03 04 05 06 01 02 03 04 05 06

Tedarikçi ile ilgili faktörler

Önem

Performans Düzeyi

Teslim hızının güvenilirliği..... 01 02 03 04 05 06 01 02 03 04 05 06

Teslim güvenilirliği performansı..... 01 02 03 04 05 06 01 02 03 04 05 06

Tedarikçinin cevap verme süresi..... 01 02 03 04 05 06 01 02 03 04 05 06

Malzemenin fiyatı..... 01 02 03 04 05 06 01 02 03 04 05 06

Tedarikçinin konumu..... 01 02 03 04 05 06 01 02 03 04 05 06

Finansal istikrar..... 01 02 03 04 05 06 01 02 03 04 05 06

Sözleşme ve teknik döküman okuma yazma yeteneği..... 01 02 03 04 05 06 01 02 03 04 05 06

Tedarikçi/yüklenici firma ilişkileri..... 01 02 03 04 05 06 01 02 03 04 05 06

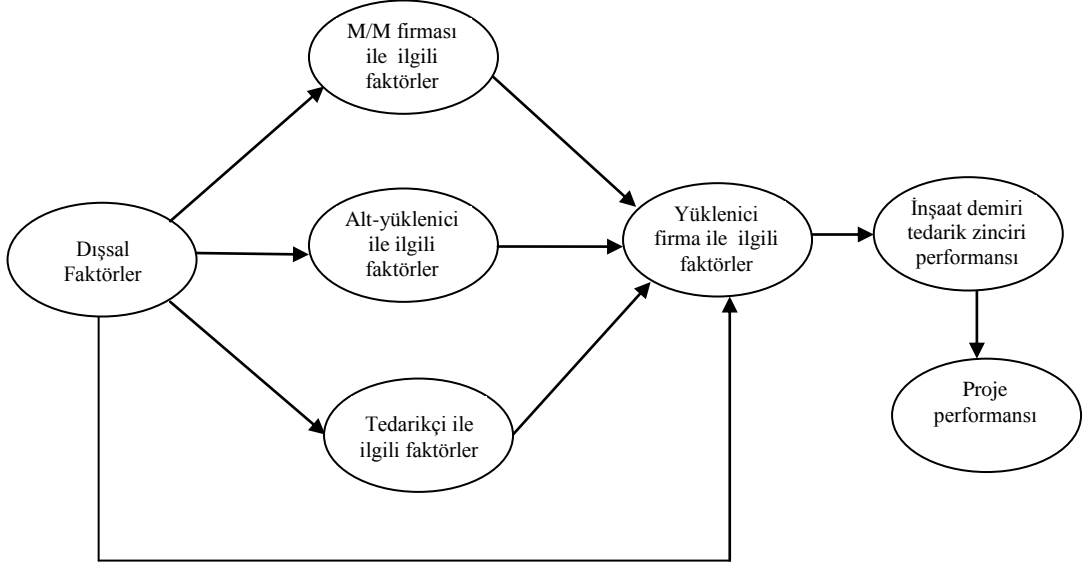
Sevkedilen hatalı ürün sayısı..... 01 02 03 04 05 06 01 02 03 04 05 06

Malzemenin kalitesi..... 01 02 03 04 05 06 01 02 03 04 05 06

Tedarikçi tarafından verilen garantiler..... 01 02 03 04 05 06 01 02 03 04 05 06

Ürün bilgisi..... 01 02 03 04 05 06 01 02 03 04 05 06

Dıřsal Faktörler	Önem	Performans Düzeyi
Ülkedeki ekonomik istikrar.....	01 02 03 04 05 06	01 02 03 04 05 06
Tařıma maliyeti.....	01 02 03 04 05 06	01 02 03 04 05 06
Hukuki kořullar.....	01 02 03 04 05 06	01 02 03 04 05 06
Müřteri özellikleri.....	01 02 03 04 05 06	01 02 03 04 05 06
Çevresel faktörler.....	01 02 03 04 05 06	01 02 03 04 05 06
Aynı sektördeki firma sayısı.....	01 02 03 04 05 06	01 02 03 04 05 06



Şekil A2.1 İnşaat demiri tedarik zinciri için önerilen kavramsal çerçeve

Zaman Ayırdığınız için Teşekkürler...

APPENDIX B

DESCRIPTIVE STATISTICS

Table B.1 Legal status of the companies

		Company Type				Total
		Contractor	AE company	Subcontractor	Supplier	
Legalstatus	Limited company	28	18	3	6	55
	Corporation	1	0	0	2	3
	individual proprietorship	4	2	13	1	20
	Total	33	20	16	9	78

Table B.2 Type of the companies

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Contractor	33	42.3	42.3	42.3
	AE company	20	25.6	25.6	67.9
	Subcontractor	16	20.5	20.5	88.5
	Supplier	9	11.5	11.5	100.0
	Total	78	100.0	100.0	

Table B.3 Responsibilities of the respondents

	Company Type				Total
	Contractor	AE company	Subcontractor	Supplier	
Owner	16	5	14	3	38
Technical staff	17	15	1	1	34
Sales staff	0	0	0	5	5
Worker	0	0	1	0	1
Total	33	20	16	9	78

Table B.4 Experience in years

	Company type				Total
	Contractor	AE company	Subcontractor	Supplier	
1-5 years	4	4	0	1	9
6-10 years	8	6	8	0	22
11-15 years	11	8	8	1	28
16-20 years	3	2	0	5	10
More	7	0	0	2	9
Total	33	20	16	9	78

Table B.5 Expertise areas of the respondent companies

		Company type				Total
		Contractor	AE company	Subcontractor	Supplier	
Expertise area	Housing	21	17	13	5	56
	Commercial	17	16	7	5	45
	Education	16	15	12	5	48
	Health	12	15	6	5	38
	Other	6	4	2	6	18

Table B.6 Annual turnover for the respondent companies

		Company type				Total
		Contractor	AE company	Subcontractor	Supplier	
Annual volume	0-1.000.000 TL	1	3	15	1	20
	1.000.000-2.000.000 TL	4	9	1	0	14
	2.000.000-5.000.000 TL	16	8	0	0	24
	5.000.000-10.000.000 TL	8	0	0	0	8
	More	4	0	0	8	12
Total		33	20	16	9	78

APPENDIX C

RAW DATA

Table C.1 Raw data for project characteristics and rbSC performance related factors

ID	PT	PS	PL	SD	RPP	rbSCperf1	rbSCperf2	rbSCperf3	rbSCperf4
1	1	2	1	1	1	4	4	5	5
2	1	2	3	1	1	4	3	4	4
3	1	2	2	1	1	4	4	3	4
4	1	2	1	1	1	4	3	5	5
5	1	3	2	2	1	4	6	6	6
6	1	3	2	2	1	5	5	5	5
7	2	3	3	3	3	5	5	4	4
8	2	3	3	3	3	5	5	4	4
9	1	3	2	2	1	6	6	6	5
10	1	2	2	2	1	5	5	3	3
11	1	2	2	2	1	6	6	6	5
12	1	3	2	2	1	6	6	6	6
13	1	3	2	1	1	6	6	6	5
14	1	3	2	1	1	5	6	5	5
15	1	2	2	2	3	4	4	5	5
16	1	2	2	2	3	5	4	4	5
17	1	3	2	1	1	6	6	6	6
18	1	2	2	1	3	6	6	5	5
19	2	3	3	1	1	6	6	6	6
20	4	3	2	1	1	6	6	5	5
21	4	3	2	1	1	6	6	5	4
22	4	3	2	1	1	5	6	5	5
23	2	2	3	4	3	4	4	3	3
24	2	2	3	4	3	5	5	4	4
25	2	2	3	4	3	5	5	2	2
26	2	2	3	2	3	5	5	5	5
27	2	2	3	2	3	5	5	5	5
28	1	2	2	2	1	6	6	5	5
29	1	2	2	2	1	6	6	5	5
30	1	3	3	2	1	4	5	4	4
31	1	2	3	3	1	5	5	4	3
32	1	3	3	3	1	4	5	5	5
33	1	2	3	3	1	5	5	4	4
34	1	2	3	3	1	5	4	3	3
35	1	2	3	3	1	5	5	5	5
36	1	2	3	3	1	5	6	5	5
37	3	2	1	2	1	5	5	5	4
38	3	2	1	2	1	6	6	3	3
39	3	2	1	1	1	5	5	4	4

ID: Questionnaire number,

PT: Project type (1:Residential, 2:Commercial, 3:Education, 4:Health, 5:Other)

PS: Project size (1:small, 2:medium, 3:big)

PL: Project location (1:high density urban area, 2:low density urban area, 3:suburban area)

SD: Construction site distance from rebar supplier (1: 0-10km, 2: 10-30km, 3: 30-50km, 4: More than 50km)

RP: Rebar preparation place (1: on-site, 2: off-site, 3: both)

Table C.1 Raw data for project characteristics and rbSC performance related factors (continued)

ID	PT	PS	PL	SD	RPP	rbSCperf1	rbSCperf2	rbSCperf3	rbSCperf4
40	3	2	1	1	1	4	4	4	4
41	3	1	1	1	1	4	4	4	4
42	3	1	1	1	1	5	5	5	5
43	3	2	1	1	1	3	4	3	3
44	3	2	1	1	1	4	4	3	3
45	5	2	1	3	1	5	4	5	5
46	5	2	1	3	1	5	3	3	3
47	5	2	1	3	1	4	4	4	4
48	5	2	1	3	1	5	3	3	3
49	3	2	3	2	1	6	2	4	6
50	3	2	3	2	1	6	4	4	4
51	1	3	2	2	1	6	6	6	6
52	1	3	2	2	1	4	4	4	4
53	1	3	2	2	1	4	4	3	3
54	1	1	1	2	1	5	5	5	5
55	1	1	1	2	1	4	4	4	4
56	1	1	1	2	1	5	5	4	4
57	1	1	1	2	1	4	4	4	4
58	5	2	1	2	1	5	5	4	4
59	5	2	1	2	1	4	5	4	4
60	5	2	1	2	1	5	5	4	4
61	3	2	1	1	1	4	4	3	3
62	3	2	1	1	1	4	4	3	4
63	3	1	3	3	2	4	4	3	3
64	3	2	3	3	2	4	4	4	4
65	3	1	3	3	2	4	4	4	4
66	5	2	2	1	1	5	5	4	4
67	3	2	1	1	1	5	5	5	5
68	3	2	1	1	1	4	4	4	3
69	3	2	1	1	1	4	4	3	4
70	2	2	3	3	1	4	4	3	3
71	2	2	3	3	1	5	5	5	5
72	1	1	2	2	1	4	4	2	2
73	1	1	2	2	1	6	6	6	6
74	1	1	2	2	1	4	4	4	4
75	1	3	3	3	1	4	4	3	3
76	1	3	3	3	1	5	5	5	5
77	1	2	2	1	1	4	4	4	4
78	1	2	2	1	1	4	4	5	4
79	5	3	2	1	3	4	4	3	3
80	5	3	2	1	3	5	5	4	4

ID: Questionnaire number,

PT: Project type (1:Residential, 2:Commercial, 3:Education, 4:Health, 5:Other)

PS: Project size (1:small, 2:medium, 3:big)

PL: Project location (1:high density urban area, 2:low density urban area, 3:suburban area)

SD: Construction site distance from rebar supplier (1: 0-10km, 2: 10-30km, 3: 30-50km, 4: More than 50km)

RP: Rebar preparation place (1: on-site, 2: off-site, 3: both)

Table C.1 Raw data for project characteristics and rbSC performance related factors (continued)

ID	PT	PS	PL	SD	RPP	rbSCperf1	rbSCperf2	rbSCperf3	rbSCperf4
81	1	3	2	1	3	5	6	5	6
82	1	2	1	1	1	4	4	3	3
83	1	2	1	1	1	4	3	4	4
84	2	3	3	3	1	4	4	3	3
85	2	3	3	3	1	4	4	5	4
86	2	3	3	3	1	5	5	4	4
87	1	3	2	2	1	4	6	6	6
88	1	3	2	2	1	5	5	4	4
89	3	2	2	2	1	5	5	5	5
90	3	2	2	2	1	5	5	4	4
91	4	2	2	2	1	4	3	3	3
92	4	2	2	2	1	4	3	3	4
93	3	3	1	1	1	4	4	3	3
94	3	3	1	1	1	4	4	3	2
95	3	2	1	2	1	5	5	5	4
96	1	3	2	2	1	5	4	3	3
97	1	2	1	2	1	4	5	2	2
98	1	2	1	2	1	4	4	2	2
99	1	2	1	2	1	4	5	2	2
100	2	3	3	3	3	5	5	1	2
101	2	3	3	3	3	5	5	2	2
102	2	3	3	3	3	5	5	1	2
103	2	3	3	3	3	4	4	3	3
104	1	2	2	2	3	4	4	5	5
105	1	2	2	2	3	4	4	4	4
106	3	3	2	2	3	4	4	5	5
107	3	3	2	2	3	4	4	5	5
108	2	3	1	2	1	5	6	5	5
109	5	1	2	1	2	6	5	4	4
110	5	1	2	1	2	6	6	6	5
111	4	3	2	2	3	4	4	4	4
112	4	3	2	2	3	5	5	5	5
113	1	2	2	2	3	5	5	5	5
114	1	2	2	2	3	4	4	4	4
115	5	1	3	3	1	4	1	3	3

ID: Questionnaire number,

PT: Project type (1:Residential, 2:Commercial, 3:Education, 4:Health, 5:Other)

PS: Project size (1:small, 2:medium, 3:big)

PL: Project location (1:high density urban area, 2:low density urban area, 3:suburban area)

SD: Construction site distance from rebar supplier (1: 0-10km, 2: 10-30km, 3: 30-50km, 4: More than 50km)

RP: Rebar preparation place (1: on-site, 2: off-site, 3: both)

Table C.2 Raw data for project characteristics and project performance related factors

ID	PT	PS	PL	SD	RPP	PROJperf1	PROJperf2	PROJperf3
1	1	2	1	1	1	4	5	5
2	1	2	3	1	1	4	5	4
3	1	2	2	1	1	5	3	5
4	1	2	1	1	1	4	4	5
5	1	3	2	2	1	3	5	6
6	1	3	2	2	1	4	4	4
7	2	3	3	3	3	4	5	5
8	2	3	3	3	3	5	5	5
9	1	3	2	2	1	6	6	6
10	1	2	2	2	1	5	5	5
11	1	2	2	2	1	6	5	6
12	1	3	2	2	1	5	5	5
13	1	3	2	1	1	6	6	6
14	1	3	2	1	1	6	4	6
15	1	2	2	2	3	6	6	6
16	1	2	2	2	3	6	6	6
17	1	3	2	1	1	4	6	6
18	1	2	2	1	3	5	6	6
19	2	3	3	1	1	6	6	6
20	4	3	2	1	1	6	6	6
21	4	3	2	1	1	6	6	6
22	4	3	2	1	1	4	4	4
23	2	2	3	4	3	4	4	4
24	2	2	3	4	3	5	5	5
25	2	2	3	4	3	4	4	4
26	2	2	3	2	3	6	4	5
27	2	2	3	2	3	6	3	4
28	1	2	2	2	1	5	4	6
29	1	2	2	2	1	6	6	6
30	1	3	3	2	1	4	4	5
31	1	2	3	3	1	4	4	4
32	1	3	3	3	1	5	5	5
33	1	2	3	3	1	5	5	5
34	1	2	3	3	1	5	5	5
35	1	2	3	3	1	5	5	5
36	1	2	3	3	1	6	4	6
37	3	2	1	2	1	3	6	6
38	3	2	1	2	1	3	5	5
39	3	2	1	1	1	4	5	5

ID: Questionnaire number,

PT: Project type (1:Residential, 2:Commercial, 3:Education, 4:Health, 5:Other)

PS: Project size (1:small, 2:medium, 3:big)

PL: Project location (1:high density urban area, 2:low density urban area, 3:suburban area)

SD: Construction site distance from rebar supplier (1: 0-10km, 2: 10-30km, 3: 30-50km, 4: More than 50km)

RP: Rebar preparation place (1: on-site, 2: off-site, 3: both)

Table C.2 Raw data for project characteristics and project performance related factors (continued)

ID	PT	PS	PL	SD	RPP	PROJperf1	PROJperf2	PROJperf3
40	3	2	1	1	1	4	4	6
41	3	1	1	1	1	5	4	5
42	3	1	1	1	1	5	5	5
43	3	2	1	1	1	4	3	4
44	3	2	1	1	1	4	4	5
45	5	2	1	3	1	3	5	6
46	5	2	1	3	1	4	5	5
47	5	2	1	3	1	4	4	5
48	5	2	1	3	1	5	5	5
49	3	2	3	2	1	6	6	1
50	3	2	3	2	1	6	6	4
51	1	3	2	2	1	6	6	6
52	1	3	2	2	1	4	4	4
53	1	3	2	2	1	5	5	5
54	1	1	1	2	1	5	5	5
55	1	1	1	2	1	4	4	4
56	1	1	1	2	1	5	5	5
57	1	1	1	2	1	4	5	4
58	5	2	1	2	1	5	5	5
59	5	2	1	2	1	4	5	5
60	5	2	1	2	1	5	5	5
61	3	2	1	1	1	4	5	4
62	3	2	1	1	1	4	5	6
63	3	1	3	3	2	4	4	4
64	3	2	3	3	2	4	4	4
65	3	1	3	3	2	4	4	4
66	5	2	2	1	1	4	5	6
67	3	2	1	1	1	4	5	6
68	3	2	1	1	1	4	4	4
69	3	2	1	1	1	4	5	6
70	2	2	3	3	1	5	5	5
71	2	2	3	3	1	5	5	5
72	1	1	2	2	1	5	3	5
73	1	1	2	2	1	6	6	6
74	1	1	2	2	1	5	5	5
75	1	3	3	3	1	4	5	5
76	1	3	3	3	1	5	5	5
77	1	2	2	1	1	4	5	5
78	1	2	2	1	1	5	5	5
79	5	3	2	1	3	4	5	5
80	5	3	2	1	3	4	5	4

ID: Questionnaire number,

PT: Project type (1:Residential, 2:Commercial, 3:Education, 4:Health, 5:Other)

PS: Project size (1:small, 2:medium, 3:big)

PL: Project location (1:high density urban area, 2:low density urban area, 3:suburban area)

SD: Construction site distance from rebar supplier (1: 0-10km, 2: 10-30km, 3: 30-50km, 4: More than 50km)

RPP: Rebar preparation place (1: on-site, 2: off-site, 3: both)

Table C.2 Raw data for project characteristics and project performance related factors (continued)

ID	PT	PS	PL	SD	RPP	PROJperf1	PROJperf2	PROJperf3
81	1	3	2	1	3	3	6	6
82	1	2	1	1	1	4	5	5
83	1	2	1	1	1	4	5	4
84	2	3	3	3	1	5	5	5
85	2	3	3	3	1	5	5	5
86	2	3	3	3	1	4	4	4
87	1	3	2	2	1	3	5	6
88	1	3	2	2	1	5	5	5
89	3	2	2	2	1	3	4	5
90	3	2	2	2	1	4	4	4
91	4	2	2	2	1	3	4	4
92	4	2	2	2	1	4	4	3
93	3	3	1	1	1	4	4	3
94	3	3	1	1	1	4	4	4
95	3	2	1	2	1	5	5	6
96	1	3	2	2	1	5	4	5
97	1	2	1	2	1	5	3	5
98	1	2	1	2	1	5	3	5
99	1	2	1	2	1	5	3	5
100	2	3	3	3	3	4	5	4
101	2	3	3	3	3	4	5	4
102	2	3	3	3	3	5	5	5
103	2	3	3	3	3	4	4	4
104	1	2	2	2	3	6	6	6
105	1	2	2	2	3	5	5	5
106	3	3	2	2	3	5	5	5
107	3	3	2	2	3	5	5	5
108	2	3	1	2	1	5	5	6
109	5	1	2	1	2	3	4	5
110	5	1	2	1	2	6	6	6
111	4	3	2	2	3	3	5	5
112	4	3	2	2	3	4	5	5
113	1	2	2	2	3	4	5	5
114	1	2	2	2	3	5	5	5
115	5	1	3	3	1	4	6	3

ID: Questionnaire number,

PT: Project type (1:Residential, 2:Commercial, 3:Education, 4:Health, 5:Other)

PS: Project size (1:small, 2:medium, 3:big)

PL: Project location (1:high density urban area, 2:low density urban area, 3:suburban area)

SD: Construction site distance from rebar supplier (1: 0-10km, 2: 10-30km, 3: 30-50km, 4: More than 50km)

RP: Rebar preparation place (1: on-site, 2: off-site, 3: both)

Table C.3 Raw data for project characteristics and contractor related factors

ID	PT	PS	PL	SD	RPP	CONT1per f	CONT2per f	CONT3per f	CONT4per f	CONT5per f	CONT6per f	CONT7per f	CONT8per f	CONT9per f	CONT10per f	CONT11per f	CONT12per f
1	1	2	1	1	1	4	4	5	5	5	4	6	5	5	5	4	5
2	1	2	3	1	1	4	5	5	3	3	4	5	4	4	5	5	5
3	1	2	2	1	1	4	4	5	5	4	4	4	3	3	5	5	4
4	1	2	1	1	1	5	5	5	4	5	5	5	4	5	6	4	4
5	1	3	2	2	1	6	6	6	6	6	6	6	6	6	5	5	6
6	1	3	2	2	1	5	5	5	5	4	4	5	5	5	3	4	5
7	2	3	3	3	3	5	5	5	5	4	4	5	5	5	5	5	5
8	2	3	3	3	3	5	5	5	5	4	4	5	5	5	4	5	5
9	1	3	2	2	1	6	6	5	6	6	6	6	6	1	5	4	6
10	1	2	2	2	1	5	5	5	5	5	5	5	6	3	3	4	5
11	1	2	2	2	1	6	6	5	6	6	6	6	6	1	6	4	6
12	1	3	2	2	1	5	5	5	5	5	5	5	5	3	4	3	5
13	1	3	2	1	1	5	6	6	5	6	6	6	6	6	5	6	6
14	1	3	2	1	1	5	6	5	5	5	6	6	6	6	6	5	6
15	1	2	2	2	3	4	4	4	4	5	5	6	4	6	4	3	6
16	1	2	2	2	3	4	6	4	4	4	5	6	4	5	4	3	6
17	1	3	2	1	1	6	6	6	5	6	6	6	6	5	4	5	5
18	1	2	2	1	3	6	6	5	6	6	6	6	5	4	5	4	5
19	2	3	3	1	1	6	6	6	6	4	5	4	6	6	6	6	6
20	4	3	2	1	1	6	6	6	6	6	6	6	6	6	6	6	6
21	4	3	2	1	1	5	5	5	5	1	1	5	5	3	3	3	3
22	4	3	2	1	1	4	4	4	4	3	3	3	4	4	4	4	5
23	2	2	3	4	3	4	4	4	4	4	4	5	6	4	4	4	5
24	2	2	3	4	3	4	4	4	4	2	2	5	4	3	3	3	4
25	2	2	3	4	3	3	3	2	3	2	2	5	5	3	3	3	5

ID: Questionnaire number,

PT: Project type (1:Residential, 2:Commercial, 3:Education, 4:Health, 5:Other)
 PL: Project location (1:high density urban area, 2:low density urban area, 3:suburban area)

SD: Construction site distance from rebar supplier (1: 0-10km, 2: 10-30km, 3: 30-50KM, 4: More than 50km)

RP: Rebar preparation place (1: on-site, 2: off-site, 3: both)

Table C.3 Raw data for project characteristics and contractor related factors (continued)

ID	PT	PS	PL	SD	RPP	CONT1perf	CONT2perf	CONT3perf	CONT4perf	CONT5perf	CONT6perf	CONT7perf	CONT8perf	CONT9perf	CONT10perf	CONT11perf	CONT12perf
26	2	2	3	2	3	5	5	5	5	4	4	5	5	5	4	4	5
27	2	2	3	2	3	3	3	3	3	3	3	4	4	4	4	4	4
28	1	2	2	2	1	5	4	4	5	4	4	6	5	5	4	4	6
29	1	2	2	2	1	5	5	4	5	3	3	4	4	4	3	3	5
30	1	3	3	2	1	5	5	5	5	5	5	5	5	5	5	5	5
31	1	2	3	3	1	5	5	4	4	4	4	5	5	5	4	4	5
32	1	3	3	3	1	5	5	5	5	5	5	6	6	6	6	5	6
33	1	2	3	3	1	5	5	4	4	4	4	5	5	5	4	4	5
34	1	2	3	3	1	4	4	4	4	4	4	5	5	4	4	5	5
35	1	2	3	3	1	5	5	4	4	4	4	5	5	5	4	4	5
36	1	2	3	3	1	5	6	5	5	5	5	6	6	6	6	5	6
37	3	2	1	2	1	3	3	4	4	3	3	5	4	4	4	4	3
38	3	2	1	2	1	4	4	4	4	4	4	4	5	5	4	4	3
39	3	2	1	1	1	4	4	4	4	4	4	6	6	1	1	2	6
40	3	2	1	1	1	4	4	6	4	4	4	6	5	1	3	4	4
41	3	1	1	1	1	5	5	4	4	5	4	5	5	4	3	4	4
42	3	1	1	1	1	4	5	4	4	4	4	5	5	4	3	4	4
43	3	2	1	1	1	5	5	4	4	5	4	4	3	4	3	5	5
44	3	2	1	1	1	4	4	4	4	4	4	4	4	4	3	4	4
45	5	2	1	3	1	2	2	4	4	4	3	6	6	3	2	6	6
46	5	2	1	3	1	3	3	3	3	2	2	6	6	4	3	4	4
47	5	2	1	3	1	2	2	4	4	4	4	6	6	3	3	5	5
48	5	2	1	3	1	3	3	3	3	2	2	6	6	4	3	4	4
49	3	2	3	2	1	6	5	6	6	6	3	6	5	4	3	5	6
50	3	2	3	2	1	5	5	5	5	5	4	5	5	4	4	5	5

ID: Questionnaire number,

PT: Project type (1:Residential, 2:Commercial, 3:Education, 4:Health, 5:Other)

PS: Project size (1:small, 2:medium, 3:big)

PL: Project location (1:high density urban area, 2:low density urban area, 3:suburban area)

SD: Construction site distance from rebar supplier (1: 0-10km, 2: 10-30km, 3: 30-50KM, 4: More than 50km)

RP: Rebar preparation place (1: on-site, 2: off-site, 3: both)

Table C.3 Raw data for project characteristics and contractor related factors (continued)

ID	PT	PS	PL	SD	RPP	CONT1perf	CONT2perf	CONT3perf	CONT4perf	CONT5perf	CONT6perf	CONT7perf	CONT8perf	CONT9perf	CONT10perf	CONT11perf	CONT12perf
51	1	3	2	2	1	6	6	6	6	6	6	4	6	4	6	6	4
52	1	3	2	2	1	4	4	4	4	2	2	5	5	3	5	5	5
53	1	3	2	2	1	4	4	4	4	4	4	4	4	2	3	4	4
54	1	1	1	2	1	5	5	5	5	5	5	6	5	2	3	4	5
55	1	1	1	2	1	4	4	4	4	3	3	5	4	1	2	3	4
56	1	1	1	2	1	4	4	4	4	4	4	5	5	2	3	3	4
57	1	1	1	2	1	5	5	5	5	5	5	5	5	2	3	3	3
58	5	2	1	2	1	5	5	5	5	5	5	6	6	2	2	3	4
59	5	2	1	2	1	4	4	4	4	3	3	5	4	1	2	3	4
60	5	2	1	2	1	5	5	5	5	4	4	6	6	2	4	3	5
61	3	2	1	1	1	4	4	4	4	3	3	6	3	2	4	4	4
62	3	2	1	1	1	2	2	4	4	3	4	6	5	2	4	4	4
63	3	1	3	3	2	5	5	3	4	3	3	5	5	4	3	4	5
64	3	2	3	3	2	4	4	4	4	4	4	5	6	4	4	4	5
65	3	1	3	3	2	4	6	2	4	4	4	4	4	4	4	4	4
66	5	2	2	1	1	3	3	3	3	4	3	6	6	3	3	4	6
67	3	2	1	1	1	2	2	4	4	4	3	6	6	3	3	6	6
68	3	2	1	1	1	3	3	3	3	4	4	5	5	4	4	4	5
69	3	2	1	1	1	2	2	4	4	3	5	6	4	2	3	4	4
70	2	2	3	3	1	4	4	4	4	2	2	5	4	4	2	2	5
71	2	2	3	3	1	5	5	3	5	4	4	5	5	5	3	3	5
72	1	1	2	2	1	4	4	4	4	3	3	4	4	4	4	4	4
73	1	1	2	2	1	5	5	5	5	5	5	5	5	5	5	4	4
74	1	1	2	2	1	5	5	4	5	3	4	4	4	6	4	4	6
75	1	3	3	3	1	5	4	4	5	4	4	6	5	4	5	4	4

ID: Questionnaire number,

PT: Project type (1:Residential, 2:Commercial, 3:Education, 4:Health, 5:Other)

PS: Project size (1:small, 2:medium, 3:big)

PL: Project location (1:high density urban area, 2:low density urban area, 3:suburban area)

SD: Construction site distance from rebar supplier (1: 0-10km, 2: 10-30km, 3: 30-50KM, 4: More than 50km)

RP: Rebar preparation place (1: on-site, 2: off-site, 3: both)

Table C.3 Raw data for project characteristics and contractor related factors (continued)

ID	PT	PS	PL	SD	RPP	CONT1perf	CONT2perf	CONT3perf	CONT4perf	CONT5perf	CONT6perf	CONT7perf	CONT8perf	CONT9perf	CONT10perf	CONT11perf	CONT12perf
76	1	3	3	3	1	5	5	5	5	4	5	6	5	4	5	5	5
77	1	2	2	1	1	5	4	4	5	4	4	6	5	4	5	4	4
78	1	2	2	1	1	4	5	5	5	5	6	6	5	4	6	5	5
79	5	3	2	1	3	5	5	5	5	5	5	6	6	6	5	5	6
80	5	3	2	1	3	4	4	5	4	4	4	6	5	4	4	4	5
81	1	3	2	1	3	3	3	5	5	5	4	6	6	5	5	6	6
82	1	2	1	1	1	4	4	5	5	4	4	6	4	5	3	3	4
83	1	2	1	1	1	4	5	5	3	3	4	6	4	4	4	5	5
84	2	3	3	3	1	4	4	4	4	2	2	5	4	4	3	3	4
85	2	3	3	3	1	4	5	5	5	5	5	5	5	4	4	4	4
86	2	3	3	3	1	5	5	3	5	4	4	5	5	6	4	4	6
87	1	3	2	2	1	6	6	6	6	5	5	6	6	5	5	5	5
88	1	3	2	2	1	6	6	6	6	2	2	6	5	3	3	3	6
89	3	2	2	2	1	6	6	6	5	5	5	6	6	4	4	5	5
90	3	2	2	2	1	5	5	5	5	2	2	6	5	3	3	4	6
91	4	2	2	2	1	3	3	3	4	4	4	6	6	5	5	4	5
92	4	2	2	2	1	3	4	4	3	3	4	5	4	4	4	3	5
93	3	3	1	1	1	4	4	4	4	3	3	6	4	2	3	2	4
94	3	3	1	1	1	2	2	2	2	3	4	6	5	2	3	4	4
95	3	2	1	2	1	3	3	4	4	4	3	6	5	3	3	6	6
96	1	3	2	2	1	4	4	4	4	2	2	4	4	4	3	3	5
97	1	2	1	2	1	4	4	4	4	4	4	6	5	5	5	4	4
98	1	2	1	2	1	4	4	4	4	2	2	4	4	4	3	3	5
99	1	2	1	2	1	4	4	4	4	4	4	6	5	5	5	4	4
100	2	3	3	3	3	4	4	4	4	2	2	6	6	5	3	3	6

ID: Questionnaire number,

PT: Project type (1:Residential, 2:Commercial, 3:Education, 4:Health, 5:Other)

PS: Project size (1:small, 2:medium, 3:big)

PL: Project location (1:high density urban area, 2:low density urban area, 3:suburban area)

SD: Construction site distance from rebar supplier (1: 0-10km, 2: 10-30km, 3: 30-50KM, 4: More than 50km)

RP: Rebar preparation place (1: on-site, 2: off-site, 3: both)

Table C.3 Raw data for project characteristics and contractor related factors (continued)

ID	PT	PS	PL	SD	RPP	CONT1perf	CONT2perf	CONT3perf	CONT4perf	CONT5perf	CONT6perf	CONT7perf	CONT8perf	CONT9perf	CONT10perf	CONT11perf	CONT12perf
101	2	3	3	3	3	4	4	4	4	4	4	4	4	4	4	4	4
102	2	3	3	3	3	4	4	4	4	2	2	6	6	5	3	3	6
103	2	3	3	3	3	4	4	4	4	4	4	4	4	4	4	4	4
104	1	2	2	2	3	4	4	4	4	4	4	6	5	5	3	3	6
105	1	2	2	2	3	4	4	4	4	4	4	4	4	4	4	4	4
106	3	3	2	2	3	4	4	4	4	5	4	6	4	4	4	4	5
107	3	3	2	2	3	4	4	4	4	4	4	4	4	4	4	4	4
108	2	3	1	2	1	5	5	6	6	5	5	3	6	4	6	5	4
109	5	1	2	1	2	3	4	3	3	3	3	6	5	1	1	2	4
110	5	1	2	1	2	5	6	6	5	6	6	6	6	6	5	6	6
111	4	3	2	2	3	6	6	6	6	6	6	6	6	6	6	6	6
112	4	3	2	2	3	5	6	5	5	6	6	6	6	6	6	6	6
113	1	2	2	2	3	5	6	5	5	6	6	6	6	6	6	6	6
114	1	2	2	2	3	6	6	6	6	6	6	6	6	6	6	6	6
115	5	1	3	3	1	6	6	6	6	6	6	6	6	4	4	6	6

ID: Questionnaire number,

PT: Project type (1:Residential, 2:Commercial, 3:Education, 4:Health, 5:Other)

PS: Project size (1:small, 2:medium, 3:big)

PL: Project location (1:high density urban area, 2:low density urban area, 3:suburban area)

SD: Construction site distance from rebar supplier (1: 0-10km, 2: 10-30km, 3: 30-50KM, 4: More than 50km)

RP: Rebar preparation place (1: on-site, 2: off-site, 3: both)

Table C.4 Raw data for project characteristics and sub-contractor related factors

ID	PT	PS	PL	SD	RP	SUBCONTP 1	SUBCONTP 2	SUBCONTP 3	SUBCONTP 4	SUBCONTP 5	SUBCONTP 6	SUBCONTP 7	SUBCONTP 8	SUBCONTP 9	SUBCONTPI 0	SUBCONTPI 1	SUBCONTPI 2	SUBCONTPI 3
1	1	2	1	1	1	4	5	6	4	4	4	3	5	4	5	3	4	5
2	1	2	3	1	1	5	5	4	5	4	4	5	4	5	5	4	4	4
3	1	2	2	1	1	3	5	5	3	5	5	5	4	5	4	4	4	4
4	1	2	1	1	1	5	5	4	5	4	4	5	4	5	4	4	5	5
5	1	3	2	2	1	6	6	5	4	6	6	6	4	6	5	6	6	6
6	1	3	2	2	1	5	5	5	3	3	5	5	4	5	5	5	5	5
7	2	3	3	3	3	5	5	5	3	3	4	5	4	6	4	5	5	5
8	2	3	3	3	3	4	4	6	4	4	5	5	5	6	5	5	5	5
9	1	3	2	2	1	4	5	1	2	3	5	5	5	6	4	5	6	6
10	1	2	2	2	1	3	3	1	1	1	4	4	4	5	4	4	4	5
11	1	2	2	2	1	6	5	1	5	5	6	6	5	6	4	5	6	6
12	1	3	2	2	1	2	3	2	2	2	4	4	4	5	3	4	5	5
13	1	3	2	1	1	5	6	5	5	4	6	5	6	6	5	5	4	5
14	1	3	2	1	1	6	6	5	5	5	6	6	6	6	6	6	5	5
15	1	2	2	2	3	5	6	4	5	4	6	4	4	3	4	4	4	5
16	1	2	2	2	3	5	6	4	5	4	6	4	4	3	4	3	6	5
17	1	3	2	1	1	6	6	4	4	5	6	6	6	5	5	5	5	6
18	1	2	2	1	3	4	4	4	3	4	4	5	4	5	4	4	4	5
19	2	3	3	1	1	5	5	6	3	4	4	4	5	6	6	6	5	5
20	4	3	2	1	1	6	6	6	2	6	3	5	4	5	6	6	4	4
21	4	3	2	1	1	4	4	5	5	4	5	6	6	5	5	6	6	6
22	4	3	2	1	1	4	3	2	2	5	5	5	5	4	4	4	4	4
23	2	2	3	4	3	2	2	4	2	2	4	4	4	4	3	4	3	4
24	2	2	3	4	3	2	2	2	2	2	3	3	3	4	2	3	3	3
25	2	2	3	4	3	3	4	4	3	4	4	4	4	4	4	4	4	5

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ID: Questionnaire number,

SD: Construction site distance from rebar supplier (1: 0-10km, 2: 10-30km, 3: 30-50KM, 4: More than 50km)

PT: Project type (1:Residential, 2:Commercial, 3:Education, 4:Health, 5:Other)

RP: Rebar preparation place (1: on-site, 2: off-site, 3: both)

PS: Project size (1:small, 2:medium, 3:big)

PL: Project location (1:high density urban area, 2:low density urban area, 3:suburban area)

Table C.4 Raw data for project characteristics and sub-contractor related factors (continued)

ID	PT	PS	PL	SD	RP	SUBCONT P1	SUBCONT P2	SUBCONT P3	SUBCONT P4	SUBCONT P5	SUBCONT P6	SUBCONT P7	SUBCONT P8	SUBCONT P9	SUBCONT P10	SUBCONT P11	SUBCONT P12	SUBCONT P13
26	2	2	3	2	3	2	2	2	2	2	4	4	4	5	3	5	3	3
27	2	2	3	2	3	4	4	4	4	4	4	4	4	5	4	4	4	4
28	1	2	2	2	1	5	4	4	3	5	6	6	5	3	5	6	5	6
29	1	2	2	2	1	5	5	5	3	5	5	5	5	5	5	6	5	6
30	1	3	3	2	1	2	3	4	3	3	6	6	6	6	4	5	5	4
31	1	2	3	3	1	4	4	3	3	3	5	5	5	5	4	5	5	5
32	1	3	3	3	1	5	5	5	4	5	5	5	6	6	6	6	5	5
33	1	2	3	3	1	4	4	3	3	3	5	5	5	5	4	5	5	5
34	1	2	3	3	1	6	5	5	5	4	5	5	5	5	5	5	5	5
35	1	2	3	3	1	2	3	2	2	2	5	5	5	5	3	4	5	5
36	1	2	3	3	1	6	6	5	5	5	6	6	6	6	6	6	5	5
37	3	2	1	2	1	3	3	3	2	5	5	5	5	3	5	4	4	4
38	3	2	1	2	1	5	5	5	4	5	6	6	6	5	5	5	5	5
39	3	2	1	1	1	2	2	2	2	2	4	3	3	3	2	3	4	4
40	3	2	1	1	1	3	3	3	2	2	2	3	3	4	3	3	4	4
41	3	1	1	1	1	3	3	3	3	3	4	4	3	2	3	4	4	4
42	3	1	1	1	1	4	5	3	3	5	4	5	3	3	4	3	4	5
43	3	2	1	1	1	3	3	3	3	3	4	4	3	2	4	4	3	3
44	3	2	1	1	1	4	4	2	3	3	3	5	2	2	3	4	4	5
45	5	2	1	3	1	3	3	3	2	5	4	5	5	3	4	3	3	4
46	5	2	1	3	1	3	5	3	1	4	4	5	5	3	4	4	4	4
47	5	2	1	3	1	3	3	3	1	4	4	4	4	4	4	3	3	4
48	5	2	1	3	1	3	4	4	1	4	4	5	5	3	4	4	4	4
49	3	2	3	2	1	5	6	3	2	6	6	6	4	6	5	6	4	6
50	3	2	3	2	1	5	4	4	3	3	4	4	4	6	5	6	5	6

ID: Questionnaire number,

SD: Construction site distance from rebar supplier (1: 0-10km, 2: 10-30km, 3: 30-50KM, 4: More than 50km)

PT: Project type (1:Residential, 2:Commercial, 3:Education, 4:Health, 5:Other)

RP: Rebar preparation place (1: on-site, 2: off-site, 3: both)

PS: Project size (1:small, 2:medium, 3:big)

PL: Project location (1:high density urban area, 2:low density urban area, 3:suburban area)

Table C.4 Raw data for project characteristics and sub-contractor related factors (continued)

ID	PT	PS	PL	SD	RP	SUBCONT P1	SUBCONT P2	SUBCONT P3	SUBCONT P4	SUBCONT P5	SUBCONT P6	SUBCONT P7	SUBCONT P8	SUBCONT P9	SUBCONT P10	SUBCONT P11	SUBCONT P12	SUBCONT P13
51	1	3	2	2	1	5	5	1	4	6	3	4	6	6	4	6	6	6
52	1	3	2	2	1	3	3	1	3	4	4	5	5	5	3	5	5	5
53	1	3	2	2	1	4	4	2	2	3	4	5	5	4	4	4	4	4
54	1	1	1	2	1	3	3	2	2	2	3	3	3	3	3	3	4	4
55	1	1	1	2	1	2	3	2	2	2	4	3	2	3	2	4	4	4
56	1	1	1	2	1	3	5	2	3	4	4	4	4	2	4	4	5	5
57	1	1	1	2	1	2	2	1	2	2	3	3	3	3	3	3	4	4
58	5	2	1	2	1	3	3	2	2	2	4	4	4	3	3	3	4	4
59	5	2	1	2	1	3	3	2	2	2	5	5	5	3	2	4	4	4
60	5	2	1	2	1	3	3	2	2	2	4	5	4	3	3	4	4	4
61	3	2	1	1	1	3	3	3	3	3	3	4	4	3	3	3	4	4
62	3	2	1	1	1	4	3	2	2	1	4	3	3	4	3	4	4	4
63	3	1	3	3	2	5	5	5	2	3	5	5	5	5	4	4	4	4
64	3	2	3	3	2	5	5	4	4	4	5	5	5	5	5	5	5	5
65	3	1	3	3	2	5	5	5	5	5	5	5	5	3	5	4	5	6
66	5	2	2	1	1	3	3	3	2	3	3	5	5	3	5	3	4	4
67	3	2	1	1	1	3	3	3	2	5	4	5	5	3	5	3	4	4
68	3	2	1	1	1	3	3	2	2	2	2	2	2	3	3	3	4	4
69	3	2	1	1	1	4	3	2	2	1	4	3	3	4	3	4	4	4
70	2	2	3	3	1	3	3	3	2	3	4	4	4	5	3	3	4	4
71	2	2	3	3	1	5	4	4	4	4	4	4	4	5	3	4	4	5
72	1	1	2	2	1	4	4	3	3	4	4	5	5	4	4	4	4	4
73	1	1	2	2	1	5	6	6	5	5	5	5	5	6	6	6	6	6
74	1	1	2	2	1	4	4	4	4	4	4	4	4	4	4	4	4	4
75	1	3	3	3	1	4	4	4	3	3	4	5	5	5	2	4	4	5

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ID: Questionnaire number,

SD: Construction site distance from rebar supplier (1: 0-10km, 2: 10-30km, 3: 30-50KM, 4: More than 50km)

PT: Project type (1:Residential, 2:Commercial, 3:Education, 4:Health, 5:Other)

RP: Rebar preparation place (1: on-site, 2: off-site, 3: both)

PS: Project size (1:small, 2:medium, 3:big)

PL: Project location (1:high density urban area, 2:low density urban area, 3:suburban area)

Table C.4 Raw data for project characteristics and sub-contractor related factors (continued)

ID	PT	PS	PL	SD	RPP	SUBCONT P1	SUBCONT P2	SUBCONT P3	SUBCONT P4	SUBCONT P5	SUBCONT P6	SUBCONT P7	SUBCONT P8	SUBCONT P9	SUBCONT P10	SUBCONT P11	SUBCONT P12	SUBCONT P13
76	1	3	3	3	1	4	4	4	3	3	4	5	5	5	4	3	3	4
77	1	2	2	1	1	3	3	4	3	3	4	4	4	4	4	4	4	4
78	1	2	2	1	1	5	4	4	2	3	4	5	5	5	5	1	4	5
79	5	3	2	1	3	4	3	3	2	4	4	4	4	5	3	4	4	4
80	5	3	2	1	3	4	4	3	2	2	5	5	5	5	4	4	4	5
81	1	3	2	1	3	4	5	4	2	5	4	4	4	3	4	3	3	4
82	1	2	1	1	1	4	5	6	4	4	4	3	5	4	5	3	4	5
83	1	2	1	1	1	5	5	2	2	2	4	5	3	3	3	3	5	5
84	2	3	3	3	1	3	3	3	2	3	4	4	4	5	3	3	4	4
85	2	3	3	3	1	5	4	4	2	3	4	5	5	5	3	4	5	5
86	2	3	3	3	1	4	4	4	2	2	4	4	4	5	3	4	4	5
87	1	3	2	2	1	6	6	5	4	6	6	6	5	6	5	6	6	6
88	1	3	2	2	1	4	4	6	4	4	5	5	5	6	5	5	5	5
89	3	2	2	2	1	6	6	5	4	6	6	6	5	6	5	6	6	6
90	3	2	2	2	1	4	4	6	4	4	5	5	5	5	4	4	5	5
91	4	2	2	2	1	4	4	5	2	3	5	4	4	4	3	4	4	4
92	4	2	2	2	1	4	4	4	2	3	4	5	5	5	4	5	5	4
93	3	3	1	1	1	2	3	2	2	2	3	4	4	2	4	3	4	4
94	3	3	1	1	1	4	3	2	2	2	5	4	2	4	5	5	5	5
95	3	2	1	2	1	3	3	3	3	4	4	4	4	3	4	4	4	5
96	1	3	2	2	1	4	4	3	3	4	4	5	5	5	4	4	4	4
97	1	2	1	2	1	3	5	2	2	2	5	5	3	3	3	3	4	4
98	1	2	1	2	1	4	4	3	3	4	4	5	3	3	4	3	4	4
99	1	2	1	2	1	3	5	2	2	2	5	5	5	5	5	3	4	4
100	2	3	3	3	3	1	2	1	1	1	4	4	4	5	2	4	5	5

ID: Questionnaire number,

SD: Construction site distance from rebar supplier (1: 0-10km, 2: 10-30km, 3: 30-50KM, 4: More than 50km)

PT: Project type (1:Residential, 2:Commercial, 3:Education, 4:Health, 5:Other)

RP: Rebar preparation place (1: on-site, 2: off-site, 3: both)

PS: Project size (1:small, 2:medium, 3:big)

PL: Project location (1:high density urban area, 2:low density urban area, 3:suburban area)

Table C.4 Raw data for project characteristics and sub-contractor related factors (continued)

ID	PT	PS	PL	SD	RPP	SUBCONT P1	SUBCONT P2	SUBCONT P3	SUBCONT P4	SUBCONT P5	SUBCONT P6	SUBCONT P7	SUBCONT P8	SUBCONT P9	SUBCONT P10	SUBCONT P11	SUBCONT P12	SUBCONT P13
101	2	3	3	3	3	2	3	2	2	2	5	4	4	5	3	5	5	5
102	2	3	3	3	3	1	2	1	1	1	4	4	4	5	3	5	4	5
103	2	3	3	3	3	2	3	2	2	2	5	4	4	4	3	4	5	5
104	1	2	2	2	3	4	4	4	4	4	5	5	5	5	4	5	5	5
105	1	2	2	2	3	4	4	4	2	2	4	4	4	4	2	4	4	4
106	3	3	2	2	3	4	4	4	4	4	6	6	6	5	4	5	5	5
107	3	3	2	2	3	4	4	4	2	2	4	5	5	5	3	5	4	4
108	2	3	1	2	1	5	4	3	6	3	5	6	6	3	5	3	6	4
109	5	1	2	1	2	2	2	1	1	1	4	4	4	5	3	5	5	5
110	5	1	2	1	2	5	6	5	5	4	6	5	6	6	5	5	4	5
111	4	3	2	2	3	5	5	5	5	6	6	6	6	5	4	4	6	6
112	4	3	2	2	3	5	5	5	5	5	6	5	5	5	5	5	6	6
113	1	2	2	2	3	5	5	5	5	5	6	5	5	5	5	5	6	6
114	1	2	2	2	3	6	6	6	5	6	6	6	5	4	4	4	6	6
115	5	1	3	3	1	4	4	4	4	5	4	4	4	3	3	4	4	4

ID: Questionnaire number,

PT: Project type (1:Residential, 2:Commercial, 3:Education, 4:Health, 5:Other)

PS: Project size (1:small, 2:medium, 3:big)

PL: Project location (1:high density urban area, 2:low density urban area, 3:suburban area)

SD: Construction site distance from rebar supplier (1: 0-10km, 2: 10-30km, 3: 30-50KM, 4: More than 50km)

RP: Rebar preparation place (1: on-site, 2: off-site, 3: both)

Table C.5 Raw data for project characteristics and supplier related factors

ID	PT	PS	PL	SD	RPP	SUP1perf	SUP2perf	SUP3perf	SUP4perf	SUP5perf	SUP6perf	SUP7perf	SUP8perf	SUP9perf	SUP10perf	SUP11perf	SUP12perf
1	1	2	1	1	1	4	5	5	3	4	4	4	3	4	4	5	5
2	1	2	3	1	1	4	4	3	5	5	3	4	5	3	3	5	5
3	1	2	2	1	1	4	5	5	4	4	5	4	2	4	5	4	4
4	1	2	1	1	1	4	5	4	4	4	6	4	5	3	5	5	5
5	1	3	2	2	1	6	6	6	6	6	6	6	6	6	6	6	6
6	1	3	2	2	1	6	6	6	6	5	6	4	5	6	6	5	5
7	2	3	3	3	3	5	5	5	6	4	6	4	4	5	6	5	5
8	2	3	3	3	3	6	6	5	6	5	6	4	5	6	6	5	5
9	1	3	2	2	1	4	4	6	6	6	6	6	6	5	6	6	6
10	1	2	2	2	1	4	4	4	4	5	5	3	4	5	5	5	5
11	1	2	2	2	1	4	4	6	6	6	6	6	6	5	6	6	6
12	1	3	2	2	1	5	5	5	6	5	5	3	3	5	5	4	4
13	1	3	2	1	1	5	6	5	5	4	5	6	5	5	6	5	6
14	1	3	2	1	1	6	6	6	6	6	6	6	5	5	6	6	6
15	1	2	2	2	3	4	5	5	6	4	4	1	4	4	6	3	4
16	1	2	2	2	3	4	4	4	6	4	4	1	4	4	5	3	3
17	1	3	2	1	1	6	6	6	5	5	5	5	5	5	6	5	5
18	1	2	2	1	3	6	6	6	6	5	6	5	6	6	6	6	6
19	2	3	3	1	1	6	6	6	3	6	6	5	6	6	6	6	6
20	4	3	2	1	1	6	6	6	6	6	6	4	6	6	6	6	4
21	4	3	2	1	1	5	5	5	6	6	6	4	4	5	5	3	3
22	4	3	2	1	1	6	6	6	6	4	5	4	5	5	5	5	6
23	2	2	3	4	3	3	3	3	4	3	5	4	4	3	4	4	4
24	2	2	3	4	3	5	4	4	4	3	5	3	3	4	5	5	5
25	2	2	3	4	3	3	3	3	3	3	5	2	2	4	4	3	3

ID: Questionnaire number,

PT: Project type (1:Residential, 2:Commercial, 3:Education, 4:Health, 5:Other)

PS: Project size (1:small, 2:medium, 3:big)

PL: Project location (1:high density urban area, 2:low density urban area, 3:suburban area)

SD: Construction site distance from rebar supplier (1: 0-10km, 2: 10-30km, 3: 30-50KM, 4: More than 50km)

RP: Rebar preparation place (1: on-site, 2: off-site, 3: both)

Table C.5 Raw data for project characteristics and supplier related factors (continued)

ID	PT	PS	PL	SD	RPP	SUP1perf	SUP2perf	SUP3perf	SUP4perf	SUP5perf	SUP6perf	SUP7perf	SUP8perf	SUP9perf	SUP10perf	SUP11perf	SUP12perf
26	2	2	3	2	3	3	3	3	4	4	4	4	4	4	4	4	4
27	2	2	3	2	3	4	4	4	4	5	5	3	3	5	5	3	5
28	1	2	2	2	1	6	6	6	6	6	6	6	6	6	6	6	6
29	1	2	2	2	1	6	6	6	6	6	6	5	5	6	6	6	6
30	1	3	3	2	1	4	4	4	6	4	5	3	3	4	4	4	4
31	1	2	3	3	1	5	5	5	5	5	5	5	4	5	5	5	5
32	1	3	3	3	1	6	6	6	6	6	6	6	4	5	6	6	6
33	1	2	3	3	1	5	5	5	5	5	5	5	4	5	5	5	5
34	1	2	3	3	1	4	4	4	4	4	4	4	4	4	4	4	4
35	1	2	3	3	1	4	4	4	5	5	5	3	3	4	4	4	5
36	1	2	3	3	1	6	6	6	6	6	6	6	4	5	6	6	6
37	3	2	1	2	1	5	5	5	5	4	5	5	6	5	6	6	5
38	3	2	1	2	1	4	4	4	5	5	4	5	6	5	6	6	5
39	3	2	1	1	1	5	5	5	6	5	5	4	4	5	5	5	5
40	3	2	1	1	1	5	5	5	5	4	5	4	4	5	6	5	5
41	3	1	1	1	1	4	4	4	3	5	5	5	5	4	5	5	5
42	3	1	1	1	1	4	4	4	3	5	5	3	3	4	5	4	4
43	3	2	1	1	1	5	5	5	5	5	4	5	5	4	5	5	5
44	3	2	1	1	1	5	5	5	5	5	5	3	3	5	5	4	3
45	5	2	1	3	1	5	6	6	5	5	5	5	6	6	6	6	6
46	5	2	1	3	1	5	6	6	6	2	5	4	5	5	5	5	5
47	5	2	1	3	1	5	5	5	5	3	5	5	6	6	6	6	6
48	5	2	1	3	1	5	6	6	6	2	5	4	5	5	5	5	5
49	3	2	3	2	1	6	5	3	6	6	6	6	5	6	5	5	6
50	3	2	3	2	1	6	5	3	6	6	6	6	5	6	5	5	6

ID: Questionnaire number,

SD: Construction site distance from rebar supplier (1: 0-10km, 2: 10-30km, 3: 30-50KM, 4: More than 50km)

PT: Project type (1:Residential, 2:Commercial, 3:Education, 4:Health, 5:Other)

RP: Rebar preparation place (1: on-site, 2: off-site, 3: both)

PS: Project size (1:small, 2:medium, 3:big)

PL: Project location (1:high density urban area, 2:low density urban area, 3:suburban area)

Table C.5 Raw data for project characteristics and supplier related factors (continued)

ID	PT	PS	PL	SD	RPP	SUP1perf	SUP2perf	SUP3perf	SUP4perf	SUP5perf	SUP6perf	SUP7perf	SUP8perf	SUP9perf	SUP10perf	SUP11perf	SUP12perf
51	1	3	2	2	1	6	6	6	5	6	6	6	6	6	6	5	6
52	1	3	2	2	1	5	5	5	5	5	5	5	5	5	5	5	5
53	1	3	2	2	1	5	5	5	5	5	5	3	3	5	6	3	3
54	1	1	1	2	1	5	5	5	3	5	5	3	4	5	6	4	5
55	1	1	1	2	1	4	4	4	3	4	5	5	4	5	4	4	4
56	1	1	1	2	1	4	4	4	4	4	4	4	4	4	5	3	4
57	1	1	1	2	1	6	6	6	4	5	5	5	4	6	6	5	6
58	5	2	1	2	1	4	4	4	5	4	5	3	4	5	5	5	5
59	5	2	1	2	1	4	4	4	5	4	5	5	4	5	5	5	5
60	5	2	1	2	1	4	4	4	6	4	5	3	4	5	5	5	5
61	3	2	1	1	1	4	4	4	5	5	5	4	4	4	5	4	4
62	3	2	1	1	1	4	4	3	4	4	3	5	4	5	5	5	5
63	3	1	3	3	2	2	3	3	3	4	5	2	5	5	4	3	5
64	3	2	3	3	2	3	3	3	3	4	5	4	4	5	5	4	4
65	3	1	3	3	2	2	4	6	3	5	6	2	4	5	6	4	5
66	5	2	2	1	1	5	6	6	5	5	6	5	6	6	6	6	6
67	3	2	1	1	1	5	6	6	5	5	6	5	6	6	6	6	6
68	3	2	1	1	1	4	4	4	4	4	4	4	3	4	4	4	4
69	3	2	1	1	1	4	4	3	4	4	3	5	4	5	5	5	5
70	2	2	3	3	1	5	5	5	5	5	5	4	4	5	5	5	4
71	2	2	3	3	1	6	6	6	6	6	6	6	6	6	6	6	6
72	1	1	2	2	1	5	5	5	4	5	5	4	4	5	5	5	3
73	1	1	2	2	1	5	5	5	4	5	5	5	5	5	5	3	5
74	1	1	2	2	1	6	6	6	6	6	6	6	6	6	6	6	6
75	1	3	3	3	1	4	4	4	5	2	5	3	3	4	5	4	4

ID: Questionnaire number,

SD: Construction site distance from rebar supplier (1: 0-10km, 2: 10-30km, 3: 30-50KM, 4: More than 50km)

PT: Project type (1:Residential, 2:Commercial, 3:Education, 4:Health, 5:Other)

RP: Rebar preparation place (1: on-site, 2: off-site, 3: both)

PS: Project size (1:small, 2:medium, 3:big)

PL: Project location (1:high density urban area, 2:low density urban area, 3:suburban area)

Table C.5 Raw data for project characteristics and supplier related factors (continued)

ID	PT	PS	PL	SD	RPP	SUP1perf	SUP2perf	SUP3perf	SUP4perf	SUP5perf	SUP6perf	SUP7perf	SUP8perf	SUP9perf	SUP10perf	SUP11perf	SUP12perf
76	1	3	3	3	1	5	5	5	5	3	4	4	4	5	5	4	4
77	1	2	2	1	1	4	4	4	4	4	4	3	4	4	4	4	4
78	1	2	2	1	1	5	6	5	3	5	4	3	4	5	5	4	3
79	5	3	2	1	3	5	5	5	6	5	5	4	5	5	6	5	6
80	5	3	2	1	3	5	5	5	6	5	5	3	3	5	6	3	3
81	1	3	2	1	3	5	6	6	5	5	5	5	5	6	5	6	6
82	1	2	1	1	1	4	5	5	3	4	4	4	3	4	4	5	5
83	1	2	1	1	1	4	4	3	5	5	3	3	3	5	4	4	4
84	2	3	3	3	1	5	5	5	5	5	5	4	4	4	4	4	3
85	2	3	3	3	1	5	5	5	6	3	5	4	4	5	5	4	4
86	2	3	3	3	1	6	6	6	6	6	6	6	6	6	6	6	6
87	1	3	2	2	1	6	6	6	6	5	6	4	4	6	6	4	4
88	1	3	2	2	1	5	5	5	5	5	5	5	5	5	5	5	5
89	3	2	2	2	1	5	5	5	5	6	6	5	4	5	6	4	4
90	3	2	2	2	1	5	5	5	4	5	5	4	4	5	5	4	4
91	4	2	2	2	1	4	4	4	5	4	4	3	3	5	5	5	4
92	4	2	2	2	1	5	5	5	5	5	4	3	4	5	4	4	4
93	3	3	1	1	1	4	4	4	6	5	5	4	4	4	5	5	5
94	3	3	1	1	1	4	4	4	5	5	5	5	4	5	5	5	5
95	3	2	1	2	1	5	5	5	5	5	6	5	5	5	5	5	5
96	1	3	2	2	1	4	4	4	6	5	5	3	3	4	5	5	5
97	1	2	1	2	1	5	5	5	5	5	5	3	3	5	5	4	4
98	1	2	1	2	1	5	5	5	5	5	5	3	3	4	5	5	5
99	1	2	1	2	1	5	5	5	6	5	6	3	3	5	5	4	4
100	2	3	3	3	3	6	6	6	6	4	6	2	3	5	5	4	4

ID: Questionnaire number,

SD: Construction site distance from rebar supplier (1: 0-10km, 2: 10-30km, 3: 30-50KM, 4: More than 50km)

PT: Project type (1:Residential, 2:Commercial, 3:Education, 4:Health, 5:Other)

RP: Rebar preparation place (1: on-site, 2: off-site, 3: both)

PS: Project size (1:small, 2:medium, 3:big)

PL: Project location (1:high density urban area, 2:low density urban area, 3:suburban area)

Table C.5 Raw data for project characteristics and supplier related factors (continued)

ID	PT	PS	PL	SD	RPP	SUP1perf	SUP2perf	SUP3perf	SUP4perf	SUP5perf	SUP6perf	SUP7perf	SUP8perf	SUP9perf	SUP10perf	SUP11perf	SUP12perf
101	2	3	3	3	3	5	5	5	6	5	5	2	3	6	5	5	5
102	2	3	3	3	3	5	5	5	6	4	5	3	3	5	5	4	4
103	2	3	3	3	3	5	5	5	6	5	5	2	3	6	5	5	5
104	1	2	2	2	3	5	5	5	5	5	5	5	5	5	5	5	5
105	1	2	2	2	3	4	4	4	4	4	4	4	4	4	4	4	4
106	3	3	2	2	3	5	5	5	5	5	5	5	5	5	5	5	5
107	3	3	2	2	3	5	5	5	6	5	5	5	5	5	5	5	5
108	2	3	1	2	1	6	6	4	5	5	4	5	6	6	6	6	5
109	5	1	2	1	2	4	4	4	4	4	4	1	1	5	4	2	3
110	5	1	2	1	2	5	6	5	5	4	5	6	5	5	6	5	6
111	4	3	2	2	3	6	6	5	6	5	5	6	6	6	6	6	6
112	4	3	2	2	3	6	6	5	6	5	5	6	6	6	6	6	6
113	1	2	2	2	3	6	6	5	6	5	5	6	6	6	6	6	6
114	1	2	2	2	3	6	6	5	6	5	5	6	6	5	6	6	6
115	5	1	3	3	1	6	6	6	6	4	6	6	6	6	6	4	4

ID: Questionnaire number,

SD: Construction site distance from rebar supplier (1: 0-10km, 2: 10-30km, 3: 30-50KM, 4: More than 50km)

PT: Project type (1:Residential, 2:Commercial, 3:Education, 4:Health, 5:Other)

RP: Rebar preparation place (1: on-site, 2: off-site, 3: both)

PS: Project size (1:small, 2:medium, 3:big)

PL: Project location (1:high density urban area, 2:low density urban area, 3:suburban area)

Table C.6 Raw data for project characteristics and AE company related factors

ID	PT	PS	PL	SD	RPP	AE1perf	AE2perf	AE3perf	AE4perf	AE5perf	AE6perf	AE7perf
1	1	2	1	1	1	5	5	5	5	4	4	5
2	1	2	3	1	1	4	4	5	4	5	5	5
3	1	2	2	1	1	4	3	4	4	4	3	4
4	1	2	1	1	1	4	4	4	4	5	5	5
5	1	3	2	2	1	5	5	6	6	6	5	6
6	1	3	2	2	1	5	5	5	5	5	6	6
7	2	3	3	3	3	4	4	4	4	4	5	6
8	2	3	3	3	3	5	5	5	6	5	5	6
9	1	3	2	2	1	5	5	5	5	5	4	6
10	1	2	2	2	1	5	5	5	5	5	5	6
11	1	2	2	2	1	4	6	6	4	6	4	6
12	1	3	2	2	1	5	5	5	5	5	5	6
13	1	3	2	1	1	5	6	5	5	5	6	6
14	1	3	2	1	1	5	5	4	5	5	6	6
15	1	2	2	2	3	3	4	3	5	4	5	4
16	1	2	2	2	3	3	4	3	5	4	5	4
17	1	3	2	1	1	5	5	5	6	5	5	6
18	1	2	2	1	3	4	4	4	4	4	4	5
19	2	3	3	1	1	6	6	6	6	6	6	1
20	4	3	2	1	1	6	6	6	6	6	6	1
21	4	3	2	1	1	4	4	5	5	5	5	5
22	4	3	2	1	1	5	5	5	5	5	3	3
23	2	2	3	4	3	2	2	2	3	3	2	2
24	2	2	3	4	3	2	2	2	3	3	3	3
25	2	2	3	4	3	2	2	2	3	2	2	2

ID: Questionnaire number.

SD: Construction site distance from rebar supplier (1: 0-10km, 2: 10-30km, 3: 30-50KM, 4: More than 50km)

PT: Project type (1:Residential, 2:Commercial, 3:Education, 4:Health, 5:Other)

RP: Rebar preparation place (1: on-site, 2: off-site, 3: both)

PS: Project size (1:small, 2:medium, 3:big)

PL: Project location (1:high density urban area, 2:low density urban area, 3:suburban area)

Table C.6 Raw data for project characteristics and AE company related factors (continued)

ID	PT	PS	PL	SD	RPP	AE1perf	AE2perf	AE3perf	AE4perf	AE5perf	AE6perf	AE7perf
26	2	2	3	2	3	3	3	3	3	3	3	3
27	2	2	3	2	3	5	5	5	5	5	5	5
28	1	2	2	2	1	5	5	5	5	6	6	6
29	1	2	2	2	1	5	5	5	5	6	5	5
30	1	3	3	2	1	5	5	5	6	5	4	4
31	1	2	3	3	1	5	5	5	5	5	4	5
32	1	3	3	3	1	5	5	4	5	5	6	6
33	1	2	3	3	1	5	5	5	5	5	4	4
34	1	2	3	3	1	4	4	4	4	3	3	4
35	1	2	3	3	1	5	5	5	5	5	4	4
36	1	2	3	3	1	5	5	4	5	5	6	6
37	3	2	1	2	1	1	1	1	5	4	6	4
38	3	2	1	2	1	4	4	4	4	4	4	5
39	3	2	1	1	1	3	3	3	3	2	2	4
40	3	2	1	1	1	4	4	4	4	4	1	1
41	3	1	1	1	1	2	2	2	2	2	1	2
42	3	1	1	1	1	4	4	4	4	4	3	3
43	3	2	1	1	1	1	1	1	2	3	1	4
44	3	2	1	1	1	4	4	4	4	4	2	2
45	5	2	1	3	1	1	1	2	3	4	1	5
46	5	2	1	3	1	1	1	1	3	3	2	5
47	5	2	1	3	1	1	1	1	3	3	1	5
48	5	2	1	3	1	1	1	1	3	3	2	4
49	3	2	3	2	1	5	4	4	3	6	3	6
50	3	2	3	2	1	2	2	2	3	5	2	5

ID: Questionnaire number.

SD: Construction site distance from rebar supplier (1: 0-10km, 2: 10-30km, 3: 30-50KM, 4: More than 50km)

PT: Project type (1:Residential, 2:Commercial, 3:Education, 4:Health, 5:Other)

RP: Rebar preparation place (1: on-site, 2: off-site, 3: both)

PS: Project size (1:small, 2:medium, 3:big)

PL: Project location (1:high density urban area, 2:low density urban area, 3:suburban area)

Table C.6 Raw data for project characteristics and AE company related factors (continued)

ID	PT	PS	PL	SD	RPP	AE1perf	AE2perf	AE3perf	AE4perf	AE5perf	AE6perf	AE7perf
51	1	3	2	2	1	6	6	6	6	4	4	6
52	1	3	2	2	1	6	6	6	6	4	4	6
53	1	3	2	2	1	5	5	5	5	4	4	4
54	1	1	1	2	1	4	4	4	3	4	4	4
55	1	1	1	2	1	4	4	4	4	4	4	4
56	1	1	1	2	1	3	3	3	4	4	3	4
57	1	1	1	2	1	4	4	4	4	4	3	4
58	5	2	1	2	1	5	5	5	5	5	5	5
59	5	2	1	2	1	5	5	5	5	5	4	5
60	5	2	1	2	1	4	4	4	4	4	4	4
61	3	2	1	1	1	3	3	3	3	3	3	3
62	3	2	1	1	1	4	4	4	3	1	1	1
63	3	1	3	3	2	1	1	3	4	4	3	3
64	3	2	3	3	2	2	2	2	4	3	4	4
65	3	1	3	3	2	2	2	2	3	3	3	3
66	5	2	2	1	1	1	1	2	3	3	1	5
67	3	2	1	1	1	1	1	2	3	4	1	5
68	3	2	1	1	1	3	3	3	3	3	3	3
69	3	2	1	1	1	2	2	2	2	1	1	1
70	2	2	3	3	1	5	5	5	4	4	5	5
71	2	2	3	3	1	5	5	5	5	5	4	5
72	1	1	2	2	1	6	6	6	6	6	6	6
73	1	1	2	2	1	5	5	5	6	5	3	3
74	1	1	2	2	1	5	5	5	5	5	5	5
75	1	3	3	3	1	5	5	5	5	4	4	6

ID: Questionnaire number**SD:** Construction site distance from rebar supplier (1: 0-10km, 2: 10-30km, 3: 30-50KM, 4: More than 50km)**PT:** Project type (1:Residential, 2:Commercial, 3:Education, 4:Health, 5:Other)**RP:** Rebar preparation place (1: on-site, 2: off-site, 3: both)**PS:** Project size (1:small, 2:medium, 3:big)**PL:** Project location (1:high density urban area, 2:low density urban area, 3:suburban area)

Table C.6 Raw data for project characteristics and AE company related factors (continued)

ID	PT	PS	PL	SD	RPP	AE1perf	AE2perf	AE3perf	AE4perf	AE5perf	AE6perf	AE7perf
76	1	3	3	3	1	5	5	5	5	5	5	5
77	1	2	2	1	1	5	5	5	4	4	5	5
78	1	2	2	1	1	5	4	4	4	5	5	6
79	5	3	2	1	3	4	4	3	4	4	5	5
80	5	3	2	1	3	5	5	5	5	5	5	5
81	1	3	2	1	3	2	3	3	5	4	5	6
82	1	2	1	1	1	5	5	5	5	4	4	5
83	1	2	1	1	1	4	4	5	4	5	5	5
84	2	3	3	3	1	5	5	5	4	4	6	6
85	2	3	3	3	1	5	4	4	4	5	5	6
86	2	3	3	3	1	5	5	5	5	4	5	5
87	1	3	2	2	1	5	5	6	6	6	5	6
88	1	3	2	2	1	5	5	5	5	5	5	6
89	3	2	2	2	1	5	5	5	5	4	6	6
90	3	2	2	2	1	4	6	4	3	4	5	6
91	4	2	2	2	1	4	4	4	5	3	5	5
92	4	2	2	2	1	5	3	5	4	4	6	6
93	3	3	1	1	1	2	2	2	3	3	2	5
94	3	3	1	1	1	2	2	2	3	2	2	2
95	3	2	1	2	1	1	1	1	3	4	3	3
96	1	3	2	2	1	5	5	5	5	5	6	6
97	1	2	1	2	1	6	6	6	6	6	6	6
98	1	2	1	2	1	6	6	6	6	6	6	6
99	1	2	1	2	1	6	6	6	6	6	6	6
100	2	3	3	3	3	3	3	3	3	3	5	5

ID: Questionnaire number**SD:** Construction site distance from rebar supplier (1: 0-10km, 2: 10-30km, 3: 30-50KM, 4: More than 50km)**PT:** Project type (1:Residential, 2:Commercial, 3:Education, 4:Health, 5:Other)**RP:** Rebar preparation place (1: on-site, 2: off-site, 3: both)**PS:** Project size (1:small, 2:medium, 3:big)**PL:** Project location (1:high density urban area, 2:low density urban area, 3:suburban area)

Table C.6 Raw data for project characteristics and AE company related factors (continued)

ID	PT	PS	PL	SD	RPP	AE1perf	AE2perf	AE3perf	AE4perf	AE5perf	AE6perf	AE7perf
101	2	3	3	3	3	4	3	4	5	4	5	5
102	2	3	3	3	3	4	4	4	4	4	5	5
103	2	3	3	3	3	4	4	4	4	4	4	4
104	1	2	2	2	3	4	4	4	4	3	2	5
105	1	2	2	2	3	4	4	4	4	4	4	4
106	3	3	2	2	3	3	3	3	3	3	2	5
107	3	3	2	2	3	4	4	4	4	4	4	5
108	2	3	1	2	1	6	5	4	4	5	5	4
109	5	1	2	1	2	1	1	3	3	3	2	4
110	5	1	2	1	2	5	6	5	5	5	6	6
111	4	3	2	2	3	4	4	4	6	4	6	6
112	4	3	2	2	3	5	4	5	5	4	5	5
113	1	2	2	2	3	5	4	5	5	4	5	5
114	1	2	2	2	3	5	5	5	6	4	6	6
115	5	1	3	3	1	3	6	6	3	6	5	3

ID: Questionnaire number

SD: Construction site distance from rebar supplier (1: 0-10km, 2: 10-30km, 3: 30-50KM, 4: More than 50km)

PT: Project type (1:Residential, 2:Commercial, 3:Education, 4:Health, 5:Other)

RP: Rebar preparation place (1: on-site, 2: off-site, 3: both)

PS: Project size (1:small, 2:medium, 3:big)

PL: Project location (1:high density urban area, 2:low density urban area, 3:suburban area)

Table C.7 Raw data for project characteristics and external factors

ID	PT	PS	PL	SD	RPP	EXT1perf	EXT2perf	EXT3perf	EXT4perf	EXT5perf	EXT6perf
1	1	2	1	1	1	4	5	5	4	5	6
2	1	2	3	1	1	3	5	5	5	3	4
3	1	2	2	1	1	3	4	5	3	5	5
4	1	2	1	1	1	5	5	4	4	4	5
5	1	3	2	2	1	6	6	6	5	6	6
6	1	3	2	2	1	5	5	4	4	5	3
7	2	3	3	3	3	5	3	4	5	5	3
8	2	3	3	3	3	5	5	4	4	3	3
9	1	3	2	2	1	5	5	4	1	5	6
10	1	2	2	2	1	5	5	1	1	5	1
11	1	2	2	2	1	5	6	6	1	6	6
12	1	3	2	2	1	5	5	1	1	6	2
13	1	3	2	1	1	6	5	5	4	4	3
14	1	3	2	1	1	5	5	5	5	5	3
15	1	2	2	2	3	2	4	4	4	4	4
16	1	2	2	2	3	1	4	3	3	5	4
17	1	3	2	1	1	6	5	5	6	5	5
18	1	2	2	1	3	6	6	6	6	6	4
19	2	3	3	1	1	6	6	5	6	6	6
20	4	3	2	1	1	6	6	4	6	6	1
21	4	3	2	1	1	5	5	1	1	5	2
22	4	3	2	1	1	4	4	3	3	5	5
23	2	2	3	4	3	5	2	2	2	2	4
24	2	2	3	4	3	4	4	1	1	3	1
25	2	2	3	4	3	3	3	3	2	4	2
26	2	2	3	2	3	4	4	4	4	4	4
27	2	2	3	2	3	5	5	4	4	5	5
28	1	2	2	2	1	5	6	5	5	4	5
29	1	2	2	2	1	5	6	4	5	5	5
30	1	3	3	2	1	5	4	3	4	4	4
31	1	2	3	3	1	5	5	4	4	5	4
32	1	3	3	3	1	5	5	5	5	5	3
33	1	2	3	3	1	5	5	4	4	5	4
34	1	2	3	3	1	5	5	4	4	5	5
35	1	2	3	3	1	5	5	4	4	5	4
36	1	2	3	3	1	5	5	5	5	5	3
37	3	2	1	2	1	5	5	3	4	4	4
38	3	2	1	2	1	5	5	3	4	4	4
39	3	2	1	1	1	4	4	3	3	5	5

ID: Questionnaire number

PT: Project type (1:Residential, 2:Commercial, 3:Education, 4:Health, 5:Other)

PS: Project size (1:small, 2:medium, 3:big)

PL: Project location (1:high density urban area, 2:low density urban area, 3:suburban area)

SD: Construction site distance from rebar supplier (1: 0-10km, 2: 10-30km, 3: 30-50km, 4: More than 50km)

RP: Rebar preparation place (1: on-site, 2: off-site, 3: both)

Table C.7 Raw data for project characteristics and external factors (continued)

ID	PT	PS	PL	SD	RPP	EXT1perf	EXT2perf	EXT3perf	EXT4perf	EXT5perf	EXT6perf
40	3	2	1	1	1	5	5	3	4	4	5
41	3	1	1	1	1	4	2	4	3	3	4
42	3	1	1	1	1	4	4	4	4	4	3
43	3	2	1	1	1	4	4	4	4	4	4
44	3	2	1	1	1	5	5	3	4	4	4
45	5	2	1	3	1	6	6	3	3	3	4
46	5	2	1	3	1	5	5	4	4	5	5
47	5	2	1	3	1	6	5	4	4	5	5
48	5	2	1	3	1	5	5	4	4	5	5
49	3	2	3	2	1	6	6	6	3	6	6
50	3	2	3	2	1	6	6	6	5	6	6
51	1	3	2	2	1	6	6	6	5	5	5
52	1	3	2	2	1	5	5	1	5	5	3
53	1	3	2	2	1	5	5	3	5	5	4
54	1	1	1	2	1	4	2	3	3	4	4
55	1	1	1	2	1	3	3	3	4	4	4
56	1	1	1	2	1	4	2	3	3	4	4
57	1	1	1	2	1	4	2	3	3	4	4
58	5	2	1	2	1	3	4	3	3	4	4
59	5	2	1	2	1	3	3	3	3	3	3
60	5	2	1	2	1	4	5	3	3	4	4
61	3	2	1	1	1	5	5	4	4	4	4
62	3	2	1	1	1	5	5	4	4	4	4
63	3	1	3	3	2	3	2	3	3	4	4
64	3	2	3	3	2	5	5	3	3	5	3
65	3	1	3	3	2	3	4	6	2	2	6
66	5	2	2	1	1	6	6	3	3	2	5
67	3	2	1	1	1	6	6	3	3	2	5
68	3	2	1	1	1	4	4	3	2	4	3
69	3	2	1	1	1	4	4	3	3	3	3
70	2	2	3	3	1	5	4	4	5	5	5
71	2	2	3	3	1	6	6	4	4	6	6
72	1	1	2	2	1	5	5	5	5	5	5
73	1	1	2	2	1	5	5	3	3	5	2
74	1	1	2	2	1	6	6	4	4	6	6
75	1	3	3	3	1	4	3	2	3	4	2
76	1	3	3	3	1	4	2	3	3	4	2
77	1	2	2	1	1	4	5	2	2	5	2
78	1	2	2	1	1	3	5	3	5	4	6
79	5	3	2	1	3	5	4	4	4	5	4

ID: Questionnaire number,

PT: Project type (1:Residential, 2:Commercial, 3:Education, 4:Health, 5:Other)

PS: Project size (1:small, 2:medium, 3:big)

PL: Project location (1:high density urban area, 2:low density urban area, 3:suburban area)

SD: Construction site distance from rebar supplier (1: 0-10km, 2: 10-30km, 3: 30-50km, 4: More than 50km)

RP: Rebar preparation place (1: on-site, 2: off-site, 3: both)

Table C.7 Raw data for project characteristics and external factors (continued)

ID	PT	PS	PL	SD	RPP	EXT1perf	EXT2perf	EXT3perf	EXT4perf	EXT5perf	EXT6perf
80	5	3	2	1	3	4	4	3	3	3	3
81	1	3	2	1	3	6	6	3	4	4	4
82	1	2	1	1	1	4	5	5	4	5	5
83	1	2	1	1	1	5	6	3	3	3	3
84	2	3	3	3	1	5	4	4	5	5	5
85	2	3	3	3	1	3	5	3	5	4	4
86	2	3	3	3	1	6	6	3	3	3	4
87	1	3	2	2	1	6	6	4	4	6	6
88	1	3	2	2	1	5	5	4	4	5	3
89	3	2	2	2	1	6	6	4	4	6	6
90	3	2	2	2	1	5	5	4	4	5	3
91	4	2	2	2	1	4	5	3	2	5	4
92	4	2	2	2	1	4	4	4	4	4	1
93	3	3	1	1	1	6	6	3	4	3	4
94	3	3	1	1	1	5	6	4	4	5	4
95	3	2	1	2	1	5	5	4	4	4	5
96	1	3	2	2	1	5	5	5	2	5	5
97	1	2	1	2	1	5	5	5	2	5	5
98	1	2	1	2	1	5	5	5	2	5	5
99	1	2	1	2	1	5	5	5	2	5	5
100	2	3	3	3	3	5	5	1	1	4	2
101	2	3	3	3	3	5	4	1	2	5	2
102	2	3	3	3	3	5	5	1	1	5	1
103	2	3	3	3	3	5	4	1	2	5	2
104	1	2	2	2	3	5	4	4	4	4	4
105	1	2	2	2	3	4	5	4	3	3	3
106	3	3	2	2	3	5	4	4	4	4	4
107	3	3	2	2	3	5	5	4	3	3	3
108	2	3	1	2	1	3	5	3	6	5	6
109	5	1	2	1	2	5	2	2	2	3	2
110	5	1	2	1	2	6	5	5	4	4	3
111	4	3	2	2	3	5	6	6	6	6	6
112	4	3	2	2	3	5	6	6	6	6	6
113	1	2	2	2	3	5	6	6	6	6	6
114	1	2	2	2	3	5	6	6	6	6	6
115	5	1	3	3	1	6	6	6	6	6	4

ID: Questionnaire number,

PT: Project type (1:Residential, 2:Commercial, 3:Education, 4:Health, 5:Other)

PS: Project size (1:small, 2:medium, 3:big)

PL: Project location (1:high density urban area, 2:low density urban area, 3:suburban area)

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RP: Rebar preparation place (1: on-site, 2: off-site, 3: both)

CURRICULUM VITAE

PERSONAL INFORMATION

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Date and Place of Birth: 15.12.1978, Urfa

Marital Status: Married

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EDUCATION

Degree	Institution	Year of Graduation
MS	ITU Building Science	2003
BS	ITU Management Engineering	2002
BS	ITU Architecture	2000
High School	Yukselis College, Ankara	1996

WORK EXPERIENCE

Year	Place	Enrollment
2011-	Zirve University Faculty of Architecture and Design	Research Assistant
2010-2011	Ender İnşaat	Chief (Detailed design)
2002-2011	ARY İnşaat	Site Chief
2000-2001	Ariköy Construction Coop.	Architect

FOREIGN LANGUAGES

Advanced English, Basic German and Arabic