

**IMPORTANCE OF SUPPLIER SELECTION IN CONSTRUCTION PROJECTS:  
CASE OF TURKEY**

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**İNŞAAT PROJELERİNDE TEDARİKÇİ SEÇİMİNİN ÖNEMİ: TÜRKİYE ÖRNEĞİ**

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# **IMPORTANCE OF SUPPLIER SELECTION IN CONSTRUCTION PROJECTS: CASE OF TURKEY**

## **ABSTRACT**

The construction industry, which has grown rapidly in recent years, has been under the influence of globalization like other sectors. With globalization, the removal of borders and increasing competition cause contractors to lose large-scale jobs due to very small cost differences. For this reason, the importance of cost studies carried out during the project phase is increasing day by day. This is a fact that project cost is extremely important for all sectors. However, cost estimation and analysis studies have critical importance for the construction industry due to the high costs in question.

In this study, the effect of supplier selection on project cost is analyzed for Turkish construction sector. The aim of this study is to determine which criteria are important in the supplier selection of the projects realized in the Turkish construction sector. Within the scope of the study, a questionnaire was carried out with professionals in construction. The analysis of the results reveals the most important factors in supplier selection and it is thought that it will be beneficial to those related to this issue.

**Keywords:** construction, construction project, supply chain, supplier selection.



# İNŞAAT PROJELERİNDE TEDARİKÇİ SEÇİMİNİN ÖNEMİ: TÜRKİYE ÖRNEĞİ

## ÖZET

Son yıllarda hızlı bir büyüme gösteren inşaat sektörü, diğer sektörler gibi küreselleşmenin etkisi altına girmiştir. Küreselleşme ile sınırların kalkması ve artan rekabet, yüklenicilerin büyük kapsamlı işleri çok küçük maliyet farklılıkları sebebiyle kaybetmelerine neden olmaktadır. Bu nedenle proje aşamasında yürütülen maliyet analizi çalışmalarının önemi günden güne artmaktadır. Proje maliyeti, bütün sektörler için son derece önemlidir. Ancak inşaat sektörü için söz konusu maliyetlerin büyüklüğü sebebiyle maliyet tahmin ve analiz çalışmaları kritik derecede önem taşımaktadır.

Bu çalışmada, Türk inşaat sektörü için tedarikçi seçiminin proje maliyetine etkisi incelenmiştir. Tez çalışması kapsamında detaylı bir literatür taraması sunulmuş, tedarik zinciri ve inşaat projeleri ile ilgili kavramlara dair ayrıntılı bilgi verilmiş ve çeşitli analizler yapılmıştır. Bu çalışmanın amacı, Türk inşaat sektöründe gerçekleştirilen projelerin tedarikçi seçiminde hangi kriterlerin önemli olduğunu belirlemektir. Çalışma kapsamında inşaat sektöründeki profesyonellerle bir anket yapılmıştır. Sonuçların analizi tedarikçi seçiminde en önemli faktörleri ortaya koymakta ve bu konu ile ilgili olanlara faydalı olacağı düşünülmektedir..

**Anahtar kelimeler:** inşaat, inşaat projesi, tedarik zinciri, tedarikçi seçimi.



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# 1. INTRODUCTION

Obtain is the dictionary meaning of the word “supply”. The activities actualized to find and purchase the raw materials, auxiliary materials and capital goods required in the production process can be explained by the concept of supply in terms of businesses. (Palamutçuoğlu, 2011).

A supply chain takes place on a network of diversified internal actors such as suppliers, producers, distributors, retailers and wholesalers. The system manages information and the flow of goods in order to provide that all business processes from raw material supply to distribution and marketing of products to end consumers move in harmony can be defined as an integrated system (Paksoy, 2005).

In general, the supply chain covers the processes starting from the raw material source to the delivery of the product to the customer. These processes are basically procurement, manufacture, inventory, location and portage activities. It is inevitable for companies to make their supply chains effective and efficient in order to adapt to the changes they encounter (Şerbetçioğlu, 2007).

As supply chain members; raw material suppliers, sub-industry product suppliers, sub-assembly suppliers, product and service producers, logistics service providers, distributors, wholesalers, dealers, retailers and ultimate consumers can be listed (Palamutçuoğlu, 2011). Product flow, return flow and cash flow occur within this chain. In addition, activities such as demand prediction, order management, manufacture planning, inventory management, purchasing management, supplier management, returns management, warehouse management, portage planning and customer relations are actualized (Tanyaş, 2004).

Companies aim to increase their competitiveness with an effective supply chain management. The more efficient the supply chain of the companies, the more their competitive power increases. This competitive power ensures that customer expectations that have increased with globalization can be met. In the construction sector, supply chain management can be aforementioned as in the production sector. Generally, the high use of outsourcing in construction ensures the adoption and implementation of the construction supply chain

management. However, as the concept of construction supply chain management is quite new, it is quite open to development.

In the literature, it is seen that the concept of supply chain is generally used in the manufacturing industry. The concept of supply management serves a similar purpose in the construction industry. The goals of reducing costs, increasing quality and improving all processes from the delivery of the final product to the customer have led companies to supply chain management.

The supply chain structure in the construction sector is different than in the manufacturing industry. The process starts from the actual request of the customer and ends with the delivery of the product. This process is much longer compared to the manufacturing industry. In fact, after the delivery of the building, there is a long process that continues until the maintenance, renovation and finally demolition. Failure to supply the materials at the requested time, in the requested quantity and attributes during the construction phase is a problem encountered in the management of material activities and costs. In general, in construction projects with time constraints, the project cost comes to the fore so that the production is not interrupted and its importance is increasingly understood. Project cost is extremely important for all sectors. However, cost estimation and analysis studies are of critical importance for the construction sector due to the high costs in question.

In recent years, there has been an increase in the number of scientific studies on supply chain management. However, it is possible to say that the studies approaching the subject in terms of the construction sector are limited. Moreover, when looking at the literature, it is noteworthy that there are few studies examining the effect of supplier selection on project costs. In this context, it is hoped that this study will raise awareness on the subject by revealing the importance of supply chain management on the project cost and will not contribute positively to the basic elements of the sector and the literature.

## **1.1. Aim of the Study**

In construction, which is a locomotive sector in the country's economy, it is a very important issue to complete a project in a determined time, cost and quality. In this context, choosing the right supplier is extremely important in the success of the project. This study focuses on the supply chain management to raise awareness in the construction industry.

The aim of this study is to determine which criteria are important in the supplier selection of the projects realized in the Turkish construction sector. Therefore, the study seeks answers to the following questions;

- How is the supplier selection made in companies?
- How is the material managed and supplied?
- Is there any existing system for supplier selection?
- What is the effect of supplier selection on project cost?

The results of the study are expected to provide valuable information to those interested in procurement in the construction industry.

## **1.2. Research Method**

In order to achieve the aim of the study, the research method is as follows;

- Literature review on supply chain and supply chain management to understand the concepts and principles,
- Literature review on construction supply chain management to realize how supply chain is handled in construction and also to discuss different approaches to this issue.
- A questionnaire survey is carried out with project managers, purchase managers, engineers and chiefs to analyse the current supplier selection status in Turkish construction sector.

Data obtained from the questionnaire are analyzed using the SPSS program and results are presented.



## **2. SUPPLY CHAIN AND SUPPLY CHAIN MANAGEMENT**

### **2.1. Definition of Supply Chain**

The supply chain is a network of autonomous or semi-autonomous business activities collectively responsible for one or more product groups (Jayashankar et al., 1996). In addition, the supply chain is a structure that obtains raw materials, and transforms them into semi-finished manufactures and then delivers these manufactures to customers through a distribution system (Lee and Billington, 1995).

As a usual description, the supply chain is a series of activities with corporate functions, from ordering and procuring raw materials to manufacturing manufactures and distributing and delivering to the customer. At this point, a simple supply chain example for a single production can be given: In this chain, raw materials are supplied from the sellers. They are converted into the ended products in one-step, and then they are moved to distribution points and lastly to customers. Real supply chains contain many completed manufactures with common components, manufacture tools and capacities (Ganeshan and Harrison, 1995).

The supply chain includes a product, service and information flow of all these components from the source to the consumer in the chain (Verma and Seth, 2010). As an another definition, the supply chain is an integrated process to be created by many businesses such as supplier, producer, distributor, and retailer to turn the raw materials into the end manufactures and distribute them to the end users (Mula et al. 2010).

The supply chain is a system in which more than one supplier and intermediaries are involved and beyond which products, information, financial resources, risks and information flow, which is intended to meet the necessities of the end user. Throughout this chain, procurement, product design, production, transportation, repair, storage and sales activities are carried out (John, 2011).

Supply chain involves the keeping the balance in supply and demand, the supply of raw materials, manufacture montage, warehousing, inventory management, order management and delivery of manufactures to customers and so on and contains information systems required for all of these activities will be maintained (Verma and Seth, 2011).

Fundamentals of supply chain concept base on the physical distribution concept that symbolizes the external logistic activities of the company and aiming to reach the end product, of which production has been completed, to the end user in a cost-effective attitude. The purpose of the concept of physical distribution is to keep the balance between the costs such as stock availability, handling, warehousing, and portage costs by selecting the suitable transport method according to the structure of the manufacture. The coordination of internal and external activities came up with the spread of external transportation and removal of restricting regulations with transport in 1980's. The company has an opportunity to minimize the disadvantages of variable supply periods due to the international transportation by handling the external logistic activities that connect the manufacturer and end user to each other and internal logistics that handles transportation of end product from raw material source to the manufacturer. Besides, the companies provided more effective and productive services through such coordination and saved money on transportation costs and improved the customer satisfaction (Langley et al. 2008).

Through developing technology and spreading information share after 1990's, the integrated logistics, a coordination of internal and external logistics is replaced with a more comprehensive concept, supply chain. The concept of the supply chain has become a deeper phenomenon with the development of the information technologies today, and it has become an indispensable element for the challenging market.

Supply chain is a group of organization that takes out a product from its raw material and prepares it for a production and produces the semi-finished products and transforms into the product to present to the consumer and adds value to it at every moment and is a system that connects such organizations with product, information and pecuniary resource flow. As all of such organizations can be managed by a single company, they can also be managed by companies which produce product, semi-finished products or raw material, Third Party Logistics (3PL) or Fourth Party Logistics (4PL) logistics suppliers, retailer or wholesaler and customers who actualize their operations through a partnership, established by several congruences (Shapiro, 2006; Stadtler & Kilger, 2005).

Supply chain is a concept to ensure communication, manage all projects in a common area, cover the needs of the customers in an effective and productive manner, use the resources effectively, improve the productivity, create a planned, fast and rapid supply, production and

distribution chain among the suppliers, manufacturers, retailers and customers (Mula et al. 2010).

The scope of the supply chain differs to the businesses, and it is available at every business that produces and serve. Throughout the supply chain, there is a flow of money and information as well as the product. Beamon (1998) defines supply chain as "an integrated process, involving the supply of raw materials, turning them into end products and delivering them to the retailers by working in coordination with several businesses such as supplier, manufacturer, distributor, and retailer."

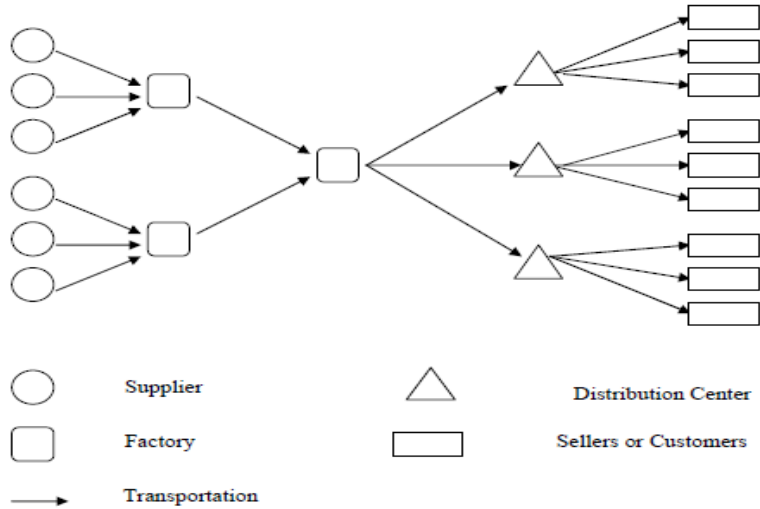
The supply chain involves all processes that add value to the product during delivering the entire product, service and information flow in a cost-effective manner in a chain that leads to the customer (Demirdöğen ve Küçük, 2007).

A supply chain of a typical product starts with the raw material and continues with delivering it to manufacturer and production and ends with delivery of end product to the customers. The product cost does not only involve factory costs that are incurred during portage of raw material into the end product and include the costs of labour and activities for transportation, storing, packing and selling of products to the final point for the customers. For that reason, the companies have to plan and handle all activities within the supply chain as a whole to minimize their costs (Chen and Paulraj, 2004). The companies aim to raise the value of the products during the flow of the products as a chain and deliver them to the customers in a specific geographical area in a timely manner and right amounts and with accurate and reasonable price within a well-structured supply chain (Shapiro, 2006).

Ensuring a close cooperation between the supply chain elements enables supply chain to act as a single organization and to meet the demands in an effective manner and improve the profitability of the general supply chain (Simatupang and Sridharan, 2002). It is very important for chain elements to accurately understand and manage the concept of supply chain that enables end products or services to deliver to the consumers in terms that result in customer satisfaction to have a competition advantage. This is only achievable if chain elements could understand and adopt the objectives and aims of the supply chain accurately. The concept of supply chain can be defined as those organizations which are gathered around a single objective to turn raw materials into manufactures and then deliver it to the end user

and contribute to such process by being in contact with each other with the support of the information technologies (Jayashankar et al., 1996).

Even though the confusion of the supply chain varies greatly from company to company and from industry to sector, it can be seen in both service and production organizations. Organizations that ensure the flow of materials and information in the field ranging from the last user of the manufactures to the first supplier of the raw materials needed for the manufactures form a company's supply chain. The rings that can be placed in a general chain are shown in Figure 2.1. (Teigen, 1997).



**Figure 2.1.** Supply chain (Teigen, 1997).

Within this chain; in addition to inputs and outputs such as product flow, return flow and cash flow take place, at the planning and organizational stage activities are actualized such as demand predicting, order management, production planning, inventory management, purchasing management, supplier management, distribution planning, return management, warehouse management, portage planning, customer relations etc.

**2.1.1. Functions of supply chain**

In a business environment three types of flows exist. The flow from the acquisition of the product to its consumption, the flow of information from the vendors to the business

environment, and from there to the customers, the financial flow from the customers who ensure the essential sources to the business environment are these types. Supply chain functions represent the product flow in the business environment (Chopra & Meindl, 2015).

Providing the right materials, services and technology are purchased from the right source, at the right time and quality in a management are under the supply chain's responsibility. The supply chain also is a network of tools and distribution options that performs the functions of providing materials, transforms these materials into ended manufactures, and distributes these ended manufactures to customers (Tan et al., 1998).

Even though its confusion varies by the type of industry or business, the supply chain exists both service and producing businesses. The service industries deliver products just like other managements that produce products. These products might be data, customer service etc. In addition, the difference between service and product production has been becoming increasingly uncertain. In fact, modern production systems need to operate more than physical phases, such as creating products or processing materials (Tan et al., 1998).

In brief, the supply chain includes procurement, manufacture design, manufacture planning, material management, fulfillment of orders, inventory management, portage, storage and customer services (Min & Zhou, 2002).

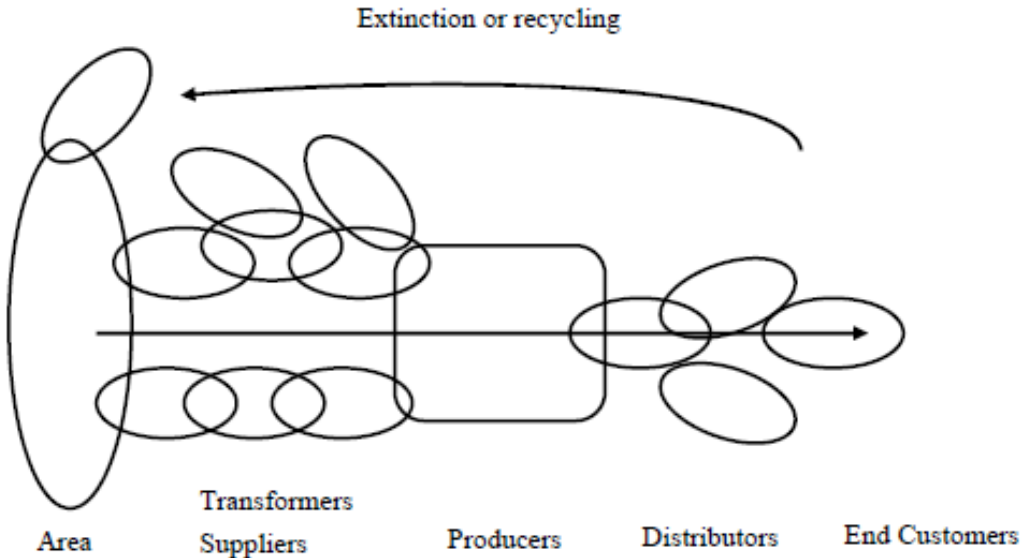
In order for corporate functions to be efficient, they must work in an integrated manner. Coordination of many functions within the organization framework is necessary to ensure that the events related to the supply chain are responded quickly and with high quality. Organizations in the supply chain have traditionally been operated independently such as marketing, distribution, planning, production and purchasing. These organizations have their own goals and these goals often overlap (Chopra & Meindl, 2015).

The high level of customer service of marketing also coincides with the maximum sales objectives, manufacture and distribution targets. Many manufacture processes are designed to maximize output and lower the costs, in ayn case of effect on inventory levels and distribution facilities. Purchase contracts are negotiated with very little information beyond the old purchasing examples. For enterprise, there is no single and integrated plan as a result. Of these factors. The number of plans is as many as the number of jobs. A mechanism is needed to integrate these different functions. At this point, supply chain management is a strategy that

can achieve such integration. It is observed that supply chain management is typically among the fully integrated companies where the material flux is owned by one firm as a whole and each channel member works independently. Therefore, the coordination of various components in the chain is ensured by their effective management (Ganeshan and Harrison, 1995).

**2.1.2. Structure of supply chain**

The purchase and acquisition required for the good to be sold is the first step of the supply chain. To support sales, it converts to inventory management and warehouse management. The delivery of the manufactures to the customers is the last step. In the supply chain, materials move from raw material sources to a manufacture level that converts these raw materials into semi-ended manufactures. Then, these semi-manufactures will be assembled at the next level to form the ended manufactures. The manufactures procured are transferred to main distribution centers and points and from there to sellers and customers (Chopra & Meindl, 2015). The Figure 2.2. briefly summarizes the general structure of the supply chain:



**Figure 2.2.** The structure of supply chain (Dobler and Burt, 1996).

The supply chain is a chain of elements. There is a constantly updated and close relationship between the elements required by the structure of the supply chain. Followings are the elements of a supply chain (Kağnıcıoğlu, 2007: 29):

- Suppliers (sub-industry, contractors, key industry producing workshops)
- Key industries (producing the finished manufacture) distributors (general main distributors, wholesalers), dealers (retailers)
- Customer (consumer)

In the supply chain management, every organization in the steps of the supply chain of a product works together with the same objectives and the most effective ways are selected for creating the product (cost, time, benefit, etc.) (Akman ve Alkan, 2006). The elements of the supply chain can be categorized as the manufacturers, distributors, retailers or wholesalers, customers and logistic service providers.

### ***1- Manufacturers***

Manufacturers are the members of the supply chain that process the materials found in nature and brings them as semi-finished products or end products. To assess a member of a supply chain as a manufacturer, it has to take part within the cycle of raw material-semi-finished manufactures /finished manufactures or semi-finished manufactures/finished manufactures. Manufacturers base their manufacture targets on the claims for the finished products on a traditional basis and stock up to compensate for the forecast mistakes. Most manufacturers strengthen their capability to respond to the market signals by accelerating the transformation of raw materials into a finished product by squeezing the lead times in the supply chain throughout the supply chain (Görçün, 2013).

### ***2- Distributors***

Distributors are the members of the supply chain that undertake the activities such as transport, storing and inventory, etc. in the course of delivering the end product or semi-finished product from the door of the factory to the customer. In general, distributors organize the activities until pre-sale process. Proportioning the distribution costs to the manufacture prices specify the effectiveness of the distribution. (Ayers, 2006). An effective distribution activity is a factor that directly influences the supply chain.

Distribution is a critical element for supply chains because it affects overall profitability and customer satisfaction directly. Distribution means linkage between supplier and customer in supply chain (Cooper et al, 1997).

### ***3- Retailers***

Retailers are members of the supply chain, offering consumers high volume products by separating them into small pieces after they receive them from the wholesalers and distributors (Görçün, 2013). Retailers are interested in selling their products and services to consumers. They set the manufacturers in motion to provide the necessary products. They outsource some specific functions such as access to expert logistics service and warehousing (Ferne and Sparks, 2009).

### ***4- Customers***

The customers as consumers are usually at the very last place of the supply chain. The end products and semi-finished products are manufactured depending on the customer request and expectations. Therefore, customers play an important role in decisions to be taken at the supply chain structure (Mentzer et al. 2001). The most important thing in the supply chain is customer expectation. For the demand, which is the starting point of the entire chain, shapes according to the customer expectation, the other conditions shape accordingly.

### ***5- Logistics Service Providers***

Logistics service providers are the members of the supply chain that provide services to the members of the supply chain. Especially with the increasing competition, the number of supply chains using third party companies has increased. These offer companies' solutions to their needs and activities that affect the performance of the whole supply chain (Sheikh and Rana, 2014). Third party companies provide added value increase especially in companies that do not carry high amounts of products, their needs are relatively uncertain, and they produce original products (Chopra and Meindl, 2010).

## **2.1.3. Factors leading to the development of the supply chain**

When compared to the events that occurred at the business in the past with the strategies that are designed for managing the actions such as engineering, marketing, manufacture, sales, and



finance that are realized within the business organization, they have the secondary importance at all times. Today, the capability of the company to consider its external environment is revealed as the measurement of the success to access to physical resources and market value, and there are five basic developments that pave the way for supply chain (Ross, 2000).

- First of all, the business organizations use computer-based techniques and management methods such as corporate resource planning, total quality management and Business Process Reengineering in their internal functions to optimize their organization within the past twenty year period, and apply agile, lean manufacturing and distribution functions to provide high level and quality service. Today, they started to apply the best operations, management and technology paradigms to the customers and suppliers with which they are in interaction. The main objective here is to eliminate all types of actions in all areas such as logistics, inventory, procurement, customer management, manufacture development and financial functions.
- The second one is that the business organizations started to seal off from the non-profitable functions or that they are weak at competition and enter into a close cooperation to develop cross-channel functions such as discovery of open areas for product development, forecasting, stock management and logistics, competition advantages with the suppliers and customers of the market leader companies.
- The third reason is that global trade boom enables to access to the new markets and new business models that are not possible a couple of years ago on a visual basis and eliminate the limitations of doing business by the companies thanks to the revolutions in the international logistics and today's interactive internet technology.
- The fourth reason is that today's market conditions compel companies to cooperate with the customers and suppliers to cover the needs of the customers in a shorter time.
- Finally, companies can access to the many new markets, which were once seen inaccessible through the development of the electronic trade.

#### **2.1.4. Types of supply chain**

Supply chains vary in their increasing complexity and can be classified as single-phase and multi-phase according to their structure. The flow on the supply chain can occur as material, money, or information flow. The downstream flow takes place from the procurement phase to

the customer, and upstream flow occurs in the opposite direction from the customer to the point of supply.

The single-phase supply chain combines the material flow functions of the acquisition of raw materials, production and distribution (Tunacan, 2004). There are many information processing and decision-making functions in this kind of supply chain. The management of funds is also covered, because working capital in the form of debts and receivables is as important as working capital in the form of inventory and equipment (Arslan, 2006).

The multi-phase supply chains are generally multi-company supply chains, and in particular, multiple replicas of the single-phase supply chains. The Volkswagen brand provides a good example of a multi-phase supply chain. In this example, the manufacturer works with its dealers electronically receiving future order information and actual orders, and daily car manufacture planning (Metz, 1998).

In addition to these phases, environmentally oriented reverse supply chains, which include the recycling of products, have also been an issue that attracts attention especially in recent years. The concept of reverse supply chain, also known as reverse logistics, is a name used in logistics environments where products and materials are reused. Possible cost reductions and environmental issues have recently led to increased interest in reverse logistics. An example of reuse is the use of recycled materials in re-manufacturing. After manufacturing, the product is considered as good as new (Kocaoğlu, 2003). Various countries assume the responsibility of the producers throughout the life cycle of their products within the framework of environmental laws. A return obligation is imposed in several product categories such as electronics, packaging materials and automobiles. In addition, customer requests also force companies to reduce the burden of their products on the environment. "The green image" is becoming an important marketing item. From a logistics perspective, reuse activities will now speed up the flow of goods from customers to producers. The management of this flow, which is in contrast to the traditional supply chain, is related to the supply chain in contrast to the areas that have recently developed. Issues arising include distribution network, inventory and product management (Fleischmann et al., 2000).

## **2.2. Supply Chain Management**

Supply chain management is the planning, management and coordination of all activities among suppliers, manufacturers, intermediaries, third parties and customers. These activities, including procurement, transportation, stock control, logistics, reverse logistics, recycling, storage, distribution, pick-up, production, sales, aftersales product and service development, should be carried out in cooperation with the contribution of supply chain management (Opengart, 2015).

Supply chain management is an effective way management of the flow of materials and finished goods from the vendor to the customer, using production tools and warehouses as potential intermediate stops. However, this service can not be described as a new concept at all. In the recent times, enterprises have started to pay attention to the fact that as a result of giving a favorable structure to the supply chain, they can develop their customer service levels, excess their inventories in the system, and lower the unessential costs in the business network. Advanced technology, IT management, and mathematics of operations research to plan and control expanding factors component to manufacture and deliver manufactures and services in a way that will satisfy the customer are used by supply chain management. Relational databases and similar technical tools are used by advanced programs. Even if its technology is complex, the most important concepts and working techniques of supply chain management are quite understandable (Metz, 1998).

A basic operating system that handles the internal resources of the company as an entire, in order to manage and work effectively with the supply providers outside the company identifies supply chain management system . The aim is to take the company further by increasing the company's manufacturing capacity, improving the sensitivity to the market, and improving the relationships between the consumer and those undertaking the supply business.

Supply chain management can increase supply chain surplus by lowering supply chain costs. It can also provide a tremendous competitive advantage by reducing the bullwhip effect that causes more than twelve to twenty percent of the cost for each company. Thus, with lowering costs, better quality production methods, more reliable transport and storage methods can be invested. In addition, by recognizing the chain from supplier to end-user customer, suppliers and other intermediaries will be able to invest in their facilities in a market that lacks of risk and uncertainty to offer better services and products. Over time, suppliers can develop better

products and services with the information that customers share by improving integrated supply chain (Sunil Chopra, 2009).

### **2.2.1. Functions of supply chain management**

Strategic, tactical and operational level are supply chain management functions' operate levels. The period of time the decisions separates levels from each other. are made. At the strategic level, the following issues are covered: Where will the production be assigned and what will be the best sourcing strategy. Predicting, planning, ordering materials with short lead times and scheduling to meet the production needs are included at the tactical level. Inventory distribution, detailed scheduling and what to do when an machine is broken are included at the operational level (Misni & Lee, 2017).

Coordination with customers and suppliers is essential for supply chain management. However, market dynamics make this difficult. Change or cancellation are made by customers frequently. Make late deliveries or the wrong materials can supplied by suppliers. To respond swiftly to the dynamics of the market while minimizing lead times and inventory are essential for systems. (Yamak,1999).

As in the market, the base of manufacture is dynamic. Deviations from scheduled activities can be led by planless events. The manufacture control system needs to respond to these events by methods that will optimize manufacture objectives for a planned manufacture. Events can cause problems in some cases. Therefore, the production control system should be coordinated with higher-level functions such as planning activities, sales and marketing (Fox et al., 1993).

### **2.2.2. Main components of supply chain management**

Global competition forces companies to produce better and faster products and to deliver products more quickly. However, the complexity throughout the supply chain hampers all these goals. On the other hand, this situation constantly brings new markets, new products, new operations, new factories and facilities, new threats and new possibilities. Now, the challenge is how companies can manage to grow their market share and profitability in these difficult times (Handfield et. al., 2005).

In this day and age, organizations feel the need to go beyond processing and automating business applications. It has begun to be recognized that hierarchy-based organizational structures, vertically integrated manufacturing and distribution processes, distant relationships with suppliers and consumers, and systems without flexibility are insufficient for success. In today's supply chain management, technology is the most important part of its ability to successfully compete in the global market (Opengart, 2015).

Within this scope, the channel used by the organization to operate its information potential is critical. It is known that organizations benefiting from supply chain management gain many benefits in this way. One of the biggest problems that arise as an outcome of the evolution of today's management systems is that the functions integrated in the framework of the company are not seen as a whole (Opengart, 2015).

Supply chain management should consist of modules that directly cover all the functions of the business in order to optimize the supply chain performance of the organizations and make profit in the field of economic competition. The supply chain management system should consist the following components: Demand planning, supply planning, production planning module, transportation planning module, graphic supply chain model preparer module, supply chain optimizer module, basic module, sales module, demand control module, material requirement planning module, purchasing module, inventory management module, routing module, product tools module, work orders module, capacity planning module, costing module and prediction modules (Handfield, 1996).

In addition to these, there are five basic components of supply chain management. These are production, inventory, transportation, location and information (Hugos, 2003). For a more effective supply chain, these components must be managed well.. Also, each of these components and how they work should be explained by an effective supply chain. In addition, it is seen in the literature that planning, source and return of goods items are added to these five basic components (Christopher, 2016).

### ***1- Production***

The capacity of the supply chain to make products available and stored are mentioned by production. Production-related facilities consist of factories and warehouses. Issues related to how to resolve the exchange or imbalance between competence and efficiency are among the

main problems faced by managers. In other words, how the dilemma between meeting demand and efficiency is resolved depends on the decisions of managers regarding production. Factories and warehouses can be flexible and respond swiftly to sudden fluctuations in product demand, if they have more capacity than necessary. However, if excess capacity creates an empty capacity that does not generate income, it may be necessary to bear the additional costs created by this excess. The occurrence of such a situation means a low level of efficiency and operation for businesses in the chain (Hugos, 2003).

## ***2- Inventory***

Inventory covers all stages seen along the supply chain. Where to position themselves between meeting demand and efficiency through inventory decisions must be decided by managers. Holding large amounts of inventory adds the ability to respond to fluctuations in customer demand across an enterprise or its entire supply chain. Conversely, finding and storing inventory is a cost element. Inventory cost should be kept as low as possible to achieve high efficiency (Tan, 2001).

## ***3- Location***

The geographic location of supply chain facilities are mentioned by location. It is also concerned with decisions about which operation will take place at which facility. When a settlement is decided it is necessary to deal with a number of factors related to the chosen location. These factors are; facility cost, labor cost, employee skills, infrastructure condition, taxes and tariffs, proximity to consumer and supplier. Settlement decisions are considered among the most important strategic decisions since large amounts of money are tied to a long-term plan. Location decision has a strong impact on the cost of the supply chain and performance metrics. When the size, number and location of the facilities are determined, this actually also defines the possible routes for the products to reach the consumer. The location decision of a business also determines the main strategies it will use to bring its products to the market (Tan, 2001).

## ***4- Transportation***

Transportation is defined as the movement of all products between different facilities in the supply chain, from raw materials to final goods. Speed and efficiency are significant in choosing the mode of portage. Airplanes, which are a fast way of transportation, are very

expensive, although they can respond quickly. The slower choice of ship and rail, on the other hand, is not as fast as airplanes, although they are very cost effective. Since transportation cost accounts for almost one third of the operating cost of the supply chain, transportation decisions are very significant (Hugos, 2003).

### ***5- Information***

Decision-making on the other four supply chain elements, information is the basis. Information enables the link between all operations and activities in the supply chain. The stronger this bond, the better companies in the supply chain make decisions about their own operations. In the supply chain, information is used for two objectives (Hugos, 2003):

***Coordination of daily activities related to the operation of the other four supply chain elements:*** Companies in the supply chain make decisions on weekly production plans, inventory levels, portage routes and stocking zones using available data on product demand and supply.

***Forecasting and planning to forecast and meet future demands:*** It is used in preparing production schedules and making important strategic decisions. When deciding between meeting demand and productivity in a business, a comparison is made between the benefits of good information and the cost of obtaining this information. While sufficient and accurate information enables effective operational decisions and better forecasting, it can be very costly to set up and operate systems that will provide such information.

### **2.2.3. Inventory management in supply chain**

Larger demand for higher quality goods and better services with shorter delivery times have to be met by businesses today. A tough competitive environment has been built by changes in the global markets. This situation has created an environment in which managers must make decisions in less time, with less information and higher penalty costs. Now, products are less standardized since customers demand the features they want. For example, computers are evaluated based on their speed and cost, and cars for their reliability (Fıçrı, 2006: 22).

The full effect of these changes are felt by managers in the supply chain. Managers are compelled to do more with less staff by staff costs. a. At the same time, less inventory is

required due to the cost. Because of the ever-increasing level of competition in most markets, any error cannot be ignored. Moreover, as both suppliers and customers are more knowledgeable about performance measurement, it will be easier to eliminate these errors (Ciravoğlu, 2006: 36).

Despite the daunting challenges of today's competitive environment, some companies are able to grow. These are the companies that can integrate quick response and flexibility while giving importance to time factor in management. Companies that succeed in linking combined performance with various market factors can be considered as successful (Fıçrı, 2006: 45).

Customers give their jobs to time-based competitors and most of them will to pay more if they can get the goods or services in a very short time, because this means that they will reduce their stock levels while saving time and money. In a well-managed supply chain, the amount of stock excluded from the chain is very low, because the stock that travels between the rings of the chain suffers very little delays (Handfield, 1996). Shortening in deployment time turns not only with less inventory, but less rework, higher manufacture quality, and less expense in every element of the supply chain. All these developments have a serious impact on the company.

#### **2.2.4. Advantages of supply chain management**

Supply chain management enables the development of outputs such as price, quality and technology, and applications to be compatible, integrated and high performance. The basis for versatile and useful development are formed by supply chain management. Applications improve harmonious strategies, communication leadership and business process management. In all areas from raw material sources to the end consumer are emerged by the benefits of supply chain management.

The real impact of supply chain management is related to the visibility which it creates in the supply chain. Economic calculations indicates that supply chain management can achieve the maximum amount of balancing for businesses operating on lower shipment.

According to a study (Murat, 2006: 13), an integrated stock chain capacity produces the following results:



- Improving distribution performance more than 50%
- More than 32% cost reduction
- More than 95% reduction in stock lists
- More than 5% increase in customer satisfaction

In the same research, the working outcomes of the integrated supply chain are as follows:

- Increase in distribution performance (16-28%),
- Decrease in stock amounts (25-60%),
- An accuracy of 25-80% in estimates,
- Productivity increase of 10-16% in company activities

### **2.2.5. Disadvantages of supply chain management**

All manufacturing companies have different supply chain management systems. Nevertheless, several of them are immature, complex or uncontrollable. Similarly, some companies have not achieved completely integration and united functional system. Supply chain management is generally between perpetual immaturity and high performance. If the competitive position is developed, there is a need to examine where the firm is in continuity (Lambert & Cooper, 2000).

Supply chain management occasionally causes waste of time due to priority activities, so that the desired level of supply chain management application cannot be obtained. Inessential costs are caused by concentrating on wrong attempts. Another disadvantage is that the continuity of the relations and the resulting are the difficulties in eliminating disputes. In addition, it may be the case that the chosen institution does not meet the expectations (Lambert & Cooper, 2000).

### **2.2.6. Supply chain decisions**

Strategic and operational decisions are two broad categories of supply chain decisions. Strategic decisions are made for a long period of time. These are tightly linked to the business strategy and guide supply chain policies from a design perspective. Otherwise, operational decisions are short-term and focus on daily activities. The effort in such decisions is to

manage the product flow in the “strategic” supply chain effectively and efficiently (Ganeshan & Harrison, 1995).

There are four basic decision areas in supply chain management and each decision area contains both strategic and operational elements.

1. Placement
2. Production
3. Inventory
4. Distribution

#### ***2.2.6.1. Placement decisions***

The geographical location of production centers, stock points and resource points is naturally the first step in establishing a supply chain. Once the size, number and location of these and possible routes for the products to flow to the final customer are determined. These decisions are of great importance to a firm, as access to customer markets represents its core strategy and has a significant impact on income, cost and service level. An optimization routine that takes into account production costs, taxes and production limitations should determine these decisions. While settlement decisions are basically strategic, they are also related to an operational level (Ganeshan & Harrison, 1995).

#### ***2.2.6.2. Production decisions***

Strategic decisions include which products will be produced in which mills, the allocation of suppliers to mills, distribution centers of mills and customer markets of distribution centers. These decisions have a major impact on businesses' income, cost and customer service levels. Also, these decisions assume the existence of the means of production, but they determine the exact route of the flow to and from these vehicles.

Another critical issue is the capacities of the means of production. This is largely dependent on the degree of vertical integration within the enterprise. Detailed production scheduling are focused on by operation decisions. These decisions include the creation of basic production

schedules, scheduling of machinery and equipment maintenance. Other issues are balancing workload and quality control criteria in a production center.

#### ***2.2.6.3. Inventory decisions***

Inventory decisions are about how to manage inventory. Inventories are available at every level of the supply chain, either raw materials, semi-ended or ended manufactures. The main objective of these are to reduce or eliminate any uncertainty that may exist in the supply chain. It is important to have inventories and manage them effectively in supply chain transactions.

Strategic goals should be determined by senior management. However, many researchers approached inventory management from an operational perspective. These decisions contain distribution policies, order quantities, determination of order points, and control policies that include setting the level of safe inventory at each stock point. These levels are significant as they are the main determinant of customer service levels (Ganeshan & Harrison, 1995).

#### ***2.2.6.4. Distribution decisions***

The choice of methods for these decisions should be more strategic. These are closely linked to inventory decisions. Air transportation is fast and safe, but expensive. However, shipping by sea or rail is cheaper, but it requires relatively large amounts of inventory to reduce uncertainty. Therefore, customer service stages and geographic location are very significant in these decisions. It will be economically beneficial to work efficiently, as shipping accounts for over 30% of logistics costs. Transportation quantities, determining routes and scheduling are key issues for the effective management of an enterprise's shipping strategy (Ganeshan & Harrison, 1995).

### **3. SUPPLY CHAIN MANAGEMENT IN CONSTRUCTION INDUSTRY**

In the construction industry, the supply chain covers a very wide process from the customer's request to the delivery. Construction supply chain management is the effective management of information, material and cash flows between design, construction, main contractor, subcontractor and supplier (Şerbetçioğlu, 2007).

The representation of construction as a supply chain rather than the development of a manufacture ensures the most effective approach for organizing the industry's production and business activities. The process starts with a customer requesting facility. This facility can be a building, a private or commercial revenue generating property, other infrastructure works such as roads and railways, and central and local government jobs. Ultimately, the process results in a product or facility that will be deemed appropriate by the customer or several other designs. Processes can be repeated several times, thanks to the fact that the process is rotating (Şerbetçioğlu, 2007).

In literature, experts have identified the problem of poor performance and with it the importance of innovation in the construction industry. Components of SCM have started adaption in some sectors of this industry, for example, methods for better procurement practices (Khalfan & McDermott, 2006) have been under study for several years, as well as methods for supplier integration and incorporation into organizational structures (Karim, Marosszeky, & Davis, 2006).

Since the mid-1990s, construction supply chain management (CSCM) has been studied. Qualitative and conceptual frameworks are focused on by the most existing studies. The major CSCM topics verified are about:

- (1) logistical problems (Vidalakis et al., 2011),
- (2) CSC relationships (Meng, 2010), such as clients, contractors (Proverbs et al, 2000), subcontractors (Dainty et al., 2001),
- (3) source choice (Palaneeswaran et al., 2001), and source of uncertainty (Gosling et al., 2013),

(4) risk management (Liu & Guo, 2009),

(5) decision-making (Kaare & Koppel, 2010).

CSCM who discussed by Lam et al. (2010), solves a material supplier selection problem by using the selection model on the fuzzy Principal Component Analysis (PCA) from the perspective of property developers.

Safa et al. (2014) develop an integrated construction material management (ICMM) model related in supplier selection process. The objective is to optimize and validate purchasing process at each stage of manufacture for the construction material management package.

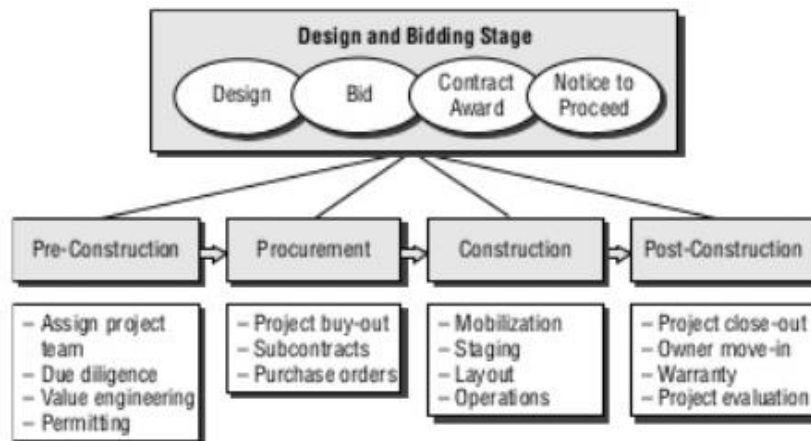
On the other hand, there are Lean strategies which seek to improve performance by waste elimination. Lean strategy aligns with Supply Chain Management (SCM) since it also targets the elimination of waste in the chain of upstream and downstream processes through the optimization of internal and external supplier capabilities and the use of technological resources to generate an appropriate and effective coordination of the supply chain flow. By this, SCM is able to increase competition and provide value the customer (Paulraj, 2002). Lean and SCM can be used in conjunction for ultimate results. As SCM focuses on the flow of the process in a macro manner, Lean strategies look for improvements at the micro level in the flow of processes, enabling better process management. Therefore, the introduction of Lean Supply Chain Management as a broader framework makes sense in an industry like construction.

### **3.1. Construction Stages**

Construction stages can be grouped under six headings as follows (Figure 3.1) (Jackson, 2010):

- Design
- Pre-construction
- Procurement
- Construction
- Post-construction

- Owner occupancy



**Figure 3.1.** Construction project stages (Jackson, 2010).

**Design:** The design phase can be defined as the foundation of the whole construction project. Intensive works and numerous steps take place at this stage before starting the construction process. Then, the project is finalized, and tender documents and specifications are prepared according to the demands of the owner (Barrie and Paulson, 1992). The tender stage is actually an intermediate stage after the design stage. At this stage, project cost estimates are calculated

**Pre-construction:** The pre-construction phase is another planning phase and is the last phase before construction actually begins. This stage starts with the tender, and the project cost and schedule details are transmitted to the project manager. Thus, the necessary corrections on the estimates and planning can be made by the project manager.

**Procurement:** At this stage, the project resources such as the equipment, materials, labor etc. are purchased in accordance with the requests of the construction team (Bennett, 2003). This stage can be complex depending on the size of the project, because purchasing and procurement processes are much more complex for larger projects.

Procurement's position will assist companies in maximizing income. Different key stakeholders need to find innovative and improved ways to drive supplier engagement, strategic cost reductions and margins, improved spend management, and supplier partnerships

for competitive differentiation. Therefore, procurement also helps in the management of enforcement and the reduction of supply chain risk.

In order to innovate quicker, firms need a new approach to how they work internally and externally with suppliers and stakeholders in an ever-changing regulatory climate. Procurement enables companies to become suppliers' "customer of choice," allowing manufacturers to drive creativity and deliver goods to market more quickly. Cause of quickly changing customer choices, procurement also aids producers effectively manage their supplier engagement through life cycles (Kamak, 2019).

**Construction:** The construction phase is the phase that starts with the construction work and ends with the completion of all construction activities. The phase between the start of construction activities and the completion of all construction activities is called the construction phase. At this stage, resources are started to be used. "The decision about the construction methodology and other cost expenses taken in the pre-construction phase are applied at this stage." (Baltaş, 2017: 15). The intermediate stage after the construction is completed is called "the commissioning stage".

**Post-construction:** In the post-construction phase, which starts with the commissioning phase, tests are applied to all systems and equipment in order to detect possible malfunctions in the system.

**Owner Occupancy:** The last stage, the owner occupancy stage, is the stage agreed with the owner regarding the resulting product and project. "This phase begins when the owner accepts the project and this process continues while initiating the warranty period" (Jackson, 2010).

### **3.1.1. Construction estimates and construction cost**

Construction cost constitutes a significant part of the total project cost and is under the control responsibility of the construction project manager. Varies and differences at each stage of project development are estimated by the accuracy of construction cost. For example, because the design decisions taken at the beginning of the project are not final, it is common to mistake cost estimates made in the early stages. In other words, the accuracy of the cost estimation in the construction sector is evaluated according to the available information during the estimation.

Although many cost estimates can be used at different stages of a project, it is possible to divide the cost estimates in the construction sector into three categories according to their functions: Design estimates, bid estimates and control estimates. A design or a bid estimate is used first to generate financing for a construction project (Hendrickson, 2008).

- **Design Estimates:** Design estimation is about the owner or designers. This type of forecast works in parallel with planning and design.
- **Bid Estimates:** The bid estimate relates to the contractor. The bid estimate presented to the landlord consists of direct construction cost, overheads and a pricing that includes profit.
- **Control Estimates:** The purpose of the control estimate is to monitor the project during construction. Available information is compiled to generate this estimate.

Material and procurement management is of great importance in construction costs. Although the material has a larger share in construction, it is seen that material and procurement management techniques are not used effectively in the construction sector. For example, controlling the material cost and decreasing the material costs at a certain rate can directly increase the profit rate (Besen, 2006).

It is possible to plan and control the material used in the construction industry, from the time it is needed to the moment of use in manufacture. The planning process contains the use and control of the material, its effects on cost, organizational structure and system planning. In the correct use of construction resources, site management and, accordingly, material management are of great importance. For this reason, it is essential to know what kind of problems the material management includes and to reach these problems to rational solutions by using the right methods and taking the necessary precautions in a timely manner (Çetiner, 2004).

Material and procurement management in the construction industry, material quantification, preparation of demand information, forwarding request information to the relevant unit, determining suppliers, receiving offers from suppliers, evaluating offers, selecting suppliers and making contracts, monitoring suppliers for delivering the material on time, quality for materials to have the desired properties It includes the necessary planning, control and supervision processes for the control, the reliable and economical delivery of the material to the construction site, and the disposal of scrap and return materials (Stukhard, 1995).



The distribution of the material is as important as its procurement. Especially if the construction sites are structured away from the center, it may be necessary to purchase a large number of materials or distribute them to different construction areas.

Ensuring the most rational use of the material can be achieved with an effective material and procurement management. Approximately 60% of the building cost is made up of materials. Therefore, the efficiency and correct use of the material positively affect the building cost.

Management is of great importance in achieving high efficiency. Workers and machines may remain unloaded due to the fact that the material is not ready when requested. Material control ensures that these requests are fulfilled on time, that materials are taken in the most economical way and that stocks are not more than necessary (Çetiner, 2004).

Other important factors affecting the cost estimation are the project delivery method and contract types. These define the responsibilities of each partner involved in the project in the construction process. General construction contract types are "lump sum", "unit price", "cost plus fee" and "guaranteed maximum price". Also, project delivery methods can be defined as "design-bid-build", "design-build", "construction manager contract with fee" and "integrated project delivery methods". The responsibilities of the project partners such as owner, contractor, designer and construction manager vary according to the type of project delivery method (Stevens, 1990).

For example, in some projects, the contractor may not be responsible for the design cost. However, the contractor must set an estimated budget for the draft. When making this cost estimate, it can simply be multiplied by the draft time by the drafter's salary. If the draft is subcontracted, a cumulative amount for the subcontractor must also be added to the estimated cost (Stevens, 1990).

### **3.2. Construction Project Management**

The formation of a building project involves many closely related stages. Each stage consists of many actions, and one stage can begin before the other is finished (Barrie & Paulson, 1992).

In the life cycle of building projects, procurement management is a mandatory step to get effective results in the production phase and not to lower quality standards. It includes the preparation of the necessary administrative and technical special specifications and logistics planning studies, where issues such as the definition of the work with the contractor and subcontractors, determination of construction conditions, payment terms, material and machinery equipment purchases are specified (Benek & Ulucan, 2007).

The construction phase, which is passed after the procurement phase reaches a certain phase, is the process in which design plans turn into physical structures and activities. It covers the coordination of all resources in order to realize the project according to the quality standards of the designer, within budget and in accordance with the program (Keskinel F., 2000).

Effective use of resources is very significant for the successful completion of projects with the desired performance, on time, within budget limits. For this reason, the steps of project procurement management, project estimates and project cost should be carefully planned in the organization of project management.

### **3.2.1. Project procurement management in construction industry**

Project procurement management covers the processes required to purchase or obtain the required manufactures, services or results from exterior of the project team. It contains the contract management and change control processes required to prepare and manage contracts and purchase orders issued by authorized project team members.

In other words, project procurement management manages the procurement of external resources required by the project. Resources planned to be obtained and when is in this process. The most significant step of this process is the decision to purchase or procure from within the organization. Project procurement management occurs to four basis processes that follow each other (Araújo et al., 2017).

**1. Procurement Planning:** The process of documenting the procurement decisions of the project, indicating the approach and defining potential suppliers.

- **Procurement Management Plan:** Defines how procurement processes will be managed each process from the development of procurement documents to the termination of the contract.
- **Procurement Statement of Work:** In accordance with the project scope baseline and identifies only the part of the project scope to be contained in the relevant contract composed each procurement statement of work.
- **“Make-or-Buy” Decisions:** Document the decisions reached about which project products, project services, or project results will be acquired from outside the project organization and which will be carried out by the project team within the organization.
- **Procurement Documents:** Procurement documents are used to demand quotations from applicant suppliers.

**2. Conducting Procurement:** The process of getting responses from vendors, choosing a vendor, and signing a contract.

**3. Procurement Management:** The process of managing procurement relationships, observing contract performance and making changes and rectifications when needed.

**4. Procurement Closure:** It is the process of closing all supplies under the project.

These processes coact with each other and processes in other areas. Each process may require at least one person working, attached to the requirements of the project. If the project is divided into phases, all processes are actualized at least once in each project and can be actualized in several phases.

### **3.2.2. Project estimates and project cost in construction industry**

In construction management, it is aimed to complete the work on time, to keep costs low, to increase productivity, and to produce construction components and buildings at the desired quality (Çetiner, 2004). With the increase in the importance given to construction management, the search for new techniques and their application has increased. For this reason, the importance given to planning has also increased, and the primary goal has been to minimize the production costs of the project and to complete it on time. The controls to be made to achieve the goal are as follows: Continuously controlling the material, determining

the amount of material by using the work program, ordering at the right time and at the desired quality, preventing material losses, working mutually and in parallel with the control unit.

It is known that cost and time are pretty important in project estimates. Therefore, cost estimates should be made as detailed as possible. While evaluating direct cost items, it should be aimed to reduce costs, and while estimating the project, it is essential to pay attention to many cost factors. These are design cost, drawing cost, material cost, labor cost, equipment cost, hand tool, apparatus, fixture cost, inspection cost and overhead cost (Murugan, 2011).

Project estimation process are generally based on three components:

- Quantity
- Pricing
- Productivity

These three components are interrelated. In other words, quantity is taken into consideration when pricing and efficiency information is used when calculating the project duration. Thus, a project estimate is created thanks to these three components.

The first step of the project estimation is the review of project plans and specifications. Then, the products are analyzed and a query list is created. During this period, pre-proposal visits and meetings can be held. Site visits are essential for an accurate forecast, because site visits are mandatory in order to know items such as ground condition, construction site and traffic around the construction site. Before the tender, meetings are held by the owner and the designer. Thus, the questions of the contractors regarding the design, specification or project can be answered (Stadtler & Kilger, 2005).

Although project designs are sometimes similar, all projects are different from each other. Variables such as the location and time of the project have direct effects on the project cost. All these factors should be studied in detail when developing an estimate on project cost. The most basic of these factors that affect the pricing of the project are as follows (Akintoye, 2010; Jackson, 2010; Moore, 2003):

**Size:** One of the most important factors influencing the pricing of the project is the size of the project. The size of the project indirectly increases the productivity, because productivity

increases with the project. Otherwise, as the project grows, the unit cost decreases in bulk purchases.

**Complexity:** As Jackson (2010) points out, other important factors that increase productivity are the complexity and details of the project. What is meant by project complexity here are variables such as the type of product and the complexity of the design.

**Feasibility:** Project feasibility is affected by the scope of prefabrication and the integration of services into the construction process (Moore, 2003). Because these factors have an impact on a project's profitability and management, estimators should carefully consider them during forecasting.

**Location and Restrictions:** Location, constraints and project duration directly and indirectly affect productivity, material sourcing and delivery of materials. Therefore, these factors and possible differences must be considered for an accurate project calculation.

**Time:** There is usually a time gap between the acceptance of the project and the time it actually started. Therefore, fluctuations in prices, availability of labor and other variables should be carefully monitored during this free time period.

**Quality of Work:** As the details of the project become clear and become known to the relevant parties, the completion process of the project is positively affected. In addition, determining the required standards in advance affects the quality of work and the activity process.

**Team:** As Akintoye (2010) states in their work, "It is the responsibility of the estimation department to create resources and determine their costs". Therefore, selecting the project team from experienced people ensures control of resources and accurate costing.

**Management:** Management factors include determining different owner approaches and expectations and perceiving accordingly.

**Market and Economic Conditions:** Local and global economic conditions and the market are closely interrelated. Both have an impact on the pricing of all items of the project.

**Tender:** The level of competition seen in tenders has a strong effect on project pricing (Kim & Reinshmidit, 2010).

## **4. SUPPLY CHAIN IN TURKISH CONSTRUCTION SECTOR**

Supply chain management is very significant in construction sector in keeping the cost, time and quality at optimum. All these leads the project to be completed in success. In this context, supplier selection is also an extremely important issue in project success. This study aims to determine which factors are considered when choosing a supplier in the Turkish construction industry. Therefore, a questionnaire was conducted to define the most significant factors in supplier selection. The questionnaire used in the study includes two parts. First part was designed to have information about the selection way of the supplier company of the participants. The second part is for getting general information about the supplier company. The questionnaire was sent via "Google Forms" to 81 people (project managers, purchase managers, engineers and chiefs) working in different sub-branches of the construction industry throughout Turkey.

The results of the questionnaire was analyzed by using SPSS 21.0 and was run at a 95% confidence level. When the normality is examined, it is seen that each score does not provide normality. Nonparametric test techniques were used in the study because the scores did not show a normal distribution. To analyze whether the scale score differed according to demographic characteristics, Mann Whitney test and Kruskal Wallis test were used. While the Mann Whitney test was used in the analysis of demographic variables with two groups, the Kruskal Wallis test was used in the analysis of variables with groups of  $k$  ( $k > 2$ ).

### **4.1. Validity and Reliability Analysis**

#### **4.1.1. Exploratory factor analysis**

Exploratory factor analysis was managed to specify the construct validity of the scales used in the study. KMO and Bartlett tests were conducted for to understand whether the scale is suitable for factor analysis. While the KMO coefficient is calculated to test the size of the sample, the normal distribution condition is examined with the Bartlett test. In this context, the KMO test measurement result should be 50 and higher, and the Bartlett sphericity test result should be statistically important (Jeong, 2004). In the factor analysis process, the factor

load values were examined in the assignment of scale items to factors or removing them from the scale.

#### 4.1.2. Reliability analysis

Cronbach's alpha coefficient gives the reliability level of the scale. The coefficient ranges from 0 to 1. Attached to the Alpha ( $\alpha$ ) coefficient, the reliability of the scale is interpreted as follows (Nunnally, 1967).

- $.00 \leq \alpha < .40$  the scale is not reliable,
- $.40 \leq \alpha < .60$  the scale is lowly reliable,
- $.60 \leq \alpha < .80$  the scale is very reliable,
- $.80 \leq \alpha < 1.00$  the scale is highly reliable

KMO and Bartlett test results for the importance of factors in supplier selection for the construction company are shown in Table 4.1.

**Table 4.1.** KMO and Bartlett test results for the importance of factors in supplier selection for the construction company

|  |                    |          |
|--|--------------------|----------|
| Kaiser-Meyer-Olkin Measure of Sampling Adequacy. |                    | ,825     |
|  | Approx. Chi-Square | 2274,823 |
| Bartlett's Test of Sphericity                    | df                 | 561      |
|  | Sig.               | ,000     |

The KMO value was calculated as 0.825 in the factor analysis performed for the importance of factors in the selection of suppliers for the construction company. Accordingly, the sample size is suitable for factor analysis ( $KMO > 0.500$ ). Within the scope of Bartlett test, the  $X^2$  value was found to be 2274,823 and statistically significant ( $p < 0.05$ ). In accordance with the KMO and Bartlett test results, it was resulted that the data were suitable for factor analysis.

The Bartlett test makes decisions whether the data matrix is the unit matrix and whether the correlation between the variables is sufficient. It tests the null hypothesis that "All correlation

coefficients are zero". If the P value is  $<0.05$ , the data set is suitable for factor analysis. It clarifies whether the sample is sufficient for analysis.

KMO explains whether the sample is sufficient for analysis. KMO takes a value between 0 and 1. The closer it is to 1, the more suitable the sample is for factor analysis. The KMO value should be greater than 0.50.

A high KMO value means that each variable in the scale can be predicted perfectly by other variables. If the values are 0 or close to 0, no interpretation can be made based on these values because there is a scatter in the correlation distribution. As a result of the KMO test, if the value is less than 0.50, it is interpreted that the factor analysis cannot be continued (Cokluk et al., 2012).

#### **4.2. Analysis of the Results**

Due to the COVID-19 pandemic conditions, in this questionnaire conducted using Google Forms, all the answers given by the participants. It was determined that 81 participants answered each question. The participants consist of project managers, purchasing managers, supervisors, civil engineers and architects living in different cities of Turkey and working actively in the relevant sector. The survey questions consist of two parts, and can be seen in Appendix A. In the first part of the questionnaire, the working area of the company, the types of projects carried out and the number of people employed are asked.

The second part of the questionnaire includes 40 questions about supplier selection. Participants are asked to answer these questions in order of importance from 0 to 5.

At the end of the questionnaire, the analysis of the data was made with SPSS 21.0. While the validity and reliability analysis was actualized, the control of the construct validity of the scales was made with factor analysis. KMO and Bartlett tests were applied to understand whether the scale was suitable for factor analysis.

Factors in supplier selection are presented in Table 4.2., sorted from largest according to their own criteria.



**Table 4.2.** Factor analysis results for the importance of factors in supplier selection for the construction company

| Criteria  | Matter   | Factor Load | Disclosed Variance Ratio | Cronbach's Alpha |
|-----------|--|-------------|--------------------------|------------------|
|           | Supplier firm's ability to supply expected materials and equipment on time and in full   | ,777        |                          |                  |
|           | Discount rates provided by the supplier firm to your business  | ,768        |                          |                  |
|           | Easily communicating with the supplier firm's officials  | ,745        |                          |                  |
|           | Supplier firm can assist in case of return or change   | ,724        |                          |                  |
|           | Supplier firm's ability to deliver the work on time  | ,721        |                          |                  |
|           | Supplier firm's ability to deliver the work without errors and in full   | ,704        |                          |                  |
|           | Supplier firm's ability to respond to changes in the process   | ,693        |                          |                  |
|           | The ability of the supplier to offer free service and support in case of customer complaints   | ,692        |                          |                  |
| Criteria1 | Supplier firm can provide fast solutions to customer complaints  | ,666        | 31,914                   | ,953             |
|           | The problem-solving ability of the supplier  | ,647        |                          |                  |
|           | Using suppliers shortens project completion time   | ,644        |                          |                  |
|           | Supplier firm's ability to make appropriate changes that will provide convenience and benefit to the business regarding the process after the end of work. | ,636        |                          |                  |
|           | Payment facilities provided by the supplier firm to your business (check, maturity, etc. payment possibilities)  | ,624        |                          |                  |
|           | Using suppliers increases the quality of the project   | ,599        |                          |                  |
|           | Supplier firm is in constant active communication with the company   | ,590        |                          |                  |
|           | The ability of the supplier to adapt the   | ,587        |                          |                  |

|           |  |      |        |      |
|-----------|--|------|--------|------|
|           | transportation of materials and equipment to the conditions  |      |        |      |
|           | Supplier firm has the necessary personnel power, machinery and equipment competence  | ,583 |        |      |
|           | Supplier firm's ability to comply with technical specification standards and procedures  | ,579 |        |      |
|           | Supplier firm has the responsibility of quality improvement and consumer satisfaction  | ,578 |        |      |
|           | Job follow-up and business control of the supplier firm's management   | ,576 |        |      |
|           | Supplier firm's aptitude for technological developments and its ability to integrate easily with innovations                                   | ,570 |        |      |
|           | The quotation is given by the supplier for the job   | ,544 |        |      |
|           | The reliability of the supplier and the ability to protect the confidentiality of the terms of the agreement and not to abuse business secrets | ,536 |        |      |
|           | Using suppliers increases the prestige of the project  | ,536 |        |      |
|           | Supplier firm reduces the risk   | ,486 |        |      |
|           | Supplier firm's compliance with the management principles of your business   | ,473 |        |      |
|           | Using suppliers reduces the cost of the project and increases the profit rate  | ,453 |        |      |
|           | The reputation of the supplier in the market   | ,854 |        |      |
|           | References of the supplier   | ,798 |        |      |
|           | The experience of the supplier   | ,794 |        |      |
| Criteria2 | Certificates of the supplier (quality, assurance, system documents and certificates)   | ,776 | 18,681 | ,871 |
|           | The financial status and financial strength of the supplier  | ,680 |        |      |
|           | Failing to fulfill the contract obligations or accepting penalties for poor performance  | ,591 |        |      |
|           | Supplier firm's ability to understand the  | ,469 |        |      |

goals, objectives, mission and culture of  
your business

|       |        |      |
|-------|--------|------|
| Total | 50,595 | ,954 |
|-------|--------|------|

In accordance with the factor analysis results, it was specified that the scale consists of two criteria that is for the selection of the supplier company (Criteria 1) and for the general information about the supplier company (Criteria 2). Five items that 7, 10, 11, 14 and 15 were excluded from the analysis due to crossing over. In addition, an item (item 13) was excluded from the analysis because the factor load was less than 0.300.

The first criterion's scale that is for the selection of the supplier company includes 27 items with factor loads ranging from 0.453 to 0.777. The total variance explanation rate of the criterion is 31.914% and the reliability coefficient is 0.953. Accordingly, the reliability level of the criterion is very high.

The second criterion's scale that is for to get general information about the supplier company consists of 7 items with factor loads ranging from 0.469 to 0.854. The total variance explanation rate of the criterion is 18.681% and the reliability coefficient is 0.871. Accordingly, the reliability level of the criterion is very high.

The demographic variables of the sample of the study are shown in Table 4.3.

**Table 4.3.** Demographic variables

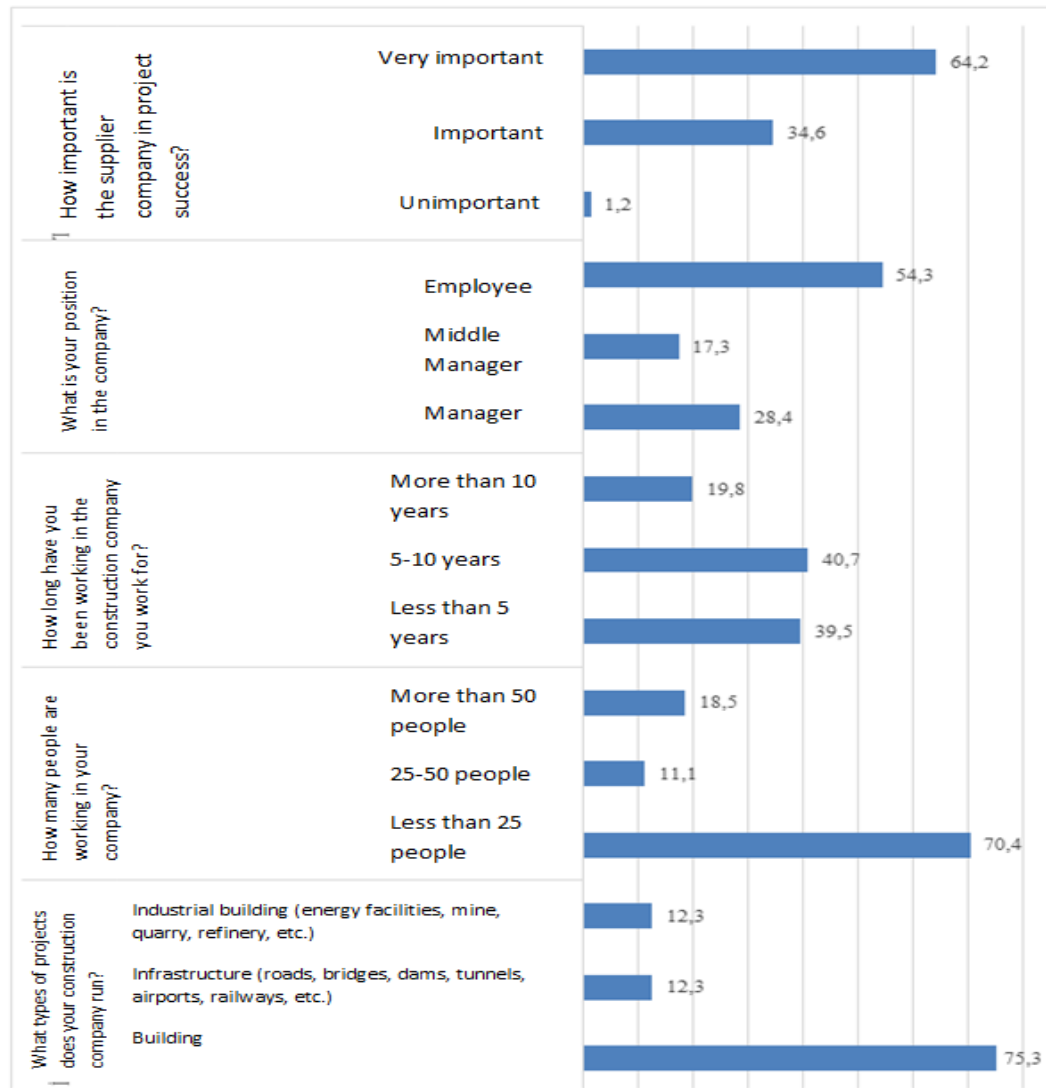
|  |           | n | %   |
|--|-----------|---|-----|
| In which city is your company located? | Ağrı      | 1 | 1,2 |
|  | Ankara    | 6 | 7,4 |
|  | Antalya   | 2 | 2,5 |
|  | Aydın     | 3 | 3,7 |
|  | Balıkesir | 3 | 3,7 |
|  | Batman    | 1 | 1,2 |
|  | Bursa     | 3 | 3,7 |
|  | Çanakkale | 2 | 2,5 |
|  | Çorum     | 1 | 1,2 |
|  | Denizli   | 3 | 3,7 |
|  | Eskişehir | 2 | 2,5 |

|  |  |    |      |
|--|--|----|------|
|  | Gaziantep  | 1  | 1,2  |
|  | Giresun  | 1  | 1,2  |
|  | Isparta  | 2  | 2,5  |
|  | İstanbul   | 22 | 27,2 |
|  | İzmir  | 3  | 3,7  |
|  | Kahramanmaraş  | 2  | 2,5  |
|  | Karabük  | 1  | 1,2  |
|  | Kırklareli   | 1  | 1,2  |
|  | Kocaeli  | 2  | 2,5  |
|  | Konya  | 1  | 1,2  |
|  | Malatya  | 1  | 1,2  |
|  | Manisa   | 1  | 1,2  |
|  | Mardin   | 2  | 2,5  |
|  | Mersin   | 1  | 1,2  |
|  | Muğla  | 1  | 1,2  |
|  | Nevşehir   | 2  | 2,5  |
|  | Ordu   | 1  | 1,2  |
|  | Samsun   | 1  | 1,2  |
|  | Sivas  | 1  | 1,2  |
|  | Tekirdağ   | 2  | 2,5  |
|  | Trabzon  | 1  | 1,2  |
|  | Van  | 1  | 1,2  |
|  | Yalova   | 1  | 1,2  |
|  | Yozgat   | 1  | 1,2  |
|  | Zonguldak  | 1  | 1,2  |
|  | Building   | 61 | 75,3 |
| What types of projects does your construction company run?               | Infrastructure (roads, bridges, dams, tunnels, airports, railways, etc.) | 10 | 12,3 |
|  | Industrial building (energy facilities, mine, quarry, refinery, etc.)    | 10 | 12,3 |
|  |  |    |      |
| How many people are working in your company?                             | Less than 25 people  | 57 | 70,4 |
|  | 25-50people  | 9  | 11,1 |
|  | More than 50 people  | 15 | 18,5 |
| How long have you been working in the construction company you work for? | Less than 5 years  | 32 | 39,5 |
|  | 5-10 years   | 33 | 40,7 |
|  | More than 10 years   | 16 | 19,8 |
| What is your position in the company?                                    | Manager  | 23 | 28,4 |
|  | Middle manager   | 14 | 17,3 |

|   |                |    |      |
|---|----------------|----|------|
|   | Employee       | 44 | 54,3 |
| How important is the supplier company in project success? | Not important  | 1  | 1,2  |
|   | Important      | 28 | 34,6 |
|   | Very important | 52 | 64,2 |

Among the participants, the rate of those whose company is in Istanbul is 27.2%, the rate of those who build construction companies is 75.3%, the rate of those who have less than 25 employees is 70.4%, the rate of those who have been working there for 5-10 years is 40.7%, the rate of those who work as employees is 54.3% and the rate of those who think the supplier firm is very significant in the success of the project is 64.2%.

Descriptive statistics regarding the order of importance of the factors for supplier selection are shown in Table 4.4. and percentages of answers in the first part of the survey are shown in Figure 4.1.



**Figure 4.1.** Company-related questions and percentages of answers in the first part of the survey

**Table 4.4.** Descriptive statistics for the order of importance of the factors given supplier selection

|  | ,0 |     | 1,0 |     | 2,0 |     | 3,0 |      | 4,0 |      | 5,0 |      | Avg  | ss   |
|--|----|-----|-----|-----|-----|-----|-----|------|-----|------|-----|------|------|------|
|  | n  | %   | n   | %   | n   | %   | n   | %    | n   | %    | n   | %    |      |      |
| The experience of the supplier               | 2  | 2,5 | 0   | 0,0 | 3   | 3,7 | 12  | 14,8 | 32  | 39,5 | 32  | 39,5 | 4,07 | 1,05 |
| The supplier firm's reputation in the market | 2  | 2,5 | 0   | 0,0 | 5   | 6,2 | 19  | 23,5 | 33  | 40,7 | 22  | 27,2 | 3,81 | 1,06 |
| References of the supplier                   | 2  | 2,5 | 0   | 0,0 | 4   | 4,9 | 24  | 29,6 | 27  | 33,3 | 24  | 29,6 | 3,80 | 1,08 |

|  |   |     |   |     |   |     |    |      |    |      |    |      |      |      |
|--|---|-----|---|-----|---|-----|----|------|----|------|----|------|------|------|
| The supplier company's certificates (Quality, assurance, system documents and other certificates)  | 2 | 2,5 | 1 | 1,2 | 5 | 6,2 | 11 | 13,6 | 24 | 29,6 | 38 | 46,9 | 4,07 | 1,17 |
| The financial status and financial strength of the supplier  | 2 | 2,5 | 0 | 0,0 | 1 | 1,2 | 15 | 18,5 | 30 | 37,0 | 33 | 40,7 | 4,10 | 1,02 |
| The supplier firm's price offer for the job  | 1 | 1,2 | 0 | 0,0 | 3 | 3,7 | 13 | 16,0 | 24 | 29,6 | 40 | 49,4 | 4,21 | 0,98 |
| The supplier firm's level of expertise (process style, skill and capability) and warranty policy   | 0 | 0,0 | 0 | 0,0 | 0 | 0,0 | 8  | 9,9  | 30 | 37,0 | 43 | 53,1 | 4,43 | 0,67 |
| The reliability of the supplier firm and the ability to protect the confidentiality of the terms of the agreement and not to abuse business secrets                      | 0 | 0,0 | 0 | 0,0 | 1 | 1,2 | 8  | 9,9  | 20 | 24,7 | 52 | 64,2 | 4,52 | 0,73 |
| The supplier firm has the necessary personnel power, machinery and equipment competence  | 0 | 0,0 | 3 | 3,7 | 3 | 3,7 | 6  | 7,4  | 25 | 30,9 | 44 | 54,3 | 4,28 | 1,02 |
| Business and technical knowledge of the supplier   | 0 | 0,0 | 0 | 0,0 | 2 | 2,5 | 9  | 11,1 | 21 | 25,9 | 49 | 60,5 | 4,44 | 0,79 |
| The supplier firm's ability to understand and meet the needs of our business   | 0 | 0,0 | 0 | 0,0 | 0 | 0,0 | 10 | 12,3 | 19 | 23,5 | 52 | 64,2 | 4,52 | 0,71 |
| Business follow-up and control of the supplier firm's management   | 0 | 0,0 | 0 | 0,0 | 0 | 0,0 | 10 | 12,3 | 25 | 30,9 | 46 | 56,8 | 4,44 | 0,71 |
| The location of the supplier (proximity to your project)   | 0 | 0,0 | 6 | 7,4 | 5 | 6,2 | 24 | 29,6 | 28 | 34,6 | 18 | 22,2 | 3,58 | 1,13 |
| While establishing the terms of the contract of the supplier firm, taking into account the interests of the other party and remaining loyal to the terms of the contract | 0 | 0,0 | 0 | 0,0 | 0 | 0,0 | 14 | 17,3 | 27 | 33,3 | 40 | 49,4 | 4,32 | 0,76 |
| Having a price policy suitable for the services provided by the supplier firm  | 0 | 0,0 | 0 | 0,0 | 3 | 3,7 | 11 | 13,6 | 28 | 34,6 | 39 | 48,1 | 4,27 | 0,84 |
| The supplier firm's ability to comply with technical specification standards and procedures  | 0 | 0,0 | 0 | 0,0 | 1 | 1,2 | 12 | 14,8 | 23 | 28,4 | 45 | 55,6 | 4,38 | 0,78 |
| The supplier firm's aptitude for technological developments and its ability to integrate easily with innovations   | 1 | 1,2 | 1 | 1,2 | 3 | 3,7 | 18 | 22,2 | 29 | 35,8 | 29 | 35,8 | 3,98 | 1,02 |
| The supplier firm can make appropriate changes that will provide convenience and benefit to the business regarding the process after the end of work                     | 0 | 0,0 | 0 | 0,0 | 0 | 0,0 | 16 | 19,8 | 32 | 39,5 | 33 | 40,7 | 4,21 | 0,75 |
| The supplier firm has the responsibility of quality improvement and consumer satisfaction.   | 0 | 0,0 | 0 | 0,0 | 2 | 2,5 | 13 | 16,0 | 35 | 43,2 | 31 | 38,3 | 4,17 | 0,79 |

|   |   |     |   |     |   |     |    |      |    |      |    |      |      |      |
|---|---|-----|---|-----|---|-----|----|------|----|------|----|------|------|------|
| The supplier firm's ability to understand the goals, objectives, mission and culture of your business             | 0 | 0,0 | 0 | 0,0 | 5 | 6,2 | 22 | 27,2 | 25 | 30,9 | 29 | 35,8 | 3,96 | 0,94 |
| The supplier firm's compliance with the management principles of your business                                    | 0 | 0,0 | 2 | 2,5 | 3 | 3,7 | 17 | 21,0 | 30 | 37,0 | 29 | 35,8 | 4,00 | 0,97 |
| The supplier firm is in constant active communication with the company  | 0 | 0,0 | 0 | 0,0 | 3 | 3,7 | 16 | 19,8 | 24 | 29,6 | 38 | 46,9 | 4,20 | 0,89 |
| The supplier firm's ability to respond to changes in the process  | 0 | 0,0 | 0 | 0,0 | 0 | 0,0 | 13 | 16,0 | 26 | 32,1 | 42 | 51,9 | 4,36 | 0,75 |
| The supplier firm's ability to supply expected materials and equipment on time and in full                        | 0 | 0,0 | 1 | 1,2 | 0 | 0,0 | 12 | 14,8 | 16 | 19,8 | 52 | 64,2 | 4,46 | 0,84 |
| The supplier firm's ability to adapt material and equipment transportation to the conditions                      | 0 | 0,0 | 0 | 0,0 | 1 | 1,2 | 7  | 8,6  | 30 | 37,0 | 43 | 53,1 | 4,42 | 0,70 |
| Discount rates provided by the supplier firm to your business   | 0 | 0,0 | 0 | 0,0 | 5 | 6,2 | 14 | 17,3 | 30 | 37,0 | 32 | 39,5 | 4,10 | 0,90 |
| Payment facilities provided by the supplier firm to your business (payment options such as draft, maturity, etc.) | 1 | 1,2 | 0 | 0,0 | 3 | 3,7 | 17 | 21,0 | 24 | 29,6 | 36 | 44,4 | 4,11 | 1,00 |
| The supplier firm's ability to deliver the work on time   | 0 | 0,0 | 0 | 0,0 | 1 | 1,2 | 6  | 7,4  | 18 | 22,2 | 56 | 69,1 | 4,59 | 0,69 |
| The supplier firm's ability to deliver the work without errors and in full  | 0 | 0,0 | 1 | 1,2 | 4 | 4,9 | 7  | 8,6  | 17 | 21,0 | 52 | 64,2 | 4,42 | 0,93 |
| Easily communicating with the supplier firm's officials   | 0 | 0,0 | 0 | 0,0 | 0 | 0,0 | 7  | 8,6  | 28 | 34,6 | 46 | 56,8 | 4,48 | 0,65 |
| Failure to fulfill the agreement obligations or accept penalties for poor performance                             | 0 | 0,0 | 0 | 0,0 | 5 | 6,2 | 18 | 22,2 | 28 | 34,6 | 30 | 37,0 | 4,02 | 0,92 |
| Providing quick solutions to customer complaints by the supplier  | 0 | 0,0 | 0 | 0,0 | 0 | 0,0 | 9  | 11,1 | 27 | 33,3 | 45 | 55,6 | 4,44 | 0,69 |
| Providing free service and support by the supplier in case of customer complaints                                 | 0 | 0,0 | 0 | 0,0 | 3 | 3,7 | 12 | 14,8 | 29 | 35,8 | 37 | 45,7 | 4,23 | 0,84 |
| The supplier firm can assist in case of return or change  | 0 | 0,0 | 0 | 0,0 | 0 | 0,0 | 13 | 16,0 | 22 | 27,2 | 46 | 56,8 | 4,41 | 0,75 |
| The problem-solving ability of the supplier   | 0 | 0,0 | 0 | 0,0 | 0 | 0,0 | 11 | 13,6 | 19 | 23,5 | 51 | 63,0 | 4,49 | 0,73 |
| Supplier company's risk reduction   | 0 | 0,0 | 0 | 0,0 | 0 | 0,0 | 14 | 17,3 | 39 | 48,1 | 28 | 34,6 | 4,17 | 0,70 |
| Using suppliers reduces project completion time   | 0 | 0,0 | 1 | 1,2 | 6 | 7,4 | 15 | 18,5 | 34 | 42,0 | 25 | 30,9 | 3,94 | 0,95 |



---

|  |   |     |   |     |   |     |    |      |    |      |    |      |      |      |
|--|---|-----|---|-----|---|-----|----|------|----|------|----|------|------|------|
| Using suppliers to increase the quality of the Project | 0 | 0,0 | 1 | 1,2 | 2 | 2,5 | 19 | 23,5 | 25 | 30,9 | 34 | 42,0 | 4,10 | 0,93 |
|--|---|-----|---|-----|---|-----|----|------|----|------|----|------|------|------|

---

|   |   |     |   |     |   |     |    |      |    |      |    |      |      |      |
|---|---|-----|---|-----|---|-----|----|------|----|------|----|------|------|------|
| Using suppliers to increase the prestige of the project | 0 | 0,0 | 2 | 2,5 | 5 | 6,2 | 17 | 21,0 | 23 | 28,4 | 34 | 42,0 | 4,01 | 1,05 |
|---|---|-----|---|-----|---|-----|----|------|----|------|----|------|------|------|

---

|   |   |     |   |     |   |     |    |      |    |      |    |      |      |      |
|---|---|-----|---|-----|---|-----|----|------|----|------|----|------|------|------|
| Using suppliers reduces the cost of the project and increases the profit rate | 0 | 0,0 | 0 | 0,0 | 2 | 2,5 | 18 | 22,2 | 28 | 34,6 | 33 | 40,7 | 4,14 | 0,85 |
|---|---|-----|---|-----|---|-----|----|------|----|------|----|------|------|------|

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In this study, which was managed to specify which factors are more significant in supplier selection in Turkey, a 5-point Likert scale was used. 0, 1.0, 2.0, 3.0, 4.0, 5.0 statements were also ranked according to the answers given by the participants from "strongly disagree" to "strongly agree".

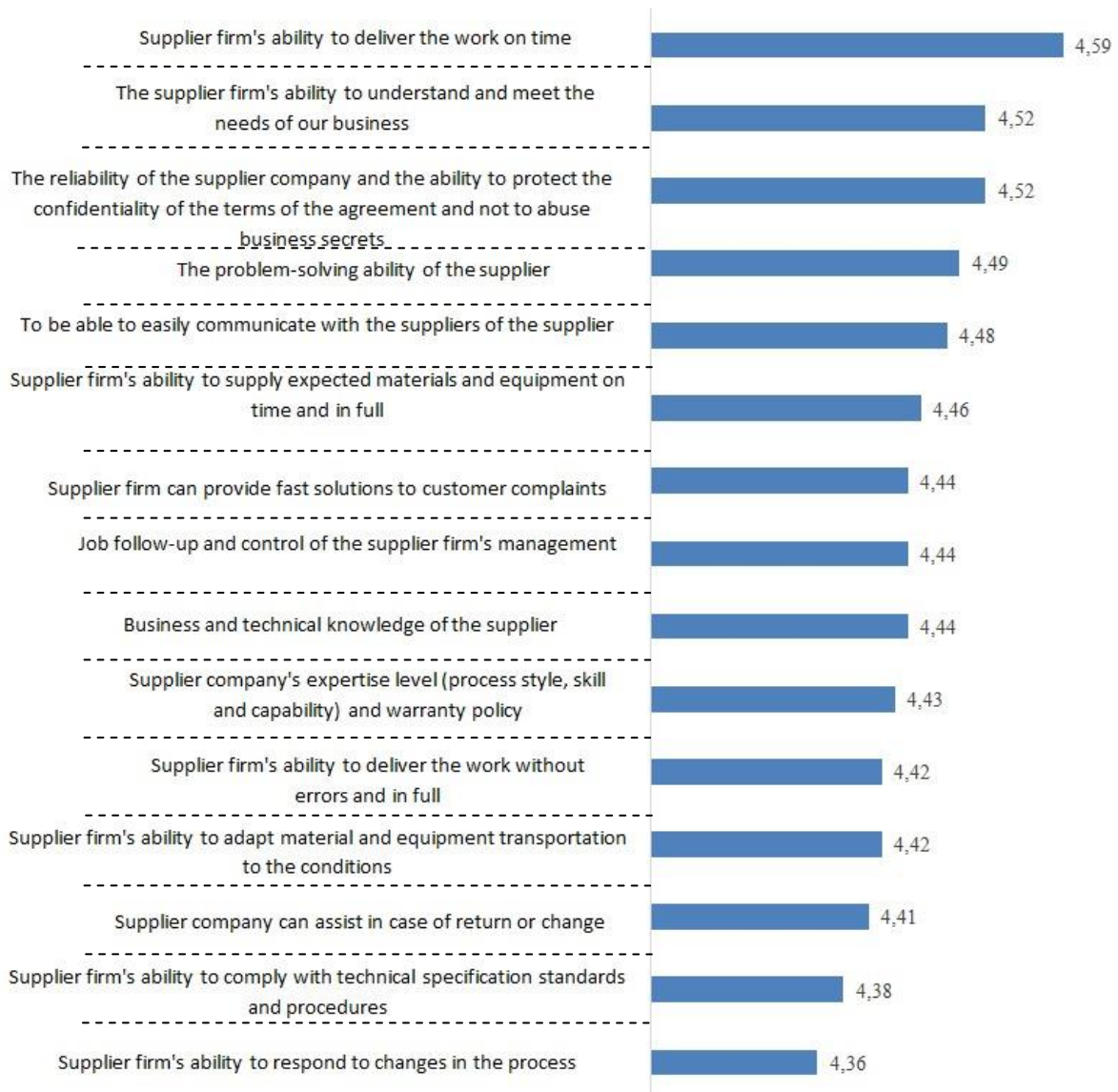
Among the factors given in the selection of suppliers for the construction company, the statements with the highest order of importance are as follows:

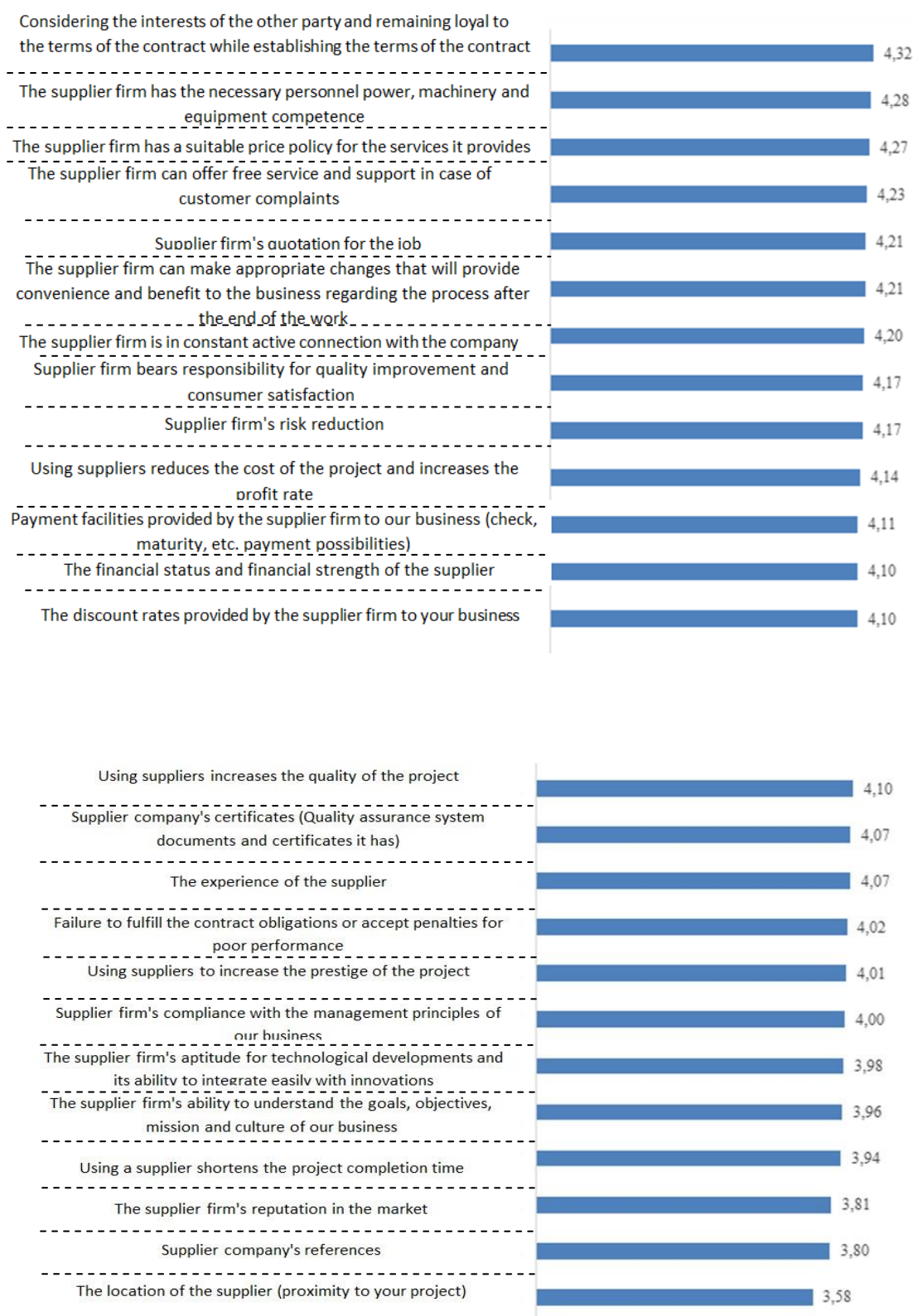
- Supplier firm can deliver the work on time
- The supplier firm's ability to understand and meet the needs of our business
- The reliability of the supplier and the ability to protect the confidentiality of the terms of the agreement and not to abuse business secrets
- The supplier's ability to troubleshoot
- Easy communication with the supplier firm's officials

The statements with the lowest order of importance are as follows:

- The location of the supplier (proximity to your project)
- References of the supplier
- The supplier firm's reputation in the market
- Using suppliers reduces project completion time
- The supplier firm's ability to understand the goals, objectives, mission and culture of your business.

Descriptive statistics on the importance of factors in supplier selection are shown in Table 4.5. and ranking of the factors in supplier selection according to the survey results in order of importance Figure 4.2.





**Figure 4.2.** Ranking of the factors in supplier selection according to the survey results in order of importance

**Table 4.5.** The importance of factors in selection of participants' suppliers

|   | n  | Minimum | Maximum | Avg  | ss   |
|---|----|---------|---------|------|------|
| The Importance of Factors in the Selection of Participants' Suppliers for the selection of the supplier company             | 81 | 2,81    | 5,00    | 4,27 | 0,57 |
| The Importance of Factors in the Selection of Participants' Suppliers to get general information about the supplier company | 81 | ,71     | 5,00    | 3,98 | 0,78 |
| The Importance of the Factors in the Supplier Selection   | 81 | 1,97    | 5,00    | 4,12 | 0,60 |

The average of The Importance of Factors in the Selection of Participants' Suppliers for the selection of the supplier company is 4.27, the average of The Importance of Factors in the Selection of Participants' Suppliers to get general information about the supplier company is 3.98, the average of The Importance of the Factors in the Supplier Selection is 4.12.

The results of the normality test for the importance of factors in supplier selection are shown in Table 4.6.

**Table 4.6.** Normality test for the importance of factors in supplier selection

|   | Shapiro-Wilk |    |      |
|---|--------------|----|------|
|   | Statistic    | n  | p    |
| The Importance of Factors in the Selection of Participants' Suppliers for the selection of the supplier company             | ,911         | 81 | ,000 |
| The Importance of Factors in the Selection of Participants' Suppliers to get general information about the supplier company | ,858         | 81 | ,000 |
| The Importance of the Factors in the Supplier Selection   | ,918         | 81 | ,000 |

According to the normality analysis, it is seen that the Importance of Factors in Supplier Selection and sub-criteria scores do not provide normality ( $p < 0.05$ ). Accordingly, nonparametric test techniques were used in our analysis.

The examination of the importance of the factors in supplier selection in terms of the type of project carried out by the construction company is shown in Table 4.7.

**Table 4.7.** The importance of project type in supplier selection

|   | What types of projects does your construction company run? |     |        |  |     |        |   |     |        | X2    | p    |
|---|--|-----|--------|--|-----|--------|---|-----|--------|-------|------|
|   | Building   |     |        | Infrastructure (roads, bridges, dams, tunnels, airports, railways, etc.) |     |        | Industrial building (energy facilities, mine, quarry, refinery, etc.) |     |        |       |      |
|   | Avg  | ss  | Median | Avg  | ss  | Median | Avg   | ss  | Median |       |      |
| The Importance of Factors in the Selection of Participants' Suppliers Criteria1 | 4,28   | ,56 | 4,41   | 3,97   | ,70 | 4,21   | 4,48  | ,38 | 4,54   | 2,614 | ,271 |
| The Importance of Factors in the Selection of Participants' Suppliers Criteria2 | 3,95   | ,84 | 4,14   | 3,96   | ,58 | 3,71   | 4,17  | ,59 | 4,14   | ,627  | ,731 |
| The Importance of the Factors in the Supplier Selection                         | 4,12   | ,63 | 4,18   | 3,96   | ,56 | 4,00   | 4,33  | ,43 | 4,30   | 1,681 | ,432 |

The results of the Kruskal Wallis test managed to examine the importance of factors in the selection of suppliers in terms of the type of project carried out by the construction company are given below.

There is no statistically important difference between the groups with different types of projects carried out by the construction company in terms of the importance of factors in supplier selection and sub-criteria scores ( $p > 0.05$ ).

The examination of the importance of the factors in supplier selection in terms of the number of employees in the company is shown in Table 4.8.

**Table 4.8.** The importance of factors in supplier selection in terms of the number of employees in their company

|   | How many people work in your company? |     |        |              |     |        |                     |     |        | X2    | p    |
|---|---------------------------------------|-----|--------|--------------|-----|--------|---------------------|-----|--------|-------|------|
|   | Less than 25 people                   |     |        | 25-50 people |     |        | More than 50 people |     |        |       |      |
|   | Avg                                   | ss  | Median | Avg          | ss  | Median | Avg                 | ss  | Median |       |      |
| The Importance of Factors in the Selection of Participants' Suppliers Criteria1 | 4,23                                  | ,62 | 4,41   | 4,33         | ,39 | 4,37   | 4,38                | ,41 | 4,41   | ,281  | ,869 |
| The Importance of Factors in the Selection of Participants' Suppliers Criteria2 | 3,91                                  | ,85 | 4,00   | 3,92         | ,60 | 3,71   | 4,26                | ,54 | 4,29   | 2,714 | ,257 |
| The Importance of the Factors in the Supplier Selection                         | 4,07                                  | ,67 | 4,15   | 4,12         | ,45 | 4,12   | 4,32                | ,36 | 4,29   | 1,110 | ,574 |

The results of the Kruskal Wallis test managed to examine the importance of factors in the selection of suppliers in terms of the number of employees in their company are given below.

There is no statistically important difference between the groups with different number of employees in their company in terms of the importance of factors in supplier selection and sub-criterion scores ( $p > 0.05$ ).

The examination of the importance of the factors in supplier selection in terms of tenure in the employee construction company is shown in Table 4.9.

**Table 4.9.** The importance of factors in supplier selection in terms of tenure in the working construction company

|   | How long have you been working in the construction company you work for? |     |        |            |     |        |                    |     |        | X2    | p    |
|---|--|-----|--------|------------|-----|--------|--------------------|-----|--------|-------|------|
|   | Less than 5 years  |     |        | 5-10 years |     |        | More than 10 years |     |        |       |      |
|   | Avg  | ss  | Median | Avg        | ss  | Median | Avg                | ss  | Median |       |      |
| The Importance of Factors in the Selection of Participants' Suppliers Criteria1 | 4,28   | ,62 | 4,46   | 4,31       | ,58 | 4,44   | 4,17               | ,42 | 4,09   | 2,498 | ,287 |

|   |      |      |      |      |     |      |      |     |      |      |      |
|---|------|------|------|------|-----|------|------|-----|------|------|------|
| The Importance of Factors in the Selection of Participants' Suppliers Criteria2 | 3,90 | 1,06 | 4,14 | 4,01 | ,51 | 4,14 | 4,07 | ,58 | 4,07 | ,072 | ,965 |
| The Importance of the Factors in the Supplier Selection                         | 4,09 | ,79  | 4,18 | 4,16 | ,47 | 4,21 | 4,12 | ,40 | 4,06 | ,452 | ,798 |

The results of the Kruskal Wallis test conducted to examine the importance of factors in supplier selection in terms of tenure in the working construction company are given below.

There is no statistically important difference between the groups with different tenure periods in the construction company they work for, in terms of the importance of factors in supplier selection and sub-criteria scores ( $p > 0.05$ ).

The examination of the importance of factors in supplier selection in terms of employee position is shown in Table 4.10.

**Table 4.10.** The importance of factors in supplier selection in terms of employee position

|   | What is your position in the company? |     |        |                |     |        |          |     |        | X2    | p    |
|---|---------------------------------------|-----|--------|----------------|-----|--------|----------|-----|--------|-------|------|
|   | Manager                               |     |        | Middle manager |     |        | Employee |     |        |       |      |
|   | Avg                                   | ss  | Median | Avg            | ss  | Median | Avg      | ss  | Median |       |      |
| The Importance of Factors in the Selection of Participants' Suppliers Criteria1 | 4,17                                  | ,60 | 4,19   | 4,33           | ,58 | 4,60   | 4,30     | ,55 | 4,39   | 1,041 | ,594 |
| The Importance of Factors in the Selection of Participants' Suppliers Criteria2 | 3,99                                  | ,65 | 4,00   | 4,18           | ,54 | 4,29   | 3,91     | ,90 | 4,00   | 1,347 | ,510 |
| The Importance of the Factors in the Supplier Selection                         | 4,08                                  | ,57 | 4,17   | 4,26           | ,53 | 4,43   | 4,10     | ,65 | 4,12   | 1,401 | ,496 |

The results of the Kruskal Wallis test managed to examine the importance of factors in supplier selection in terms of employee positions are given below.

There is no statistically important difference between the groups with different positions in terms of the importance of factors in supplier selection and sub-criteria scores ( $p > 0.05$ ).

In Table 4.11., it is seen that the importance of the factors in supplier selection is examined in terms of the significance of the supplier company in the project success.

**Table 4.11.** The importance of factors in supplier selection in terms of the importance of the supplier in the project success

|   | How important is the supplier company in project success? |     |        |                |     |        | U       | p     |
|---|---|-----|--------|----------------|-----|--------|---------|-------|
|   | Important   |     |        | Very important |     |        |         |       |
|   | Avg   | ss  | Median | Avg            | ss  | Median |         |       |
| The Importance of Factors in the Selection of Participants' Suppliers Criteria1 | 4,09  | ,48 | 4,06   | 4,40           | ,55 | 4,52   | 422,500 | ,002* |
| The Importance of Factors in the Selection of Participants' Suppliers Criteria2 | 3,77  | ,99 | 3,93   | 4,10           | ,62 | 4,14   | 595,500 | ,180  |
| The Importance of the Factors in the Supplier Selection                         | 3,93  | ,68 | 4,03   | 4,25           | ,52 | 4,26   | 512,000 | ,029* |

Mann Whitney test results are given below to examine the importance of factors in supplier selection in terms of the importance of supplier company project success.

There is a statistically important difference in terms of the Importance of Factors in Supplier Selection Criteria 1 between the groups with different importance in the supplier firm project success ( $p < 0.05$ ). While the average of those who consider it important is 4.09, the average of those who consider it very important is 4.40. Accordingly, the Importance of Factors in Supplier Selection Criteria 1 average is significantly higher for those who consider the supplier firm to be very important in project success.

There is a statistically important difference between the groups whose importance is different in the supplier firm project success in terms of the Importance of the Factors in Supplier Selection ( $p < 0.05$ ). While the average of those who consider it important is 3.93, the average of those who see it as very important is 4.25. Accordingly, the mean of the Importance of Factors in Supplier Selection is significantly higher for those who consider the supplier firm to be very important in the success of the project.



### **4.3. Discussion**

Companies apply various methods to identify its suppliers in order to establish long-term relationships and strategic partnerships. Supplier selection; development, continuity, references, reputation and experience, quality assurance, commitment to responsible supply chains, financial structure, authorization documents and other factors required by the relevant business area. Also; suppliers in line with their goals and strategies; it is constantly monitored within the scope of criteria such as providing a price advantage according to market conditions, meeting the business expectations of quality logistics performance, observing ethical rules, keeping up with the developing and changing sector conditions. Supplier selection is made by considering development, future, continuity, references, reputation and experience, quality assurance, commitment to responsible supply chains, financial structure, authorization documents and other factors required by the relevant business area. Also; suppliers in line with their goals and strategies; it is constantly monitored within the scope of criteria such as providing a price advantage according to market conditions, meeting the business expectations of quality logistics performance, observing ethical rules, keeping up with the developing and changing sector conditions.

While the role of the supplier requires meeting the demands at the desired cost, quality and time, it also requires it to systematically manage the system, product and environmental safety conditions. The objectives of reducing material costs, increasing quality and accelerating and developing all processes have led construction companies to supplier selection management in recent years. Supplier selection is a very important activity within the purchasing function. The main purpose of supplier selection; is to identify suppliers that can meet expectations.

Material supply and management in the construction industry; All planning for the realization of the functions of determining the necessary materials and their quantities, determining the suppliers from which the material will be supplied, receiving offers from the suppliers, evaluating the offers, choosing the supplier company, delivering the material on time, performing the requested quality control of the materials, delivering the material to the construction site in a reliable and economical way, includes control and supervision processes.

According to the results of the surveys conducted with 81 people working in the construction sector from various provinces of Turkey, it has been understood that the most important factor

in supplier selection is "the supplier's ability to deliver the work on time". Therefore, when choosing a supplier, it is first considered whether it can deliver the work on time. In this context, "delivering the work on time" is extremely important for sector employees.

When there is a supplier who delivers the work on time, the issue arises whether that supplier will understand the business needs and whether he can respond to the business needs. Working with a supplier that is thought to be unable to respond to the company's needs despite delivering the work on time is not a preferable situation for sector employees. Therefore, the second prominent item in supplier selection was determined as "the supplier company's ability to understand and meet the needs of our business".

When a supplier is found that can deliver the work on time and meet the company's needs, the required feature is determined as "the reliability of the company, the ability to protect the confidentiality of the terms of the agreement and not misuse the business secrets". Since the supplier companies work with many companies in the sector, it is extremely important for the employees of the sector that the secrets are kept confidential and not shared with the competitors. In this context, one of the three most important features in supplier selection is securing company secrets.

In addition to the three most important features listed above, the supplier company's ability to solve problems and the ability to easily communicate with supplier company officials are of secondary importance in supplier selection. Although not as important as the first three items, these items, which make supplier selection important, are considered indispensable for some companies.

The least important issue in the selection of the supplier company was determined as the location of the company. The location of a supplier that provides all of the above-mentioned features is not important for industry employees working with suppliers.

In addition to the position of the supplier company, its references are the second of the three least important issues in terms of company selection. In this context, sector employees choose suppliers based on interpersonal trust, not references. The third issue that is least important in choosing a company is how well-known the company is in the market. Therefore, even if it is a supplier company that has just entered the market, it can be preferred by the company when it meets the needs of "delivering the work on time, responding to the needs of the company

and protecting the company's secrets". The other least important items were determined as shortening the project period of the supplier company and the company's ability to understand the goals, mission and culture of the business. Since projects have a certain deadline, shortening this period does not make a firm more preferable. On the other hand, "delivering the work on time" is one of the main reasons for choosing the company.

75.3% of those who participated in the survey conducted with 81 people operate as a construction company that makes buildings. In 70.4% of the participating companies, the number of employees is less than 25. Considering the working time, the rate of working in the same place between 5 and 10 years was determined as 40.7%. 64.2% of all participants think that choosing a supplier is very important for a project to be successful.

No statistically important difference was found in terms of Importance of Factors in Supplier Selection and sub-dimension scores in the surveys conducted among groups with different types of projects carried out by the construction company. Considering the groups with different number of people working in the company, no statistically important difference was found between the importance of factors in supplier selection and sub-dimension scores.

No statistically significant difference was found in terms of Importance of Factors in Supplier Selection and sub-dimension scores in the surveys conducted between groups with different tenures in the construction company they work for. There is no statistically significant difference between the groups with different positions in terms of the Importance of Factors in Supplier Selection and sub-dimension scores.

A statistically significant difference was determined in terms of the Importance of Factors in Supplier Selection Dimension1 among the groups with different degrees of importance in the project success of the supplier company. In this context, the average of those who consider factors important in supplier selection is 4.09, and the average of those who consider it very important is 4.40. Therefore, the average of those who think that the supplier company is important in the success of the project is significantly higher than those who think that the factors are important in supplier selection.

There is a statistically important difference in terms of the Importance of Factors in Supplier Selection between the groups with different degrees of importance in the project success of the supplier company. While the average of those who consider the place of the supplier

company important in the project success is 3.93, the average of those who consider it very important is 4.25. Accordingly, the average of the Importance of Factors in Supplier Selection is significantly higher for those who think that the supplier company is very important in the success of the project.

## **5. CONCLUSION**

The supply chain ensures that the time, quality and cost components that form the basis of a construction project work in harmony with each other and with high performance. The increasing competition we have mentioned before has further increased the efforts of companies to offer cheaper, faster and higher quality products to the customers. A good management is required to complete projects with the optimum time and cost, together with the coordinated work of many different disciplines. When choosing a supplier company, having an organization and establishing a supplier selection management procedure is of great importance in terms of profitability, productivity and quality. In this process, the efficiency of supply chain management is extremely important. Because the more successful a company is in managing its supply chain, the more competitive power is in the market.

Close cooperation developed with suppliers; it is observed that it has made extremely positive contributions in issues such as increasing product quality, lowering purchasing costs, expanding production and distribution areas, and increasing customer satisfaction. Correct coordination of material, information and money flows ensures successful supply chain management. The more effective the supply chain management of the companies, the more their competitive power increases.

The construction supply chain consists of customer demands, design, construction, maintenance, renovation, repair and project completion stages. Supply chain management concept is a new concept in the construction industry. Therefore, the factors necessary for the formation of supply chain management in the construction sector are different from the production sector. Supply chain management in the construction sector is in a constant state of development as it has just begun to be implemented.

It was necessary and important to conduct a survey to analyze the factors affecting supplier selection in construction projects. In this context; a poll by the work of 80 people participated in the construction industry firms in different cities was held in Turkey. In the construction sector in Turkey, mostly supplier selection is performed taking into account only the cost. That's why; It was important for the purpose of the study that people from different management positions participated in the survey. According to the responses from the people, the factors that are important in the selection of the supplier in the projects were analyzed.

According to the results of the analysis of the survey, contrary to popular belief, the factors necessary for the company to progress the project in a healthier and more complete way have been superior to the time-dependent factors in the selection of the supplier. With the surveys conducted with 81 people working in the construction sector from various provinces of Turkey, the points to be considered in the selection of suppliers were determined. Respondents to the survey listed the factors they care most about in supplier selection out of 5 points, and "delivering the work on time" ranked first with 4.59.

"Delivering the work on time" has been defined as the most significant factor in selecting a supplier. The ability of the supplier company to understand and meet the business needs was determined as the second issue that company owners care most, with a score of 4.52 out of 5. Company reliability and secrecy of sectoral secrets were determined as the third most significant issue in supplier selection with a score of 4.52.

The problem-solving ability of the supplier company (4.49) and the ability to communicate easily with the authorities (4,48) were determined as other issues to be considered in supplier selection.

According to the results of the survey; No statistically important difference was found in terms of Importance of Factors in Supplier Selection and sub-dimension scores in the surveys conducted between groups with different types of projects carried out by the construction company. Considering the groups with different number of people working in the company, no statistically important difference was found between the importance of factors in supplier selection and sub-dimension scores. No statistically significant difference was found in terms of Importance of Factors in Supplier Selection and sub-dimension scores in the surveys conducted between groups with different tenures in the construction company they work for.

There is no statistically important difference between the groups with different positions in terms of the Importance of Factors in Supplier Selection and sub-dimension scores. A statistically important difference was determined in terms of the Importance of Factors in Supplier Selection Dimension1 among the groups with different degrees of importance in the project success of the supplier company. In this context, the average of those who consider factors important in supplier selection is 4.09, and the average of those who consider it very important is 4.40. Therefore, the average of those who think that the supplier company is important in the success of the project is significantly higher than those who think that the factors are important in supplier selection.

There is a statistically important difference in terms of the Importance of Factors in Supplier Selection between the groups with different importance in the project success of the supplier company. While the average of those who consider the place of the supplier company important in the project success is 3.93, the average of those who consider it very important is 4.25. Accordingly, the average of the Importance of Factors in Supplier Selection is significantly higher for those who think that the supplier company is very important in the project success.

It is thought that the results of the study can be helpful for those working in the construction sector in Turkey and also for researchers intending to study on supplier selection. In this context, the primary step to be taken is to explain to all stakeholders with concrete examples what benefits will be provided by choosing the right supplier. In future studies, it is recommended to examine the supplier selection criteria by applying different methods and making a comparative analysis.

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## APPENDIX A

QUESTIONNAIRE : Supplier selection approaches in Turkish construction firms' professionals

|   |   |   |   |   |   |   |
|---|---|---|---|---|---|---|
| 1) The supplier firm's experience   | 0 | 1 | 2 | 3 | 4 | 5 |
| 2) Recognition of the supplier in the market  | 0 | 1 | 2 | 3 | 4 | 5 |
| 3) The supplier firm's references   | 0 | 1 | 2 | 3 | 4 | 5 |
| 4) Certificates of the supplier firm (Quality assurance system documents and certificates)  | 0 | 1 | 2 | 3 | 4 | 5 |
| 5) Financial position and financial strength of the supplier firm   | 0 | 1 | 2 | 3 | 4 | 5 |
| 6) The price offer given by the supplier for the work   | 0 | 1 | 2 | 3 | 4 | 5 |
| 7) The supplier firm's level of expertise (operating style, skill and capability) and warranty policy   | 0 | 1 | 2 | 3 | 4 | 5 |
| 8) The reliability of the supplier firm, its ability to protect the confidentiality of the terms of the agreement and not to abuse business secrets | 0 | 1 | 2 | 3 | 4 | 5 |
| 9) Required personnel strength and equipment adequacy of the supplier firm  | 0 | 1 | 2 | 3 | 4 | 5 |
| 10) Business and technical information of the supplier firm   | 0 | 1 | 2 | 3 | 4 | 5 |
| 11) The supplier's ability to understand and meet the needs of our business   | 0 | 1 | 2 | 3 | 4 | 5 |
| 12) Work follow-up and work control of the supplier firm's management   | 0 | 1 | 2 | 3 | 4 | 5 |
| 13) Location of the supplier (proximity to your project)  | 0 | 1 | 2 | 3 | 4 | 5 |

|   |   |   |   |   |   |   |
|---|---|---|---|---|---|---|
| 14) While the supplier firm establishes the terms of the contract, the other party's interests are also observed and it remains loyal to the terms of the contract. | 0 | 1 | 2 | 3 | 4 | 5 |
| 15) The supplier firm has an appropriate price policy for the services it provides.   | 0 | 1 | 2 | 3 | 4 | 5 |
| 16) The supplier's ability to comply with technical specification standards and procedures  | 0 | 1 | 2 | 3 | 4 | 5 |
| 17) The susceptibility of the supplier to technological developments and the ability to easily integrate with innovations   | 0 | 1 | 2 | 3 | 4 | 5 |
| 18) The supplier's ability to make appropriate changes that will provide convenience and benefit to the business regarding the process after the end of the job.    | 0 | 1 | 2 | 3 | 4 | 5 |
| 19) The supplier's responsibility for quality improvement and consumer satisfaction   | 0 | 1 | 2 | 3 | 4 | 5 |
| 20) The supplier's understanding of the goals, objectives, mission and culture of our business  | 0 | 1 | 2 | 3 | 4 | 5 |
| 21) Compliance of the supplier firm with the management principles of our business  | 0 | 1 | 2 | 3 | 4 | 5 |
| 22) The supplier firm is in a continuous active connection with the business  | 0 | 1 | 2 | 3 | 4 | 5 |
| 23) The supplier's ability to respond to changes in the process   | 0 | 1 | 2 | 3 | 4 | 5 |
| 24) The supplier's ability to provide the expected materials and equipment on time and completely   | 0 | 1 | 2 | 3 | 4 | 5 |
| 25) The supplier's ability to adapt the transportation of materials and equipment to the requirements   | 0 | 1 | 2 | 3 | 4 | 5 |
| 26) Discount rates provided by the supplier firm to our business  | 0 | 1 | 2 | 3 | 4 | 5 |
| 27) Payment facilities provided by the supplier firm to our business (check, maturity etc.)   | 0 | 1 | 2 | 3 | 4 | 5 |
| 28) The supplier's ability to deliver the job on time   | 0 | 1 | 2 | 3 | 4 | 5 |
| 29) The supplier's ability to deliver the work without errors and in full   | 0 | 1 | 2 | 3 | 4 | 5 |
| 30) Easy communication with the authorities of the supplier firm  | 0 | 1 | 2 | 3 | 4 | 5 |
| 31) The supplier's ability to accept penalties for failure to fulfill its contractual obligations or for poor performance   | 0 | 1 | 2 | 3 | 4 | 5 |
| 32) The supplier's ability to provide quick solutions to customer complaints  | 0 | 1 | 2 | 3 | 4 | 5 |
| 33) The supplier's ability to provide free service and support in case of customer complaints   | 0 | 1 | 2 | 3 | 4 | 5 |
| 34) The supplier firm can help in case of return or exchange  | 0 | 1 | 2 | 3 | 4 | 5 |

|  |   |   |   |   |   |   |
|--|---|---|---|---|---|---|
| 35) Troubleshooting capability of the supplier   | 0 | 1 | 2 | 3 | 4 | 5 |
| <b>The Questions about the Supplier Contributions to the Project</b>                   |   |   |   |   |   |   |
| 36) Utilizing suppliers reduces risk   | 0 | 1 | 2 | 3 | 4 | 5 |
| 37) Utilizing suppliers shortens project completion time                               | 0 | 1 | 2 | 3 | 4 | 5 |
| 38) Utilizing suppliers increases the quality of the project                           | 0 | 1 | 2 | 3 | 4 | 5 |
| 39) Utilizing suppliers increases the prestige of the project                          | 0 | 1 | 2 | 3 | 4 | 5 |
| 40) Utilizing suppliers reduces the cost of the project, and increases the profit rate | 0 | 1 | 2 | 3 | 4 | 5 |



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