SUPPLIERS' INVOLVEMENT IN PRODUCT DESIGN PROCESS: A STUDY ON TURKISH AUTOMOTIVE INDUSTRY

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ABSTRACT

SUPPLIERS' INVOLVEMENT IN PRODUCT DESIGN PROCESS: A STUDY ON TURKISH AUTOMOTIVE INDUSTRY

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New product development is a challenging process which plays a significant role for the rise of the competitiveness of a firm. This process benefits from cooperative relations in the supply network of the firm, such as the collaboration in buyer- supplier relations. The automotive industry presents a good example for studying buyer supplier relations. The positive effects of supplier involvement in product design and development process have been discussed intensely in the literature due to the exceptional success of OEMs – Original Equipment Manufacturers- in the Japanese automotive industry.

This study analyzes the role of suppliers in the automotive sector, the buyer-supplier interface and relations, and new product development process specific to the automotive industry in order to highlight the outcomes of supplier involvement in product development process especially during the design phase. A descriptive questionnaire study on the Turkish automotive supplier industry was conducted. The questionnaire was completed by 25 supplier firms who are members of the Association of Turkish Automotive Parts & Components Manufacturers (TAYSAD) and 5 OEM firms. The questionnaire results show that the level of supplier involvement in the product design phase is low compared to the other project phases such as introduction to the project, prototype production, pre-launch, and mass production. Following this preliminary study, two in-depth interviews were conducted with one OEM and one supplier representatives, and more detailed information on suppliers' involvement in product design was gathered.

Keywords: Supplier Involvement, Automotive Industry, Product Development, Collaborative Design

ÖZ

TEDARİKÇİLERİN ÜRÜN TASARIM SÜRECİNE KATILIMI: TÜRK OTOMOTİV ENDÜSTRİSİ ÜZERİNE BİR ÇALIŞMA

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Yeni ürün geliştirme, firmaların rekabet gücünü artırmada önemli rol oynayan zorlu ama fırsatlarla dolu bir süreçtir. Bu süreç firmanın tedarik zincirinde, örneğin satıcı ve alıcı firma arasındaki işbirliği ilişkileri ile daha verimli hale gelir. Otomotiv endüstrisi, tedarikçi firma ve ana sanayi arasındaki ilişkilerin incelenmesi açısından iyi bir örnek oluşturmaktadır. Ana sanayi-tedarikçi ilişkilerinde, tedarikçi firmanın ürün tasarım ve geliştirme sürecine katılımı ve katkısının –özellikle Japon otomotiv endüstrisindeki ana sanayi firmalarının yeni ürün geliştirme sürecindeki istisnai başarıları nedeniyle- yazında yoğun bir şekilde incelendiği görülmektedir.

Bu çalışma, otomotiv endüstrisinde faaliyet gösteren tedarikçi firmaların ana sanayi ile ilişkilerini ve özellikle ürün tasarım ve geliştirme sürecine olası katkılarını incelemektedir. Konunun Türkiye'deki durumunun belirlenmesi için Türk otomotiv endüstrisinde tedarikçilerin ürün tasarım sürecine katılım seviyesini sorgulayan bir anket çalışması yapılmıştır. Taşıt Araçları Yan Sanayicileri Derneği (TAYSAD) üyesi 25 tedarikçi firmanın ve 5 ana sanayi firmasının katıldığı anket sonucunda, Türkiye'deki otomotiv tedarikçilerinin ürün tasarım safhasına katılımlarının diğer proje safhaları olan projeye giriş, prototip üretim, önseri üretim, ve seri üretim safhalarına göre daha düşük olduğu belirlenmiştir. Anket çalışmasının ardından devam çalışması olarak bir ana sanayi temsilcisi ve bir yan sanayi temsilcisiyle olmak üzere iki görüşme yapılmış, tedarikçilerin ürün tasarım aşamasına katılımlarıyla ilgili daha ayrıntılı bilgi toplanmıştır.

Anahtar Kelimeler: Tedarikçi Katılımı, Otomotiv Endüstrisi, Yeni Ürün Geliştirme, Tasarım işbirliği

To My Grandmother

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LIST OF ABBREVIATIONS

APQP :	ADVANCED PRODUCT QUALITY PLANNING
CAD :	COMPUTER AIDED DESIGN
CAE :	COMPUTER AIDED ENGINEERING
DFMEA:	DESIGN FAILURE MODES AND EFFECTS ANALYSIS
FMEA :	FAILURE MODES AND EFFECTS ANALYSIS
NPD :	NEW PRODUCT DEVELOPMENT
OEM :	ORIGINAL EQUIPMENT MANUFACTURER
RFQ :	REQUEST FOR QUOTATION
TAYSAD:	TAŞIT ARAÇLARI YAN SANAYİCİLERİ DERNEĞİ [Association of Turkish Automotive Parts & Components Manufacturers]

CHAPTER 1

INTRODUCTION

> Product development is a crucial activity for a firm's survival, and it benefits from collaborative relations with partners, customers, research communities, competitors, and suppliers. (Takeishi, 2001, p.404)

New product development is a kind of project management activity, and as Takeishi (2001) states, it benefits from collaborative relationships with several external parties. Organizational efficiency is a prerequisite to improve product development performance in all industries(Ulrich & Eppinger, 2004). Each business has its unique characteristics. While studies show that practices of concurrent engineering in new product development lead to improvements in project efficiency, the literature brings forward the suppliers' role in the product design and development process in industries where suppliers add high value to the final product (Liker et al., 1996; Handfield et al., 1999; Takeishi, 2001).

Since the first mass manufactured Model T of Ford in 1908, the automotive industry has developed to be the locomotive industry in many countries, with the input it takes from and the contributions it makes to other industries. It represents a good example to analyze suppliers' roles in product development since an automobile is made up of thousands of parts and the majority of these parts are supplied from suppliers. Therefore, even though the new product development process is an activity in which partners, customers, research communities, and competitors participate, especially in the automotive industry, the most significant part of this process is jointly carried out by the OEMs (Original Equipment Manufacturers), which are the car manufacturers and will also be referred as "buyers" in this thesis, and supplier firms, that

manufacture and supply parts, equipment, systems to be assembled on the car based on the demand from OEMs, which will be referred as “suppliers”.

New product development (NPD) is one of the most challenging tasks in the automotive industry and providesmanycases to study the effects of collaborative relations on product development and project management processes. Each case gives opportunities for improvements in different dimensions. NPD is a process starting with concept development and ending with mass manufacturing. During this process, product design has an important impact on all other NPD activities, because of the nature of the design activity and design’s relationship with manufacturing, quality, and cost. Any contributionto the design stage can lead to improvements in the new product development process. Throughout the NPD process, the input made by suppliers in terms of contributing to the efficient management of the process is vital for OEMs. The value added by suppliers is important in all NPD activities; especially in the design phase, suppliers can take part in increasing project performance targets such as lowering costs, increasing quality, and accelerating the product development process.

1.1 Problem Statement

The effects of supplier involvement have gained attention especially due to the success of Japanese automotive companies throughout the 1980s. One of the major reasons of this success was seen as the good relations of Japanese OEMs with their suppliers, and the level of contribution made by suppliers to the NPD process. This success has pushed an increase in the level of involvement of suppliers in the US and Europe, and American and European OEMs have started using the key Japanese practices. The situation of the Turkish automotive industry remains unclear since there are not enough studies to demonstrate the position of Turkish suppliers in terms of the level of supplier involvement in NPD.

The automotive industry is one of the most important industries in Turkey and has a high export potential. Many Turkish automotive firms are joint ventures of global OEMs, manufacturing their brands. From the 1950s onwards, the developments in the industry have made the suppliers capable of producing the majority of the parts inside a vehicle. As a result, Turkish part suppliers are potential contributors to NPD in the Turkish automotive industry. In order to understand the current situation of the Turkish automotive industry, a separate study would be helpful. The literature should be analyzed with the most up to date information to be able to compare the driving factors of supplier involvement with the existing practices in the Turkish automotive industry.

1.2 Motivation behind the Study

There are various studies on suppliers' involvement in NPD in the Japanese, American, and European automotive industries. The studies in the Turkish automotive industry treat this subject in terms of buyer-supplier relations and the level of supplier involvement especially in terms of product design is not studied much in the existingliterature. As an industrial engineer studying MSc in industrial design with three years experience in Turkish automotive industry, the author considered this thesis as a valuable study to contribute to analyzing suppliers' roles in NPD, especially during the product design phase.

1.3 Aim of the Study

The goal of this study is to understand the current state of the OEM-supplier relationships in the Turkish automotive industry. The aim of this study is to investigate the contribution of suppliers in the product development and design processes as a practice that increases new product development performance and explore the current role of the Turkish suppliers in new product development, in order to provide the automotive industry a research study which shows the state of supplier involvement. While investigating their roles in the new product development process by a literature review study, a research study is designed to explore the

situation of supplier involvement in the Turkish automotive industry. The perspectives of OEM and supplier firms were thought to be a valuable information source for the study to make a synthesis of the current situation in the Turkish automotive industry. In order to gather direct information from OEMs and suppliers, a preliminary survey study was conducted, followed by two in-depth interviews conducted with an OEM and a supplier representative.The results of this study may shed light to further improvements in the industry in order to give it a more competitive power in the global automotive sector.

Consequently, the main question of this study is:

- What is the level of the suppliers' involvement in the product design and development process in the Turkish automotive industry?

This study also aims so answer following sub-questions:

- What are the effects of supplier involvement in product development process on project performance?
- How can the product development process be managed efficiently and how can supplier involvement be integrated into this process?

1.4 Structure of the Thesis

This thesis starts with a chapter of literature review firstly exploring the area of new product development, giving special emphasis on its relationship with the design process. Further focus is given on new product development for the automotive industry and supplier OEM relations. The advantages of supplier involvement in product development are studied. Supplier involvement practices, forms of supplier involvement in design are analyzed. The second part of the research starts with an overview of the Turkish automotive industry.It includes a descriptive survey study onTurkish OEMs and the TAYSAD member supplier firms. Following the survey study, two in-depth interviews are conducted, with Tofaş, the biggest Turkish OEM in terms of number of vehicles produced in 2010, and with a supplier firm, a member of TAYSAD and a supplier of Tofaş. Conclusions and discussion, limitations of the study and further research opportunities will be provided in the last chapter.

CHAPTER 2

LITERATURE REVIEW

As a strategic and competitive weapon, new product development (NPD) has gained a pace that forces high-tech industries to decrease new product developmentcycle times (Sanchez & Perez, 2003). The automotive industry is simply qualified as “high cost” and “high pressure”which are the qualities that make it difficult to manage, both for OEMs and suppliers (Coronado & Coronado, 2006). Staying competitive is equal to have the best cost at the right time, and it is the criterion to assess how efficiently the NPD process is managed. In order to understand the challenges of product development, this chapter will first examine the product development and design process in general, and then it will take a closer look at the automotive industry.

The literature was studied by the keywords such as ‘new product development’, ‘collaborative design’, ‘automotive industry’, ‘buyer-supplier relations’, and ‘supplier involvement’. To begin with, new product development process was studied in order to understand its steps, priorities, and constraints. The automotive industry represents a special case for new product development due to several reasons, such as the complexity of subcomponents and the high percentage of input from suppliers. For this reason, the literature brings forward the role of supplier involvement in NPD as a methodology to better manage the new product development process. It is observed that studies on the Japanese automotive industry are dominant in the related literature.The existing literature also represents empirical findings that compare American, Japanese, and European automotive industries.The literature between 1970 and 2010 is reviewed, since it was a period which corresponds to the rise of the automotive industry in Europe, USA, and Japan because of the technological advances in mass production.

2.1 Product Design and Development Process

The 19th century has witnessed a rapid change to mass production with the industrial revolution. Mass production replaced production in small numbers, and craftsmen were replaced by machines and engineers. In the 21st century, a product's technical specifications are not enough to guarantee it a big commercial success. Moreover, manufacturing firms are aware that through successful design, they can cut manufacturing costs significantly and reduce the time to market a product.

Industrial design is an activity that can reduce manufacturing costs when industrial designers work closely with manufacturing engineers (Ulrich & Eppinger, 2004) whose job are to optimize the production processes. For a long time, product designers have adapted an attitude described as being the "over the wall approach", where the designer, who is sitting on one side of the wall throws his designs over the wall to the manufacturing engineers (Boothroyd, Dewrust& Knight, 1994). Not having been involved in the design process, the manufacturing engineer confronts many problems in the production of the product and demands design changes. Unfortunately, design changes not also cause delay in the product development time but also increase product developmentcosts. By the time production engineers suggest making some changes to make the product more compatible with manufacturing, the design of the product has been completed so fundamental changes are needed to redesign the product and it may be too late to incorporate the changes (Hartley, 1992). In many cases, redesigns of the product that respond to production engineers' demands are impossible, and if possible, they increase the costs significantly.It has been estimated that although the design costs make up 5% of product development, its influence on the final costs is 70% including cost of materials, manufacture, use, repair, and disposal; which means that design casts the biggest shadow on final costs (Hartley, 1992). Handfield et al. (1999) have also argued that concept and design phases of the project 'lock in' as much as 80% of total costs in a new product development project, because of the effect they have on other NPD activities.

The influence of product design on other functions carried out by a manufacturing companyshows that design decisions made in the early phases of product design and development processes will have a significant impact upon future manufacturing activities (Dowlatshahi, 1997).Decisions taken in the design stage of NPD can contribute significantly to project performance, for the link between design and manufacturing is strong (Novak & Eppinger, 2001).

Echtelt (2004) argues that the significance of new product development as a source of competition can be analyzed from the proportion of sales coming from new products. A research conducted between 1994-1996 shows that 42% of the turnover of companies in Europe came from new products (Echtelt, 2004). Among many profitability measures that assess how optimally the company is carrying on its manufacturing systems, there are four that fit in the successful product development context: *product cost*, *development cost,development time,* and *product quality* (Ulrich & Eppinger, 2004). Not only do firms need to offer low prices to their customers in order to have the biggest share of the sales, they also have to introduce them quickly to stay competitive in the marketplace to keep up with technological changes and fast changing customer needs, while keeping development costs at a minimum.

A firm's net income is the difference between its total sales and costs. Hence, to increase net income, either sales can be increased or costs can be decreased. Life cycle costing or total cost of ownership, as described by Cordon and Vollman (2008),represents all the costs a product brings during the entire supply chain. Product design is a phase where an important portion of cost of a product can be reduced and controlled (Burt, Petcavage & Pinkerton, 2010).

As Burt, Petcavage, and Pinkerton (2010) suggestincreased sales in new product development can be driven by:

- Being faster to market,

- Improving quality,
- Having price flexibility,
- Developing innovative products,
- Enhancing customer satisfaction,
- Accomplishing shorter cycle and lead times,

and having lower total cost can be accomplished by:

- Better product design,
- Reducing quality costs deriving from non-conforming products,
- Eliminating downtime costs,
- Lowering cycle time costs,
- Avoiding conversion costs,
- Decreasing non-value added costs,
- Decreasing post-ownership costs.

Better product design can decrease up to 70%-80% total cost of ownership during the development stage (Burt, Petcavage & Pinkerton, 2010).Avoiding unnecessary costs will have a direct impact on decreasing total costs. According to Dowlatshahi (1997), reduction in product development cycle time can be accomplished by:

- Avoidance of costly future redesigns,
- Reduction in duplication of effort,
- Better communication and dialogue between team members,
- More efficient operations and higher productivity(p.523).

Clark and Fujimoto (1989) evaluate the project lead time performance as an end result of organizational efficiency.Being one of the factors that affect the success of a new product, quality has a strong relationship with product design: Takeishi (2001) argues that 40% of all quality problems can be traced to product design.The level of quality and reliability is “engineered in” to the product during the design activity (Burt, Petcavage &Pinkerton, 2010).

New product development refers to steps, activities, and decision points in the development of a new product from initial idea to product launch, and after (Yeh, Pai & Yang, 2008). According to Ulrich and Eppinger (2004), few products can be developed in less than one year, most of them require 3-5 years, and some even take up to 10 years. Interdisciplinary product development teams with members who are specialized in different domains are needed to carry out this process. Creating successful products requires binding the upstream NPD departments which are R&D, marketing, design, and engineeringdepartmentswith the downstream departments which are manufacturing, operations, and quality departments(Chiena & Chen, 2010). Upstream activities have an overall effect on the project performance because of the impact they have on downstream activities such as detailed design and manufacturing, product assembly, and product testing (Sullivan, 2006). One of the most important tasks in to achieve this is to plan correctly the activities in the early phases of the product development process. Correct predictions, anticipating and detecting possible risks at the early stages of NPD can prevent high development costs and enable reductions in lead time, while also helping to get products more in compliance with customer requirements and needs (Echelt et al., 2008).

2.2 New Product Development in the Automotive Industry

As Clark et al. (1987) state, product development is a set of activities that involves people from different areas of expertise over a long period, and it includes "problem solving cycles carried out by engineers who try to optimize different performance parameters in an uncertain environment" (p.733). For the automotive industry, the performance of a NPD process is measured by the quality, lead time, and cost of the product: the objective is to meet the quality requirements while minimizing cost and lead time (Clark & Fujimoto, 1991).

An automobile is made up of more than 30,000 parts,from the big body frame parts to small screws(Takeishi, 2001). These parts do not directly contribute to product performance, they form clusters of subsystems.The performance of each subsystem

is related to how well the parts in that subsystem work as well as how well the subsytem works with other subsystems (Sullivan, 2006). Vehicle parts can be grouped according to their location inside the vehicle, their function, and security level; each part needs different performance criteria according to these factors. Laseter and Ramdas (2002) have defined three clusters of the parts a vehicle is composed of: body chassis and frame, powertrain, and interior. These clusters have more specific sub-clusters as shown in Figure 1. Not all of these parts are produced by the OEM itself; 70% of a product's total value is created by suppliers (Quesada et al., 2006) and suppliers may account for 70 percent of manufacturing costs and 50 percent of engineering costs(Clark & Fujimoto, 1991).

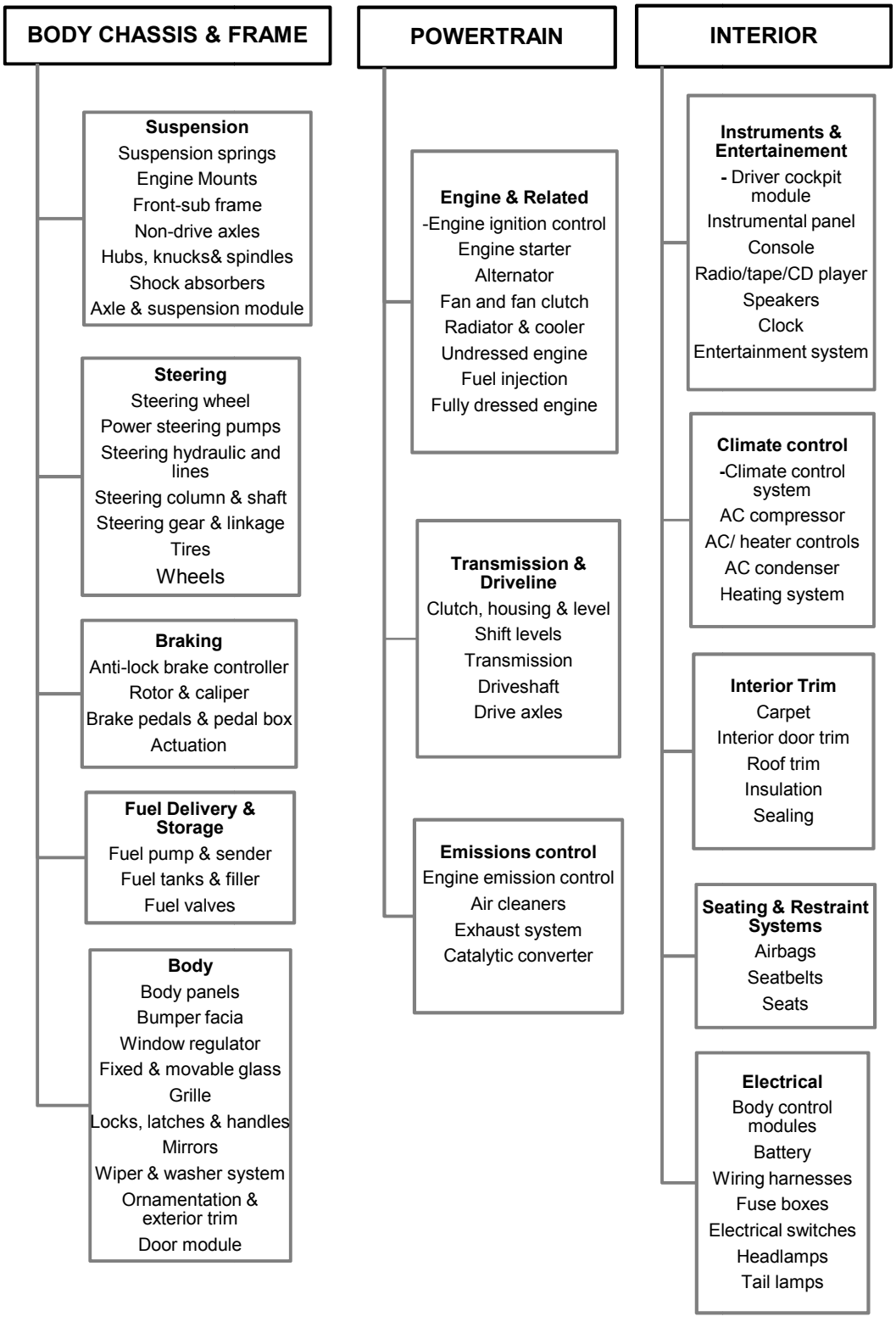

Figure 1: Automotive Product Architecture (Adapted from Laseter & Ramdas, 2002)

The reasons why an OEM may outsource some of the components can be a lack of capacity or lack of expertise and resources in a specific field (Coronado& Coronado, 2006). When we consider the manufacturing of a car in which there are many parts, each part is of the area of expertise of a different supplier. Suppliers are specialized in the tasks they are doing, and they carry out similar activities in product development for different customers, they have the chance to improve themselves to be more efficient in the set of activities they are performing (Echtelt, 2004). With fast changing technologies and short product life cycles, a buyer firm should consider its suppliers as a key point of its NPD activities (Chiena & Chen, 2010).

Component outsourcing has necessitated enhancing the management of collaborative relationships with suppliers, and the increase of the influence of suppliers in product design. Consequently, automotive and supplier industries are complementary; an OEM cannot produce all the parts making an automobile itself, it needs its suppliers' manufacturing and engineering capabilities. A supplier cannot act independently on its own, it has to go by the criteria and design that the OEM develops. It is the joint effort of the OEM and the supplier that makes a project successful: a vehicle marketed on time, within the cost targets, and having reached the quality requirements. Buyer-supplier relationships have become very important as the buyers have realized how much of their success is linked to the performance of their suppliers (Carr et al., 2008).The quality of an OEM's final product can only be as good as the quality of the inputs they receive from suppliers (Forker, Mendez & Hershauer, 1997). Quality can be constructed at the early stages of product design by exchanging expertise and knowledge between the supplier and OEM in order to foresee and avoid possible weak points that may be confronted later in the project, and to eliminate these weaknesses before they turn out to be wasteful replications and unnecessary errors (Chung & Kim, 2002). This requires strong relations between the buyer and the supplier firms.

2.2.1 OEM-Supplier Relations in New Product Development

The terms “buyer firm” and “supplier firm” are used interchangeably in the automotive industry: A firm can be a buyer and supplier at the same time. Figure 2 represents OEM-buyer-supplier terms for the automotive industry. A tier 2 supplier firm can be a buyer for a tier 3 supplier firm. In the scope of this research, the aim is to analyze the relationship between OEM and supplier firms, so the term “buyer-supplier relationship” will be restricted to OEM-supplier relationship, in which the term ‘supplier’ will be used to represent all part suppliers.

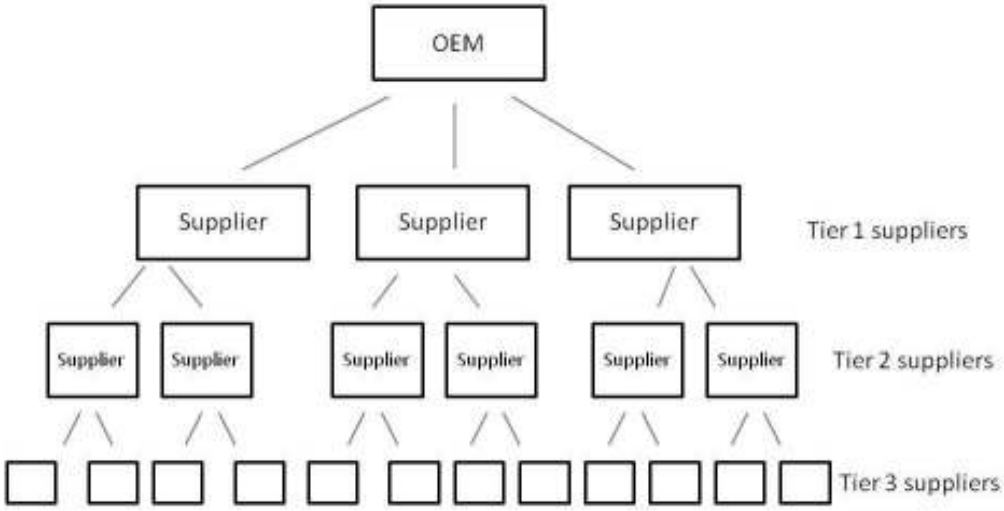

Figure 2: OEM-supplier relationships (created by the author)

The challenges of new product development inside the firm itself are multiplied when the firm is working with a supplier. The idea of working concurrently not only involves working concurrently across different departments and functions, but also with the supplier. To overcome traditional functional barriers such as conflicts between the different departments inside a firm, as well as inter-organizational barriers, the creation of joint development teams is suggested (Bozdoğan et al., 1998). OEM-supplier relations can be also categorized as a specific case of buyer-supplier relationship and as a type of vertical collaboration: Vertical or inter-

company collaboration refers to collaboration between the buyer and supplier firm. For buyer firms, vertical collaboration decreases cycle time as suppliers have specialized capabilities in their area of expertise (Echtelt, 2004). Figure 3 shows vertical collaboration as a type of collaboration between companies that are at different stages of supply chain.

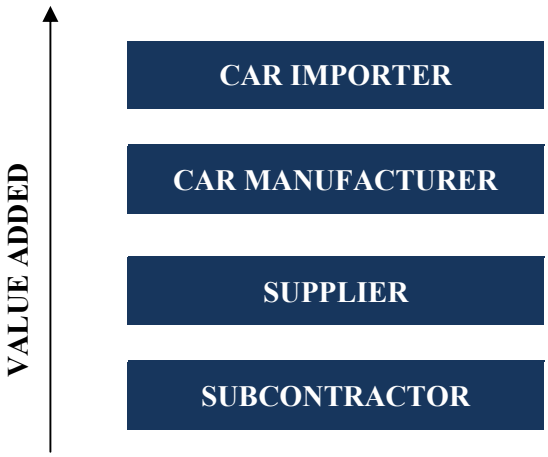

Figure 3: Vertical Collaboration Relationship (created by the author)

As the value added to a product increases, the relationships between the firms change and upstream and downstream firms are formed. As seen in Figure 3, vertical collaboration can be described as the collaboration of an upstream firm with the downstream one, such as the collaboration between a subcontractor and a supplier, or between a supplier and a car manufacturer, and so on.

As industrial markets are witnessing the changes in buyer-suppliers relations from confrontation to cooperation, "mutual comprehension of the need to satisfy the end customer" results in improved performance (Corsten,Kucza&Peyinghaus, 2006, p. 169). Considering once again that 70% of an automobile's parts are manufactured by suppliers, the relation between OEMs and their supplier network becomes significant: The cost and quality of an automobile are determined by the productivity

of a network of firms working in cooperation in industries where value added by suppliers affects significantly to the final product, the competitiveness of the OEM depends upon supplier performance (Quesada, Syamil& Doll, 2006).

The history of buyer-supplier relations originates from "combative" to "collaborative" (Cordon & Vollman, 2008). In the past, the relations between the buyers and suppliers were based on manipulative tactics which caused a win-lose outcome where the gain of one meant the other's loss. Today, buyers and suppliers begin to realize that collaborative relationships help benefit both parties and end in win-win outcomes(Burt, Petcavage & Pinkerton, 2010).*The Toyota Way*, a bookby JeffreyLiker, explains the management style of Toyota and gives clues about the success of Toyota as a company. Among the "*14 Management Principles of Toyota"*, which is the title of the book, one is to "respect the extended network of partners and suppliers by challenging them and helping them improve". Toyota has created a way to 'learn' with its suppliers (Liker, 2003). Cordon and Vollman (2008) argue that traditionally the buying and selling approaches of Western industries were to play off suppliers against each other, while their Japanese competitors enjoyed collaborative relations with their suppliers.

Although traditional approaches have improved today, still there are some opportunities to further develop buyer-supplier relations. Figure 4 shows the *Classical behavior*, *Today's best practice*, *and Tomorrow's best practice* in supplier buyer relations as summarized by Cordon and Vollman (2008):

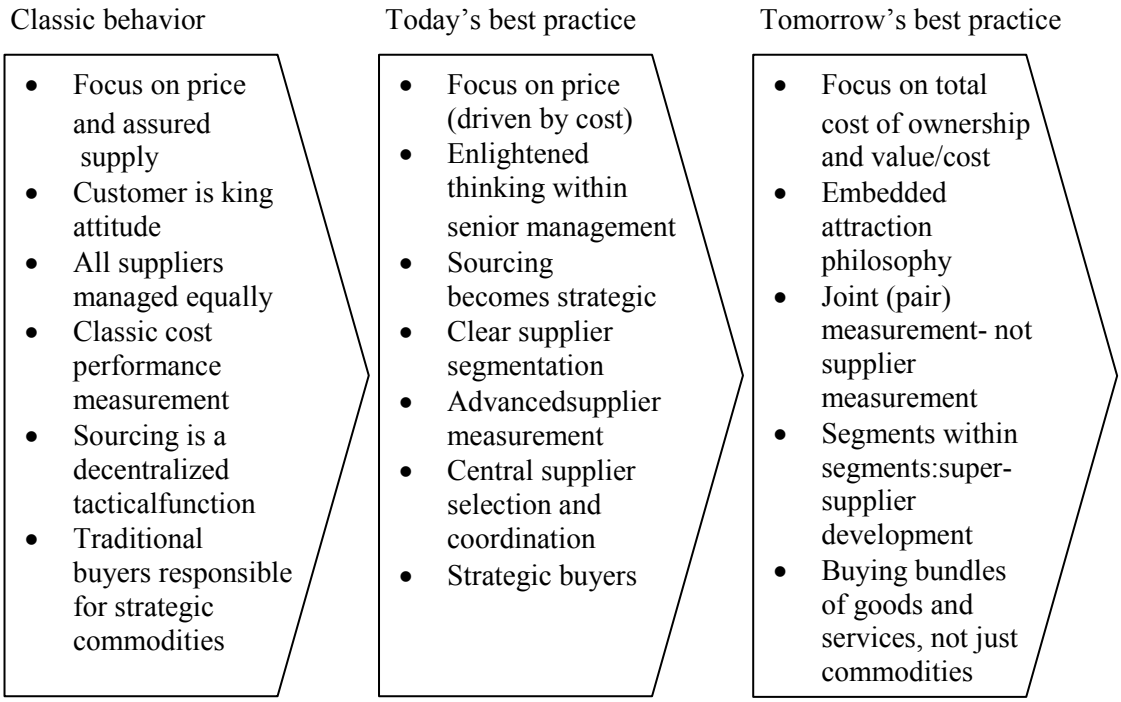

Figure 4: Evolution of supplier-buyer relations(Cordon & Vollman, 2008)

While traditionally the buyers' attitude towards supplier selection was based on prices, today cost breakdown of price is demanded by buyers, and the best practice for tomorrow will be focusing on total cost of ownership, rather than the cost of product itself. Similarly, while the buyer firm was seeing itself as the 'king' towards its suppliers, today this relationship has moved to collaboration with suppliers and the best practice of tomorrow should be partnerships with suppliers (Cordon & Vollman, 2008).

Different authors have made different classifications on buyer-supplier relationships, based on differentiators such as supply risk, supplier roles, responsibilities taken by suppliers, and so on. According to Kraljic (1983), there are four main types of purchasing scenarios for a buyer firm, which change according to the special characteristics of the purchased item, as described in Figure 5. Some products are

easily substitutable because there are many standard products produced by alternative suppliers; they have low supply risk, such as leverage items and non-critical items.

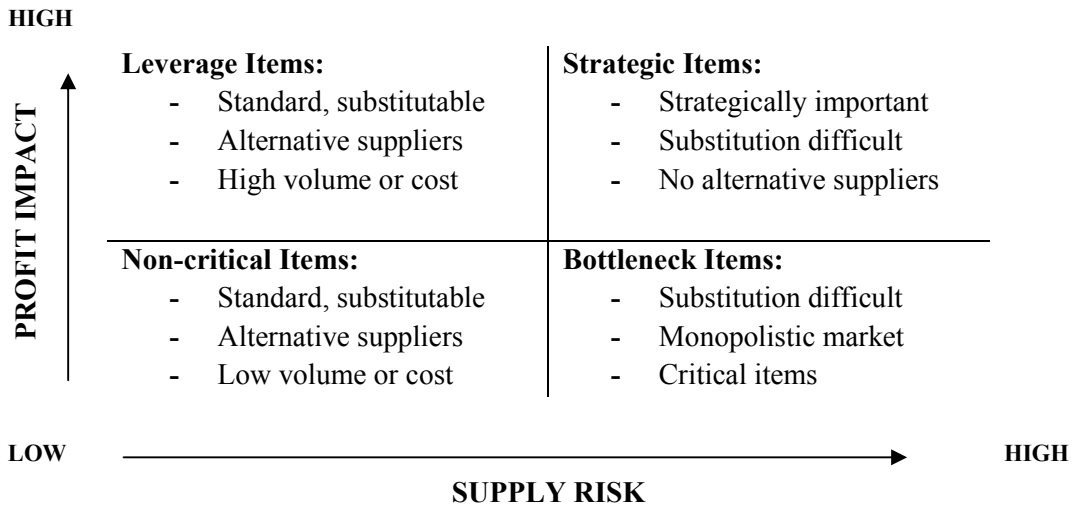

Figure 5: Purchasing Portfolio Matrix (Kraljic, 1983)

Consequently, relations between buyers and suppliers may be distant for low risk itemsand cooperation may not necessarily be a strategic issue. However, some products are strategic items or bottleneck items, their substitution is difficult, and there are no alternate suppliers. Cooperation is a more critical issue in such cases. Such kinds of products are very widespread in the automotive industry. This makes the supplier industry products strategic items, where collaboration between the supplier and the OEM becomes extremely important to decrease costs, increase quality, and decrease lead times.

Kamath and Liker (1994) describe four types of supplier roles in product development, according to their level of relationship with the OEM: partner, mature, child, and contractual. According to this classification, a ‘partner’ supplier takes an active role in product development and acts as an external department of the OEM. A ‘mature’ supplier takes major responsibilities, but under the guidance of the OEM. In

a ‘child’ type of role the supplier just executes the demands and requirements of the OEM, and lastly in the ‘contractual’ type of role the OEM purchases a standard part form the supplier. The descriptions of supplier roles and the responsibilities of suppliers in each type are described in Table 1.

Table 1: Four supplier roles in product development (Kamath & Liker, 1994)

Role	Description	Responsibilities during product development
Partner	Relationship between equals; supplier has technology, size and global reach	Entire subsystem. Supplier acts as an arm of the customer and participates from the pre-concept stage
Mature	Customer has superior position; supplier takes major responsibility with close customer guidance	Complex assembly. Customer provides specifications, and then supplier develops system on its own. Supplier may suggest alternatives to the customer
Child	Customer calls the shots, and supplier responds to meet demands	Simple assembly. Customer specifies design requirements and supplier executes them
Contractual	Supplier is used as an extension of customer’s manufacturing capability	Commodity or standard part. Customer gives detailed blueprints or orders from a catalogue and supplier builds it

These supplier roles can be differentiated according to the capabilities of the supplier and its position in the supply chain, level complexity of the product or the technology, level of technological uncertainty, project performance requirements, and OEMs’ decisions regarding the product development process, as they will be discussed in the next sections.

Finally, according to Bensaou (1999), there are fourmain types of supplier-buyerroles which are captive buyer, market exchange, captive supplier, and strategic

partnership. These relationship types are differentiatedby suppliers' and buyers' specific investments, type of product supplied, supplier know-how and skill level, frequency of interaction, degree of trust, level of information exchange, and effort for cooperation. Each type has different characteristics. All the characteristics that vary among the different types of relationships are presented in Table 2.

Table 2: Buyer-supplier relationship types (Bensaou, 1999)

Captive buyer	**Strategic partnership**
- Technically complex products with mature, stable technology and few innovations - Supplier proprietary technology and unique skills - Frequent and regular mutual visits - Strong effort by buyer for cooperation - Lack of mutual trust, tense climate	- High level of customization required - Technically complex part or integrated subsystem based on new technology - Strong supplier proprietary technology - Extensive joint action and cooperation - Frequent and "rich media" information exchange - Mutual trust
Market exchange	**Captive supplier**
- Highly standardized and simple products with mature technology and little innovation - No supplier proprietary technology - Limited information exchange - No systematic joint effort and cooperation	- Technically complex products based on new technology - Strong supplier proprietary technology - Little exchange of information - High mutual trust, but limited direct joint action and cooperation

In each of these models, it can be observed that when a part of the product development activities are carried out by the supplier, the dependencies between the buyer and the supplier are changed (Sobrero& Schrader, 1998). In the next sections, the advantages, disadvantages, and other aspects of suppliers' involvement in NPD process will be discussed, beginning with an overview of the foundations of this concept.

2.2.2 The Japanese Automotive Industry as the Forerunner of Change in OEM Supplier Relations in New Product Development

Throughout the 1980s, Japanese companies likeHonda and Toyota consistently introduced new models every three years, compared with a five-year cycle for Americancompanies General Motors and Ford (Birou&Fawcett, 1994), and they enjoyed a competitive advantage due to decreasing lead times.Table 3 shows the Japanese advantage in new product development compared to their US and European competitors during the 1980s.

Table 3: New product development cycles in the 1980s(Clark & Fujimoto, 1991)

	USA	EUROPE	JAPAN
Number of models introduced	21	38	72
Lead time for a new model development (months)	61.9	57.6	42.6
Average manufacturing time for a model (years)	8.1	12.2	4.6

Many researchers point out the fact that the competitiveness of Japanese manufacturers in the global automotive industry as opposed to US and European manufacturers is their win-win relationship with suppliers, extent of supplier involvement in product development projects, and the quality of customer supplier relationships (Bozdoğan et al., 1998). In the Japanese automotive industry, during the 1980s manufacturers started to involve suppliers in their product development process, and suppliers were being asked to optimize the design of parts they were going to produce in order to improve its manufacturability, quality, and decrease its manufacturing costs and development time (Echtelt, 2004).

The Japanese automotive industry has been a role model for industries in other countries as well, by creating ‘sense of collective identity’ with its suppliers, which increases collaboration effectiveness and as a result increasing productivity and knowledge diffusion (Corsten et al., 2006).Cordon and Vollman (2008) argue that

Toyota is seen as the best customer by its suppliers due to the fact that it does not see the supplierresponsible for all problems, provides its suppliers more information, makes fewer changes, its designs work with fewer modifications, and it helps its suppliers to solve problems.The characteristics in buyer-supplier relations in the Japanese automotive industry are defined by Wasti and Liker (1999) as:

- Long-term relationships with frequent planned communication,
- Mutual focus on total cost and quality, working together to minimize total costs,
- Intensive and regular sharing of technical and cost information to improve performance,
- Trust-building practices like stationing guest engineers at the customers' offices,
- Creating a high degree of goal congruence and mutual trust(p.445).

According to a research conducted by Clark and Fujimoto (1991), throughout the 1980s the suppliers' share in engineering efforts was found to be 30% in Japan, while it was 7% in the United States. Also, 67% of Japanese projects were developed by the active involvement of the suppliers, while this number was 16% for US vehicles (Clark & Fujimoto, 1991). These figures represent the driving factors of the Japanese advantage during the 1980s, and with the success of Japanese OEMs during these years their European and US counterparts also adapted similar methods and practices in automotive product development.

This section has described the nature of buyer-supplier relations and the ways in which they can be improved to get the best result in new product development projects. Keeping the best practice methods in automotive OEM-supplier relations in mind, thenext section will handle the new product development process in the automotive industry in more detail, and try to find out how collaboration can be integrated in the product development activity in order to create benefits both to the supplier and to the buyer.

2.3 Supplier Involvement in Product Development

Buyer-supplier collaboration can simply be defined as the participation of both parties in the decision making processes (Hoegl & Wagner, 2005). Supplier involvement is a more specific case of buyer-supplier collaboration and it can be described as the combination of buyers' and suppliers' R&D resources and use of joint capabilities (Wagner & Hoegl, 2006). In the automotive industry case, the supplier and the OEM act as a team in problem solving without giving attention to firm boundaries.Traditionally, there has been minimal involvement by suppliers in new product design in the automotive industry (Dowlatshahi, 1997). OEM supplier relationship used to be a two-step sequential interaction, where the OEM gives tasks to the supplier and both parties tend to optimize their positions (Tang & Chin, 2009). Due to the increased pressure in new product development, OEMs have started to adopt supplier involvement in order to use the suppliers' knowledge and domain expertise in enhancing design, as a strategy to improve the product design and development process (Tang & Chin, 2009).

In Figure 6, an example of thedecision making process of the OEM during the NPD process is describedin order to understand the decision making points during product development, such as make-or-buy decision, supplier selection, design decisions, and design verification process. For the OEM, the whole process is considered as a supply management activity. In case of a 'buy' decision which is followed by the selection of a supplier, the OEM has to manage this process effectively to transfer the project to the supplier and assure that the supplier will be able to supply the products that are conforming to the specifications.

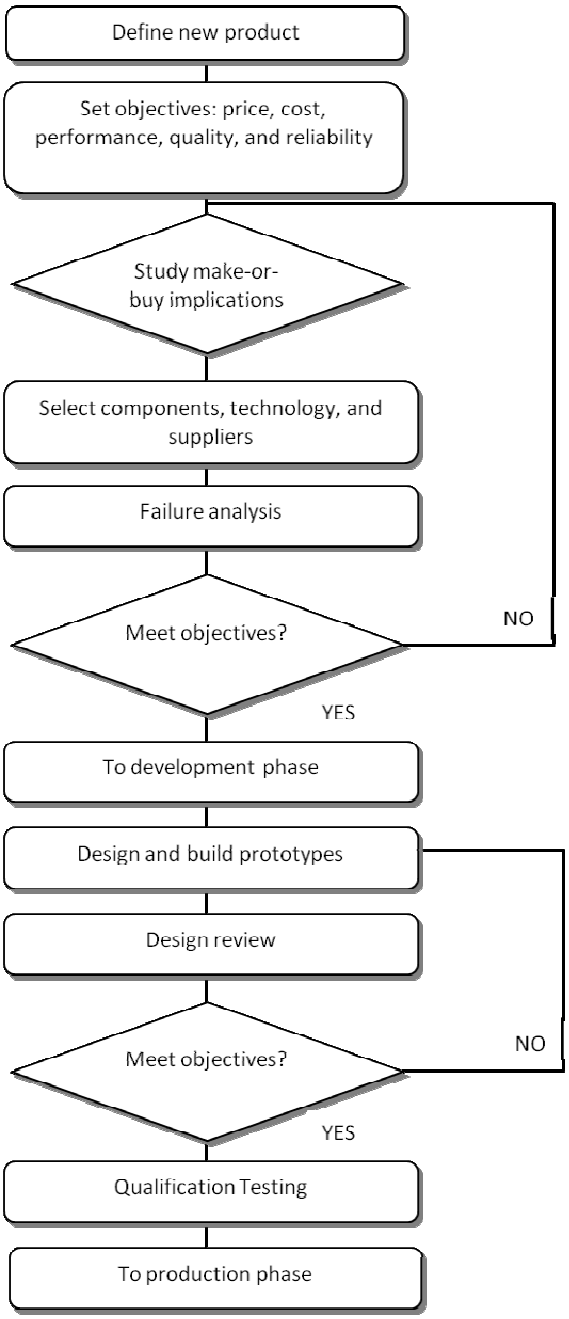

Figure 6: Supply Management Activities (Burt, Petcavage & Pinkerton, 2010)

Wynstra and Pierick (2000) have developed a supplier involvement portfolio (Figure 7) which shows the development responsibility held by the supplier according to the development risk in the project.

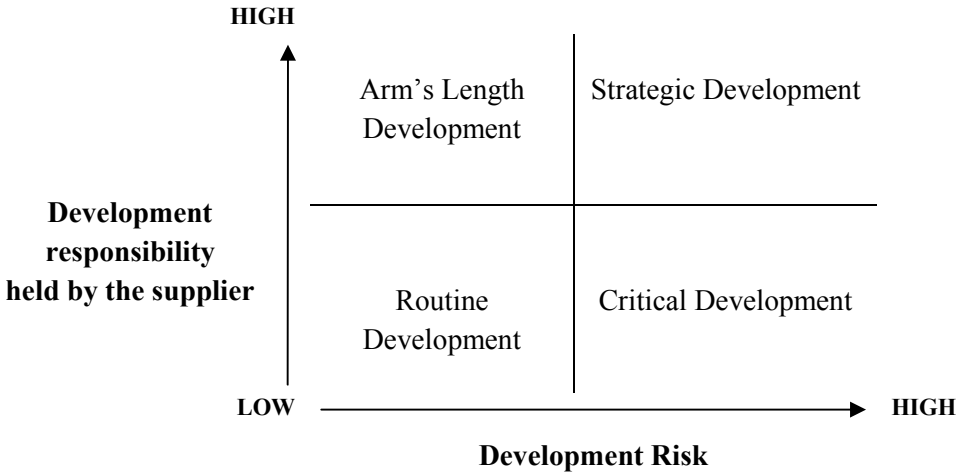

Figure 7: Supplier Involvement Portfolio (Wynstra& Pierick, 2000)

An arm's length development is based on the suppliers' independent development of the product, whereas critical development is based on the buyers' product development methodology. In a routine development, the parties have a minimum level of relationship in which they inform each other about the process. In strategic development, the supplier and the buyer are jointly developing a product as partners.

The main objectives of supplier involvement are to match the suppliers' capabilities with the customers' requirements (Vayvay&Çobanoğlu, 2006), overlap product design with production process, create less need for backtracking (Liker et al., 1996), and attain a more effective and efficient NPD process. Supplier involvement in product development starts with involvement in design. Design is a highly challenging activity in the automotive industry, because many aspects of design need to be specified in the early phases, it contains a high level of task uncertainty, it is subject to change, and the design of a part is in interaction as an input or an output

with the design of other parts (Sullivan, 2006). As a result, design can be the root cause of many problems such as high costs, poor quality, difficulties in process, or it can the source of a successful project. Japanese practices suggest that product designers should receive extensive information from manufacturing engineers regarding process capabilities; hence design and manufacturing processes should work in parallel.

2.3.1 Advantages of Supplier Involvement in New Product Development

OEMs that involve suppliers in the new product development process and especially in the product design phase together with the use of concurrent engineering practices benefit from higher supplier performance quality. Studies show that collaborative product development, when practiced optimally, shortens lead time, decreases overall costs, increases product quality, and is an input to foster innovation (Langner& Seidel, 2009). The benefits of supplier involvement in the product development process are:

- lower development costs,
- standardization of components,
- consistency between design and manufacturing capabilities,
- reduction in engineering changes,
- higher quality with fewer defects,
- improvement of suppliers manufacturing process,
- reduction in lead time (Jayaram, 2008, p.3719).

Echtelt et al.(2008) argue that the short term benefits of supplier involvement are:

- Part technical performance,
- Part cost,
- Part development cost,
- Part development lead-time;

and the long term benefits of collaborating with suppliers are:

- More effective future collaboration,

- Access to suppliers' technology,
- Technology roadmap alignment,
- Transfer of solutions developed to other projects(p.183).

On the other hand, some authors have discussed the negative impacts of supplier involvement on product development. Mikkola and Larsen (2003) suggest that although there are many advantages of early supplier involvement, there are also disadvantages that are associated with them.

Early supplier involvement in NPD advantages are:

- Shorter project development lead times
- Improved perceived product quality
- Savings in project costs
- Better manufacturability
- Shared knowledge and learning
- Improved NPD efficiency and effectiveness
- Accessibility to supplier's technical capabilities

Disadvantages of supplier involvement are:

- Risk of losing proprietary knowledge
- Hollowing out internal competencies
- Eased accessibility for competitors to copy or acquire key technologies
- Increased dependence on strategic suppliers
- Increased standardization of components through specified interfaces (Mikkola & Larsen, 2003, p.33)

The process of supplier involvement is characterized by shared responsibility by OEM-supplier design teams. More specifically, this practice creates a new approach to the definition of the product architecture, achieving significant reductions in both cost and lead time: empirical research shows that unit cost was reduced by 75% and

lead time by 33%, while product quality was much improved (Bozdoğan et al., 1998). Other than improving product development performance, productivity, product quality, and lead time, earlier and more extensive involvement of suppliers in product development process can be a source of innovation (Echtelt, 2004). Suppliers participating in this process have the chance to enhance their technical capabilities, search for new technologies, and aim to reach higher standards. The developments and improvements in suppliers' activities positively affect the OEMs' performance.

The relationship between the supplier and OEM is two-sided, and the supplier also benefits from collaborative relationships with the OEM. The competition between world-class suppliers has pushed suppliers to make sure that their potential customers' approach to problems is collaborative, their quality requirements are within capabilities; more precisely to choose "good customers" (Burt, Petcavage & Pinkerton, 2010). As a result of collaborative relations, not only will the OEM enjoy benefits, but also the supplier will manage the project easily, and develop itself by making mistakes and taking these mistakes as a "learning foundation" to improve (Burt, Petcavage & Pinkerton, 2010). From the supplier's standpoint, involvement in NPD results in cost efficiency, productivity, reducing redesign, increasing quality, increasing innovation, higher level of project performance, and perceived success by the OEM (Chung & Kim, 2002). Involvement in design provides greater flexibility for suppliers: a supplier that can design the product to be more compatible with the production technologies it uses has a greater chance to be successful, achieve quality targets, keep low costs, provide on time delivery, and respond to OEM demands more quickly.

2.3.2 Types of Know-how Sharing in New Product Development Projects

Different types of know-how sharing are possible between the OEM and the supplier during new product design and development. Tang and Chin (2009) have

describedthree types of know-how sharing: traditional partnership, decoupled partnership, and integrated partnership (Figure 8).

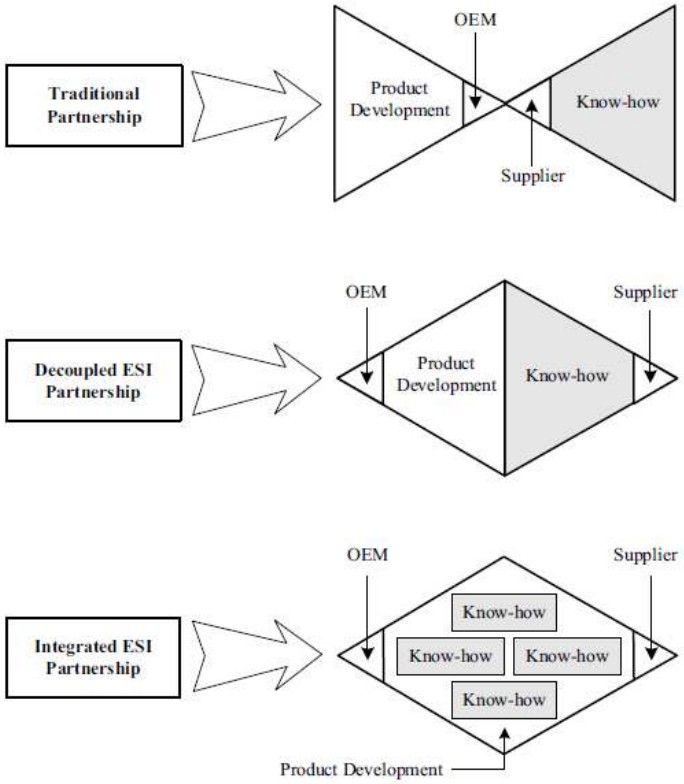

Figure 8: Different forms of know-how sharing (Tang & Chin, 2009)

In a traditional partnership the OEM and the supplier carry out the activities independently. While the supplier keeps its know-how to himself, the OEM follows the product development process without benefiting from the know-how of its supplier. In a decoupled relationship where early supplier involvement (ESI) is partially used, the supplier and the OEM carry out the tasks independently, but they have a wider interface, they contact more frequently, and exchange information more often. In an integrated relationship where early supplier involvement is used, the OEM and supplier carry out the product development activity together; they share the same level of know-how.

Takeishi (2002)points out that level of knowledge sharing is different in regular projects, in which established technologies are used,compared to innovative projects where new technologies are used. The differences in knowledge sharing also affect architectural knowledge and component specific knowledge requirements. It can be concluded that in innovative projects more effective knowledge sharing is needed than in regular projects, and suppliers should have a greater knowledge of the architecture of the vehicle. Takeishi's model is shown in Table 4.

Table 4: Regular projects vs. Innovative projects (Takeishi, 2002)

Regular Projects (using established technologies)	**Innovative Projects (using new technologies)**
Knowledge partioning is clear cut	Knowledge partioning is overlapping
Automaker should have architectural knowledge	Automaker should have architectural and component-specific knowledge
Supplier should have component specific knowledge	Supplier should have architectural and component-specific knowledge

Similar to Takeishi's argument, Ragatz et al. (2002) have found that supplier integration is more likely to be used under conditions of technological uncertainty, and its use leads to improvements in cost, quality, and lead time under these conditions.

During the product development process, while the design engineers in the OEM have architectural knowledge like the number of product components, the extent of interactions, the supplier has component specific knowledge like product complexity (Novak & Eppinger, 2001). Some product characteristics such as functional integration, interface complexity, proximity to core function settings, proximity to interior/exterior design influence the supplier's role in product development and shape the choice of supplier involvement patterns for the OEM (Fujimoto &Ge, 2006).

Likewise, Wagner andHoegl (2006) have also defined two types of projects, know-how projects and capacity projects, similar to Takeishi's model. Know-how projects are like innovative projects in which more supplier involvement is needed, and capacity projects are regular projects in which the responsibilities of the supplier are not very significant. Supplier-buyer partnerships can be seen in know-how projects; on the other hand the relationship between the supplier and the buyer is 'traditional' in capacity projects, as discussed in the previous sections. The characteristics of these projects types described by Wagner and Hoegl(2006)are shown in the below Table 5.

Table 5:Know-how projects and capacity projects (Wagner & Hoegl, 2006)

Know-How Projects	**Capacity Projects**
• Goal: acquiring and utilizing supplier knowledge	• Goal: covering shortages in own R&D capacity and become more flexible in R&D
• Innovative projects	• Less innovative projects
• Supplier takes responsibility for critical modules or systems	• Supplier takes responsibility for less (critical) components or subsystems
• Intensive integration (responsibility, timing)	• Limited integration (responsibility, timing)
• Buyer-supplier partnership	• Buyer supplier relationship often "traditional"

The arguments in know-how sharing show that different levels of know-how sharing exist between the OEM and the supplier, and characteristics of an NPD project may affect the type of know-how sharing that will be employed. In the next sections, the possible points in the decision making cycle of a NPD project, where supplier know-how can be integrated will be discussed. As the main focus of this thesis is on design related activities, more emphasis will be put to the product design phases.

2.3.3Concurrent Activities in New Product Development Process

The new product development process can be described with three main phases in the automotive industry:

plan,
make,
and*control.*

In the *plan* phase the activity plan setting is done, the *make* phase is applying the plan phase, and the *control* phase is looking at the performance review. More precisely, the project management for new product development in the automotive sector starts with the start of design continues with the development of part, engineering approval and validation, and release of production (Coronado& Coronado, 2006).

The product design cycle can be divided into different design stages:

conceptual design,
embodied design, and
detailed design.

The activities involved in the product development process may be carried out sequentially, or in parallel. Research conducted by Clark and Fujimoto (1991) point out the importance of integrated and concurrent problem solving in new product development in order to increase project performance.As a research in concurrent engineering done by Echtelt (2004) about product development and suppliers' involvement suggests, in order to decrease product development time, companies carry out design and engineering activities in parallel instead of sequentially. Moreover, Sanchez and Perez (2003) discuss that with concurrent engineering, not only the project completion time can be decreased, but also the quality of the product will be improved.

Concurrent engineering is the practice of overlapping the sequential activities during the NPD process. Nellore and Balachandra (2001) found that one of the success factors of concurrent engineering projects in the automotive industry was supplier

involvement in the NPD process. Concurrent design and supplier involvement practices make the design engineer work more closely with other project team members when making design decisions. Knowing suppliers' manufacturing constraints during the design stage may reduce the number of problems that arise during production trials (Quesada, Syamil& Doll, 2006). Concurrent engineering practices bring design and manufacturing processes to make this iterative process more efficient.As discussed earlier with over-the-wall engineering concept, the designer gives the design to manufacturers without receiving feedback, so very few changes are made during the early stages of the product development process. With concurrent engineering, the majority of changes can be made at the design stage. Although it may seem that this would increase the time to design the product and hence the whole product development process, more time spent in the design phase is compensated by savings in time later on in the project and savings in costs during the later phases (Boothroyd&Dewrust& Knight, 1994).

2.3.4Supplier Involvement in Design

McIvor, Humphreys and Cadden (2006) describe the key design related activities in new product development in a case study conducted in the electronics industry, and these activities can be considered similar to the automotive industry. These activities, as shown in Table 6, can be seen as critical steps in new product development to which suppliers can be integrated, in order to enhance knowledge sharing between the buyer and supplier firms and increase project efficiency.

Table 6: Design Related Activities in NPD (McIvor, Humphreys & Cadden, 2006)

Concept	Development	Engineering	Manufacturing
Definition of: • Target markets • Product architecture • Identify key building blocks of the product • Identify key components required	Product design and planning Small prototype Test	Product and process detailed design Conceptual prototype Build and test Engineering release	First-off production

Similar to the situation in the electronics industry, the automotive suppliers can also contribute to the concept, development, engineering, and manufacturing phases. Involvement in design related activities will have an overall impact on the NPD activity, project outcomes, and NPD performance.

Huang and Mak (2000) have also developed a model to facilitate supplier integration in new product development. This model separates the design-related activities in the new product development process to four phases which are specification, concept design, detailed design, and production design. The model is presented in Table 7.

Table 7: Supplier involvement in NPD (Huang & Mak, 2000)

New Product Development Process			
Specification	**Concept Design**	**Detailed Design**	**Production Design**
• Establish specifications collaboratively • Avoid ambiguity and information distortion • Set technical targets • Articulate trade-offs • Identify early changes	• Key product and process technologies • Product architecture • Contribute key ideas/concepts/ critical components • Participate in concept evaluation • Establish interfaces between product subsystems	• Selection of proprietary parts & components • 'Black box' designed parts & components • Tolerance design • Detail controlled parts & components • Prototype testing and demonstration • Design for manufacturability • Material selection	• Make or buy decisions • Tooling & fixturing design • Equipment acquisition • Design for manufacturability • Quality control & assurance • Raw materials
Supplier Involvement			

Suppliers can be integrated in setting the design specifications, such as setting technical targets, and articulating trade-offs with respect to constraints. They can contribute to the concept design by participating in the definition of technologies,

product architecture, and the interfaces between subsystems. During the detailed design phase, they can be responsible for the complete design, tolerance design, detailed design, or for design for manufacturability. Finally, in the production design phase, suppliers can be involved in tooling design.

2.3.5 Supplier Selection for Integration

Although supplier involvement in product development and especially to the design phase is seen as an effective strategy to improve project success, not all suppliers are involved by OEMs at the same time and at the same level. Supplier involvement can range from simple consultation to suppliers about design ideas to making the supplier fully responsible from a part or a subsystem design. This difference can come from the characteristics of the project such as regular projects vs. innovative projects and capacity projects vs. know-how projects, as described in Table 5 and Table 6 with Takeishi's (2001) and Wagner and Hoegl's (2006) models, but it may also be derived by the supplier itself. The selection of suppliers which will be involved in product development is an important issue for OEMs. Supplier selection criteria are used to manage this process effectively. According to a research conducted byHandfield et al. (1999) on 134 manufacturing companies worldwide, the 10 most rated supplier selection criteria for supplier integration are:

- Supplier's product knowledge and capability,
- Supplier's process knowledge and capability,
- Supplier's production capability and certification,
- High level of trust between supplier and the OEM,
- Supplier's design expertise,
- Supplier's ability to communicate effectively,
- Supplier's innovativeness,
- Supplier's flexibility to respond to design changes,
- Supplier's commitment to continuous improvement,
- Supplier's expertise in reducing and controlling cost(p.74).

These criteria may suggest that certain suppliers are more likely to be involved in new product development, and given more responsibility at earlier stages than others. Hence, supplier involvement can vary according to supplier's characteristics other than project and parts specific requirements, as was discussed previously.

2.3.6 Level and Timing of Supplier Involvement

Several studies show different levels of supplier involvement strategies according to the design responsibility given to suppliers, ranging from "none" and "white box" to "gray box" and "black box" supplier integration(Petersen et al., 2005; Liker et al., 1996; Wagner & Hoegl, 2006). The highest level of design responsibility is in the 'black box design' is a supplier involvement typein which the supplier, given the geometry of parts inside the vehicle, designs and manufactures the automotive part. This gives the suppliers the responsibility and autonomy to design the part itself to meet performance requirements (Liker et al., 1996). Figure9 gives a classification of different types of supplier design involvement and shown the level of supplier responsibility.

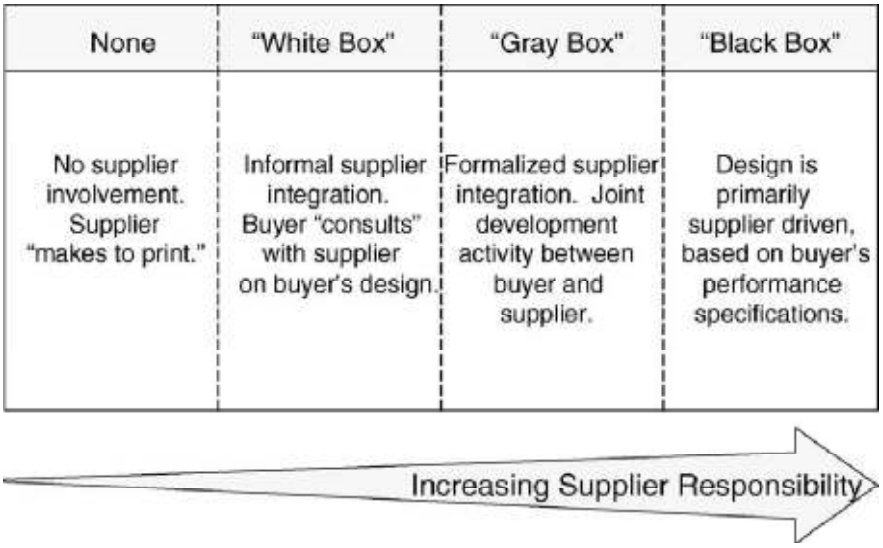

Figure 9: Supplier design involvement types(Petersen, Handfield &Ragatz, 2005)

The ‘black box’ type is also referred as *co-design* in the literature. A study conducted by Balcet and Enriettiin 2000, the purchasing strategy of Fiat- which is a global OEM that has a licence agreement with Tofaş, a Turkish OEM that will beone of the subjects of the research study of this thesis- shows that *co-design* activity is most appropriate when supplier know-how is high. In cases which supplier know-how is high, the *co-design* activity is localy or globally carried out depending on the impact of logistic cost, and where supplier know-how is low, local or global purchasing is done again depending on the logistics costs.

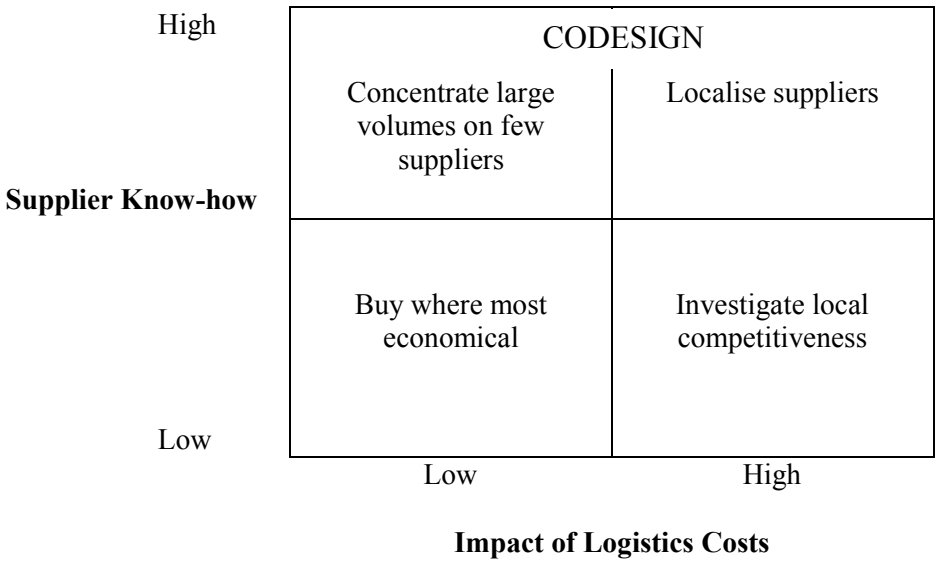

Figure 10: Purchasing Strategy of Fiat (Balcet & Enrietti, 2002)

As an example of Fiat’s co-design strategy in Turkey, the co-design activity in Tofaş, manufacturer of Fiat brand in Turkey will be handled in Chapter 3, by an in-depth interview with Tofaş.

It can be said that suppliers’ design knowledge and expertise plays the most significant role in the selection criteria to determine if the supplier will be a black box supplier or not, as shown in Figure 10.According to the project phases and

possible supplier integration points identified by Petersen et al. (2005), there are some criteria that give clues about earlier and later supplier involvement.

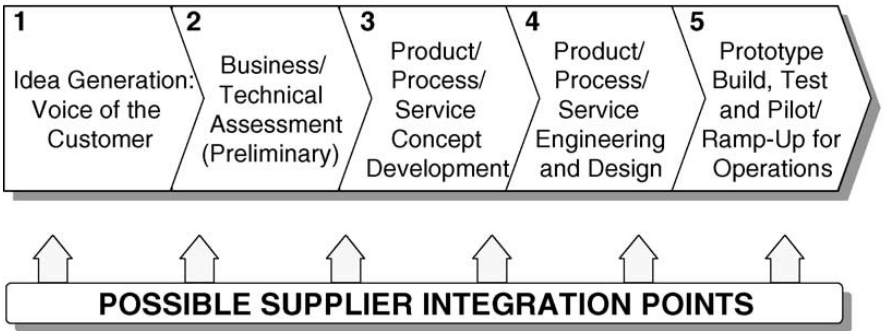

Figure 11: Possible supplier integration points (Petersen, Handfield & Ragatz, 2005)

As shown in Figure 11, suppliers can be integrated in idea generation, preliminary business/technical assessment, product/process concept development, product/ process engineering and design, and prototype build and later manufacturing operations. Some product characteristics such as functional integration, interface complexity, proximity to core function settings, proximity to interior/exterior design influence the supplier's role in product development, and shape the choice of supplier involvement patterns for the OEM (Fujimoto &Ge, 2006). The suppliers who are involved earlier in this process are suppliers of complex items, suppliers of systems or subsystems, suppliers of critical items or technologies, strategic alliance suppliers, and black box suppliers. The suppliers who are involved at the later stages are suppliers of simpler items, suppliers of single components, suppliers of less critical items and technologies, non-allied suppliers, and white box suppliers. Liker, Kamath and Wasti (1998) have also found that suppliers of complex components and complex subsystems are more likely to be involved than suppliers of simple components, and that suppliers with higher technical capabilities are those that are chosen for cooperation.

Asthe results of the literature review study show, there are different variables in supplier involvement in product developmentand design,especially in automotive industry. These variablesaffect the decisions on the involvement of the supplier,the level of responsibility that will be given to the supplier, and when will the supplier will be involved.

- *Project Type:*Innovative and know-how projects require higher levels of supplier involvement, wheras regular and capacity projects require lower levels of supplier involvement.
- *Technological Uncertainty:* As technological uncertainty about the design and manufacturing process of a product is high for the buyer firm, higher levels of supplier involvement is needed to gain the know-how and the expertise of the supplier.
- *Buyer-Supplier Relationship:* In collaborative type of relationships between buyers and suppliers, higher level of supplier involvement is likely to be used, in combative relationships; lower level of supplier involvement will be used.
- *Supplier Capabilities:* Suppliers that are more expert in the design and manufacturing activities they perform are more likely to be involved in new product development and design.
- *Component Characteristics:* The more interface complexity, the higher level of severity, the higher level of supplier involvement can be predicted. Suppliers that produce complex systems or subsystems are more likely to be involved earlier than suppliers that produce simple components.

These factors can be used to predict the extent and timing of supplier involvement used in NPD projects by OEMs (Figure 12).

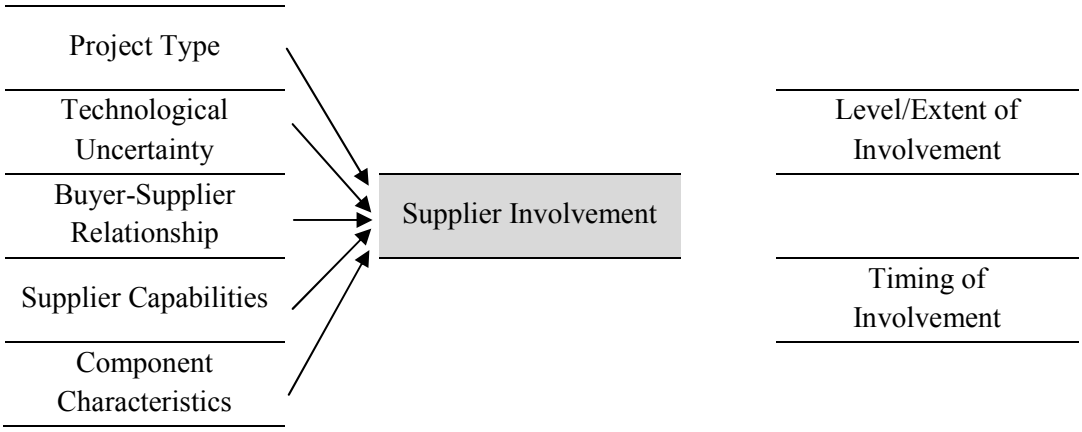

Figure 12: Factors Affecting Supplier Involvement (created by the author)

2.4 Overview of the Literature Review

The literature reviewfocused initially on the new product development process and particularly the product design phase of this process. In the sections that followed, the importance of buyer-supplier relations and its implications for OEM-supplier relations in the automotive industry were investigated. As the literature shows, collaboration between the OEM and supplier provides a proper basis for increasing project performance during product development, in terms of decreasing costs, lead time, and increasing quality. Japan has shown particular examples of successful collaborative relations between OEMs and suppliers especially in the automotive industry.

As it is discussed in the relationship of new product development and design section, product design is an important phase where the majority of the total costs and quality are determined, directly or indirectly. Hence, the collaboration between the OEM and the supplier would provide better outcomes if the level of supplier involvement couldbe higher especially during thisphase. This may contribute to the increasein project performance by lower costs, the decreasein lead times, andquality improvement.

Thefindings of the literature reviewstudy provided a base for conducting a research study on the Turkish automotive industry. The next chapterpresents the research study which analyzes the situation of the Turkish automotive supplier industryand explores the level of supplier involvement to different project phases by a preliminary questionnaire study. After the results of the questionnaire have been analyzed, a follow up study was neededto get more detailed information on the level of supplier involvement in product design. In order to further investigate suppliers' involvement in product design from the perspectives of OEM and supplier firms, in-depth interviews were conducted with one OEM representative, which is TOFAŞ; and one supplier representative.

CHAPTER 3

THE CASE OF THE TURKISH AUTOMOTIVE SUPPLIER INDUSTRY

The automotive industry has developed significantly in Turkey over the last fifty years; it has been one of the top industries in exports. It started its activities during the 1950s with TürkWillys Overland Ltd., in order to manufacture vehicles for the army. In 1955, Otosan factory, in 1968 and 1969, Tofaş and Oyak Renault factories were founded. The development of the automotive industry has an important role in the economic development of the country because of its relationship with other industries, the value it adds to the service sector, and direct and indirect employment it creates; it is seen as the locomotive industry to a country's industrial development (Bedir, 1999). The development of the Turkish automotive industry has been a pushing force to the industrial development, and in 1978 the localization of automotive parts has reached to 78% (Bedir, 1999). According to *The Top 500 Biggest Industrial Firms Report* published by the Istanbul Chamber of Commerce in 2009, there are three automotive manufacturers in the top ten, and four automotive firms are among the top ten in Turkey's top exporters list. With the entry of global OEMs as joint ventures with Turkish companies during the 1970s,the local industry has developed especially in the Bursa and Gebze regions. Together with car manufacturers, their suppliers have also developed gaining know-how in their businesses and have become competitive firms in the European zone.

3.1 The Research Framework

The literature review of this thesis focused on the benefits of supplier involvement in product design and development, and the importance of the design phasethrough the lifecycle of the product, its positive effects on cost, quality, lead time, and performance. Supplier involvement is discussed and its positive effects on the development of Japanese automotive industry are handled. This research study

investigates the findings of the literature in two parts; first of all a questionnaire study isconductedwhich is considered as a preliminary study, and following this preliminary study two in-depth interviews are done;one with a representative of an OEM firm and one with a representative of a supplier firm. The preliminaryresearch study on the situation of Turkish automotive supplier industry is conducted in order to explore the level of supplier involvement in product design and development process.

The research questions addressed in the preliminarystudy are:

- How active are Turkish suppliers in automotive product development in terms of part design?
- What is the level of supplier involvement in product design and development process?
- How is the supplier involvement in design seen by OEMs?

The aim of the secondary study is, as will be presented later, to explore the suppliers' involvement practices in new product development, from the perspectives of an OEM and a supplier firm.

3.2 Previous Research

Before presenting the research study of this thesis, itwould be valuable to look at the previous research that has been done in the Turkish automotive supplier industry. It is observed from the related literature that the studies in this field mostly focus on supplier selection, buyer-supplier relationships and their typologies. Few studies have focused on the effects of supplier involvement in product development process and few authors especially have studied the suppliers' involvement in product design.

Gules**,**Burgess and Lynch(1997) have studied the evolution of buyer-supplier relations in the Turkish automotive industry gathering data from the literature

and a survey from 83 firms in the industry. They conclude that the relationship evolution can be classified in four phases:

The supportive phase (1954-1980)

This face can be characterized by the small scale production and low productivity in the industry. As OEMs were trying to establish their local supplier base, a high level of technical and financial support from OEMs to suppliers existed. The technical capabilities of suppliers are low, and the competition in the industry is low. The OEMs are dependent on suppliers, because of the low number of suppliers.

The competitive/adversarial phase (1981-1990)

Buyer-supplier relations became more adversarial. As the number of suppliers increased as well as their technical capabilities, the OEMs started playing them agaist each other to have cost reductions. The increasing demands of the OEMs in terms of cost, quality, and delivery times forces suppliers to improve themselves together with the increasing competition. The technical and financial support of OEMs to suppliers decreased because they became less dependent on their suppliers.

The quasi-collaborative phase (1991-1996)

During this period, as a result of the increasing competition between OEMs, suppliers were encouraged to collaborate in order to reach quality and cost targets. However, the technical capabilities of suppliers and the trust between suppliers and OEMs stayed moderate.

The collaborative phase (1997-)

The suppliers are required to deliver product with high quality, low costs, and just-in-time. The technical capabilities of suppliers are very high and competition among buyers and among suppliers is also high. The buyer-supplier relationships are set to become more collaborative, with OEM firms establish closer relationships with their suppliers based on mutual trust and support.

The period after 1997 is not described as this study was conducted on 1997 but the following studies may give an idea about the later developments.

Another study byWasti (1999) shows the level of supplier involvement in product development in the Turkish automotive supplier industry. According to the results of the questionnaire study from 106 Turkish automotive part manufacturers,

- 33% indicated that they manufacture a standard part to which the OEM demands no changes,
- 48.5% stated that they manufacture a product that the OEM makes the design,
- 3.9% stated that they make the design of the product together with the OEM,
- and 14.6% stated that they complete the detailed design of the product following the specifications given by the OEM.

Also, 55.7 % of suppliers indicated that the specifications of OEMs are so tight that there can be only one part design with the given specifications, while 24.6% stated that there may be a several alternative designs that are similar to each other, and 19.7% said that there can be many different design alternatives.Another figure that is also important is about the level of information sharing:The OEMs' information sharing level in technical information which contains confidential issues was found as 39.1% while the level of information sharing concerning non-confidential issues was 76.1%.This study concludes that the relationship between Turkish OEMs and supplier is not specifically aimed at joint product development activities, the OEM is mainly responsible for product design, and the supplier is mainly responsible for production.

In a recent research conducted by Wasti, Kozan, and Kuman (2006), the types of relationships between Turkish OEMs and suppliersare analyzed according to Bensaou's model of buyer-supplier relationships. According to Bensaou, there arefour main types of supplier-buyer models which are captive buyer, market exchange, captive supplier, and strategic partnership which are distinguished by suppliers' and buyers' specific investments, as described in section 2.2.1.The study concludes that among these four types of relationships, captive buyer, market exchange, and strategic partnership relationships exists in the Turkish automotive

industry, and that the captive supplier relationship is not seen. More precisely, according to the field study that is a part of this research which is carried out by a survey distributed to suppliers and OEMs:

- 35% of relationships are strategic partnerships, 24% are market exchanges, and 41% are captive buyers according to the OEMs
- 41.5% of relationships are strategic partnerships, 17% are market exchanges, and 41.5 % are captive buyers according to suppliers

Among these relationship types, the strategic partnership is the one in which the supplier is involved in the product design and development process the most.

While the above mentioned studies investigated the OEM-supplier relationships and supplier involvement in product design, another study shows the cooperation of OEMs and suppliers in product development. In 2007, Zerenler and Güngör conducted a study on the Turkish automotive supplier industry by analyzing 63 companies. Out of 63 questionnaires sent to selected suppliers, 13 were found useful to be used for the study. According to their study results, nearly half of the companies cooperate with customers and suppliersto improve their production processes, only three companies in the mentioned half cooperate with their customers in product design and development, indicating a low percentage of supplier involvement in part design and development.

In another study on the Turkish automotive supplier industry carried out by Wasti, Kozan, and Çınar (2009), the investment made by the OEM to the relationship between its suppliers was observed. The findings of the study show thatthree factors affect the specific investments made by the OEM regarding its relationship with the suppliers:

- The specific expertise and capability required for the component
- The interface of the component with the final product
- The technological uncertainty involved in the component

The results of the survey conducted on Turkish OEMs and suppliers show that the most significant characteristic that positively affects the specific investment the OEM makes to its relationship with the supplier is the technological uncertainty involved in the component. The other two factors have also positive relationships with the level of specific investment made.

The Turkish automotive industry is still open to some improvements. In the *Turkish Automotive Sector Strategy and Action Report* published in February 2011 by the Ministry of Industry and Commerce, the weaknesses of the industry related to product development activities are listed as follows:

- The lack of effective and cooperative relationships between OEMs and suppliers,
- The lack of R&D investments,
- The small number of suppliers who can participate in joint design activities,
- The lack of expertise in designing and developing powertrain parts,
- Not having enough certified test centers,
- The imbalance of supply and demand of qualified personnel (p.24).

In the same report, in order to make improvements in these weaknesses and to increase the competitiveness of the Turkish automotive industry, developing the R&D infrastructure and enhancing design and manufacturing skills and capacities of OEMs and suppliers is foreseen as possible opportunities.

In order to analyze the current situation in Turkish automotive supplier industry and contribute to the research already done, some indicators of supplier involvement are used in order to assess the level of supplier involvement in product development and especially design. These indicators collected from the literature are combined with the new product development methodology APQP and FMEA, which are described in the next section. Questionnaire questions were designed according to these

indicators to assess the level of supplier involvement in new product development process.

3.3 Survey

To have a general idea of the Turkish automotive suppliers' level of involvement in product development activities, a descriptive survey was conducted with OEMs and part suppliers as a preliminary study. This study gives an overview of the Turkish automotive industry although the results are not statistically meaningful.

Before presenting the study instrument of the survey, a background of the items present in the questionnaire will be discussed. The questionnaire items are determined to observe the level of supplier involvement in different project phases, and some systems of product development commonly used in the automotive industry are used in the questions. These methods are widely accepted and used in the industry and are not unfamiliar to questionnaire participants since the companies that are supplying goods to the automotive industry are required to get the ISO/TS 16949 certificate which is an international technical certification aimed at developing quality management systems in the automotive industry, it applies to the design, development, and manufacturing stages. So the methodologies included in the TS 16949specification are assumed to be familiar to all questionnaire participants.

3.3.1 Study Instrument

Advanced Product Quality Planning (APQP) is a quality system used for developing new products in the automotive industry. It is based on the quality standards ISO 9001 and TS 16949 designed for the automotive industry. It was first developed during the 1980s by the collaborative efforts of General Motors, Ford, and Chrysler, members of Automotive Industry Action Group, and it was publishedas a quality manual in 1994. Its aim is to create a quality system in order to eliminate problems during the early stages of the product developing process by mistake proofing in order to face fewer problems during mass manufacturing. Its goal is to support the

cross-functional and cross-company product development teams, such as design, engineering, manufacturing, quality, and planning functions.

APQP is designed to eliminate potential problems that may be confronted during the production stage, thus is based on the principle to take corrective action before the problem occurs; such as anticipating problems and taking counter-measures. Mistake-proofing a product's design and its manufacturing process is a key element of APQP. The involvement of the supplier in the APQP team can be considered as an indicator of a high level of involvement of the supplier in the NPD process.

One of the most important elements of APQP, Failure Modes and Effects Analysis(FMEA)was first used by US Department of Defense in the 1949 for aerospace/rocket development and it is described in the military standard *Procedures for Performing a Failure Mode, Effect and Criticality Analysis.* In the 1970s, Ford Motor Company used it for the first time in the automotive industry.

> A failure mode and effects analysis is an engineering technique used to define, identify, and eliminate known and/or potential failures, problems, errors, and so on from the system, design, process, and/or service before they reach the customer (Stamatis, 2003, p.21).

FMEA is used to identify potential failure modes, determine their effects on the mass production of the product, and identify actions to eliminate the failures. A crucial step is anticipating what might go wrong with a product. Although anticipating every failure mode is not possible, the development team should formulate an extensive list of potential failure modes and define their solutions. According to Stamatis (2003), a FMEA simply aims to answer the following questions:

1. What can go wrong?
2. If something goes wrong, what is the probability of it happening and what is (are) the consequences?

More specifically, the handbook of FMEA (2001), prepared by the Ford Motor Company, DaimlerChrysler Corporation, and General Motors Corporation, defines FMEA as a "systematic group of activities intended to determine and analyze the potential failure of a product/process and the effects of that failure, identify methodsthat could eliminate or reduce the chance of the potential failure occurring, and document the entire process" (p.1).

A good FMEA identifies known and potential failure modes, identifies the causes and effects of each failure mode, prioritizes the identified failure modes according to the risk priority number, and provides problem follow-up and corrective action (Stamatis, 2003). Pantazopoulos and Tsinopoulos (2005) discuss that FMEA can lead to reductions in internal defects (during and after the manufacturing process), customer complaints, failures in the field, performance deficiencies, and warranty claims; all of which may lead to cost reductions and quality improvements during the lifecycle of the product. Suppliers' involvement in FMEA can be considered as an indicator of the suppliers' involvement in product development and especially product design.

A study conducted by Jayaram (2008) investigates the level of the following practices in new product development projects:

- Communicating with key suppliers during concept stage,
- Participation of key suppliers in NPD team,
- Sharing design knowledge with key suppliers,
- Involvement of key suppliers in defining the architecture of new products,
- Involvement of key suppliers in setting design specifications,
- Involvement of key suppliers in prototype building,
- Getting feedback and suggestions from key suppliers on design modifications,
- Getting feedback and suggestions from key suppliers on problem solving,
- Sharing manufacturing knowledge with key suppliers(p.3723).

Jayaram (2008) investigates how the OEM involves its suppliers in the new product development process, the extent, and timing by a survey conducted with OEMs and suppliers. The above mentioned practices in new product development projects in Jayaram's model are used in this study not as a template but as a reference patternfor thesurvey questions, in order to determine the level and the timing of supplier involvement in the Turkish automotive industry. The questions in thesurveys given to supplier and OEM firms are separated for each project phase:

1. Introduction to the project
2. Product Design
3. Prototype
4. Pre-launch
5. Mass Manufacturing

In each phase, statements mentioning the factors related to that phase are given. The objective of separating the project phases is to evaluate in which phase more emphasis is put on supplier involvement, the timing of supplier involvement. Five point likert scales were used in order to measure the level of supplier involvement. The reason for using five point likert scales -unlike the way in Jayaram'smodel whousedten point Likert scales- is to simplify the differences between the ratings and the better comprehension of the participants between them. Table 8gives the factors in each of the project phases to assess supplier involvement. The questionnaire questions are adapted from these criteria.

Before the survey questions, in the supplier survey, the number of employees, and the names of the OEM firms the supplier is working with is asked in order to gather information about firm size and the customer profile of the firm.

Table 8: Project Phases and Related Factors to Assess Supplier Involvement

Project Phases	Related Factors in the Project Phases to Assess Supplier Involvement
Introduction to the project	a. The level of direct contact with the supplier during concept/Request for quotation phase b. The level of sharing design knowledge with the supplier during concept/RFQ phase c. The level of sharing manufacturing and assembly knowledge with the supplier d. The level of sharing customer requirements with the supplier
Product design	e. The level of involvement of the supplier to the APQP/product development team f. The level of involvement of the supplier in defining the geometry and position of the parts inside the vehicle g. The level of involvement of the supplier in design reviews/DFMEA h. The level of involvement of the supplier in part design
Prototype	i. The level of direct contact with the supplier during the prototype phase j. Getting feedback from suppliers about design problems during the prototype phase k. Getting feedback from suppliers about quality problems during the prototype phase l. The level of acceptance and execution of supplier suggestions during the prototype phase
Pre-launch	m. The level of direct contact with the supplier during pre-launch phase n. Getting feedback from suppliers about design problems during the pre-launch phase o. Getting feedback from suppliers about quality problems during the pre-launch phase p. The level of acceptance and execution of supplier suggestions during the pre-launch phase
Mass Manufacturing	r. The level of direct contact with the supplier during mass manufacturing phase s. Getting feedback from suppliers about design changes during mass manufacturing phase t. Getting feedback from suppliers about problem solving during mass manufacturing phase u. The level of acceptance and execution of supplier suggestions during mass manufacturing phase

The questionnaire has two forms of wording, one for the supplier firms and the other for the OEMs. The reason for applying the same questionnaire to suppliers and OEMs separately is toget the two different perspectives on the same issues. On the other hand, questions 3.l., 4.p., and 5.u. are asked only to the suppliersbecause those statements can only be evaluated by the suppliers. Likewise, an additional question is asked in the OEM questionnaireto assess the performance of the suppliers, which can only be answered by the OEMs. The additional question in the OEM questionnaire is:

- What is the level of feedback you get from your suppliers about your requirements considering all the factors mentioned above?

Additionally, in order to get the respondents' further opinions, the following open ended questions are asked in the supplier questionnaire:

- How do you evaluate the OEMs' approach to supplier firms about suppliers' involvement in new product development and design?
  [Original version in Turkish: Yeni ürün tasarım ve geliştirme sürecine tedarikçinin katkılarıyla ilgili olarak, ana sanayi firmalarının tedarikçiye yaklaşımları ile ilgili görüşlerinizi belirtir misiniz?]

And in the OEM questionnaire:

- Could you define as keywords your expectations from suppliers you consider working with, keeping in mind the contributions of suppliers to the new product design and development process?
  [Original version in Turkish: Yeni ürün tasarım ve geliştirme sürecine katkılarıyla ilgili olarak, Firmanızın birlikte çalışmayı isteyeceği/tercih ettiği tedarikçilerin sahip olması gerektiğini düşündüğünüz özelliklerinden kısaca bahseder misiniz? (*sadece anahtar sözcükler kullanabilirsiniz*)]

These two questions are evaluated separately, as they provide qualitative results. The questionnaire in original Turkish version and English translation can be found in Appendix A.

3.3.2 Population and Sampling

There are 15 OEMs in the Turkish automotive industry; a table from the TAYSAD (Association of TurkishAutomotive Parts & Components Manufacturers) database is presented in Appendix B representing the production volume of each OEM in 2010. It can be seen from the table that Tofaş, Oyak Renault, and Ford Otosan, who are also the respondents of the survey, are the top 3 manufacturers in terms of production volume. Also in 2009, the total production volume of these three OEMs was equal to 80% of the vehicle production in the Turkish automotive sector.

TAYSAD is the biggest representative of automotive suppliers in Turkey with 287 members. Its members represent 65% of the Turkish automotive suppliers' industry and 70% of the industry's exports, employing 80 000 employees.The diversity of parts that TAYSAD members produce is sufficient to supply 85-90% of parts needed for the automobile production in Turkish automotive industry (www.taysad.org.tr). The automotive parts that can be manufactured by TAYSAD member suppliers are:

- Complete engines and engine parts,
- Power trains,
- Brake systems and parts,
- Hydraulic and pneumatic spare parts,
- Suspension parts,
- Safety spare parts,
- Foam and rubber parts,
- Chassis parts and spare parts,
- Forged and cast parts,
- Electrical equipment and illumination systems,
- Batteries,

- Automobile glass,
- Seats(www.taysad.org.tr).

The questionnaireswere sent separately to OEMs and suppliers. The supplier questionnaire was sent by TAYSADbecause of its large supplier database and its trustworthy status among its members. It was sent by e-mail because e-mail replies were considered as quicker, considering the limited time to gather responses. The e-mail sent by TAYSAD can be found in Appendix C. The questionnaire was sent to the 'technical' mail group of the suppliers; quality managers or engineering managers. After the first contact with suppliers by TAYSAD, a reminder e-mail was senttwo weeks later.OEM questionnaires were sent by the author. Among 285 suppliers, 25 replies were received, resulting in a response rate of 8.77%. From 15 OEM firms, 5 replied to the OEM questionnaire, constituting a response rate of 33.33%.

From the supplier questionnaire replies, the company profiles were analyzed. The questionnaire participants are quality, engineering, project, or sales managers who have at least three years of experience in their firms. The average years of experience of the questionnaire respondents is 6.17 years, and the average number of employees working in the supplier firms is 490. The supplier firms' and the respondent's profiles in the supplier questionnaire are given in Table 9.According to the information provided by supplier representatives who participated in the questionnaire, the automotive parts the supplier firms are manufacturing vary and it can be said that they provide a good sampling with respect to the list of automotive parts produced by Turkish part suppliers are listed by TAYSAD. However, it is seen that the automotive glass manufacturers and seat manufacturers have not participated in the supplier questionnaire.

Table 9: Supplier Survey Population

Supplier	Automotive Parts Manufactured by the Supplier Firm	Number of Employees	Respondent's Title	Respondent's experience (years)
1	Gearbox parts	490	R&D Manager	5
2	Fuel tanks	290	Project& Sales Engineer	3
3	Electrical equipment	96	Quality Manager	8
4	Forged and cast parts brake system parts	430	Quality Engineer	3
5	Batteries	700	Sales Manager	15
6	Plastic injection parts & accesories	560	-	4
7	Forged and cast parts	200	-	9
8	Suspension parts & engine parts	300	-	15
9	Forged and cast parts	600	R&D Manager	-
10	Chasis parts & forged and cast parts	210	-	19
12	Rubber parts	3000	Project Manager	2
13	Batteries	760	R&D Manager	3
14	Chasis parts & power trains	600	Sales Manager	2
15	Plastic injection parts	300	Sales Manager	4
16	Foam parts	103	Quality Manager	10
17	Foam parts	10	-	3
18	Foam and rubber parts	242	Sales Manager	3
19	Plastic airducts	320	R&D Manager	13
20	Plastic injection parts	265	Quality Manager	5
21	Washer tanks	280	Project Manager	3
22	Air filters	300	Project Manager	4
23	Interior systems	570	Quality Engineer	3
24	Engine parts & Plastic injection parts	400	Quality Engineer	3
25	-	-	-	-
	Average number of employees=	490	Average experience=	6.17

Among the replies received, one respondent did not give any information of his company, and 6 respondents did not provide their positions. Among the firms who gave information about their companies, all of them gave information about the OEMs their companies are working with. According to their responses, the top three Turkish OEMs the suppliers who participated in the questionnaire are working with are Ford, Renault, and Tofaş. These answers are summarized in Figure 13.

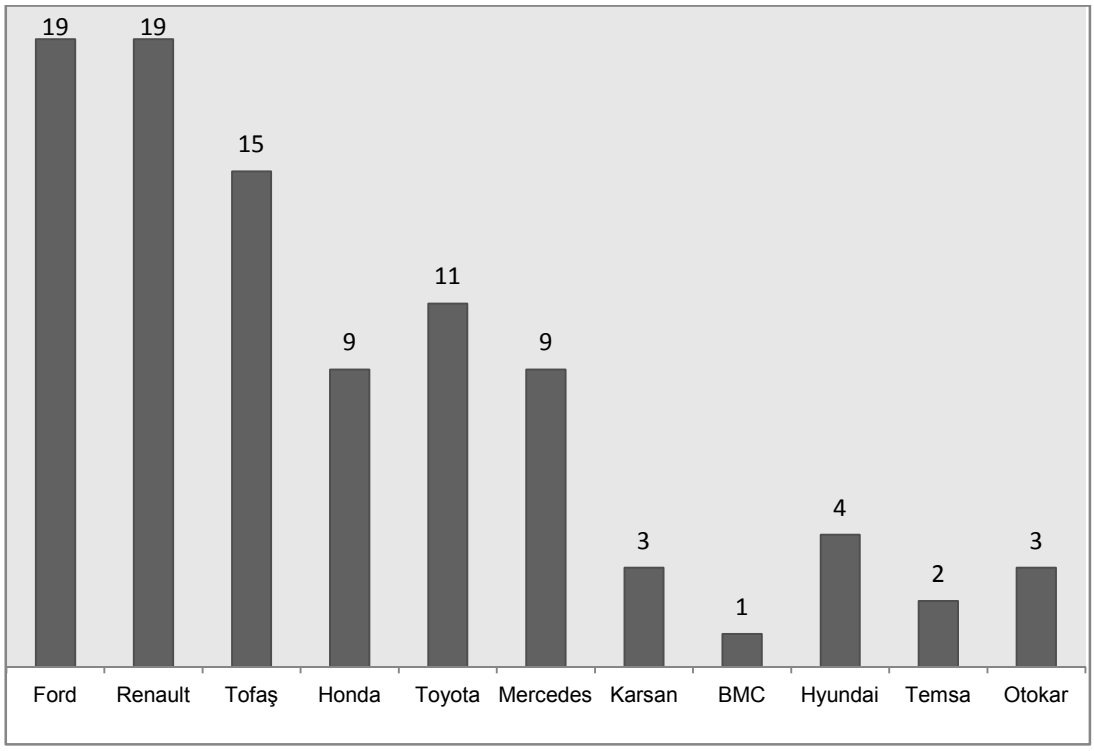

Figure 13: OEM firms the suppliers are working with

Among the OEM questionnaire respondents, each participant gave information about their companies, titles, and the years of experience. Four of the OEMs who participated in the questionnaire are automobile manufacturers; one of them is a bus manufacturer. All of the participants' positions are related with supplier quality, although each has different titles related with the organizational structure of his/her company. The respondents' average years of experience in their current position is 6 years.

3.4Results of the Questionnaire

The questionnairequestions' ratings were given as five point Likert scales and the mean and standard deviation of the replies given to each question were calculated.Also the average of the ratings were converted to percentages and calculated for the 5 project phases mentioned in section 3.2.1. Each question shows the level of supplier involvement, and the average percentages of project phases were observed to see the timing of supplier involvement with respect to the phases mentioned.

3.4.1 Supplier Questionnaire Results

The statistical analysis of the supplier questionnaire results are shown in Table 10.According to the responses given by the questionnaire participants, the top three rated items are for which the level of supplier involvement is the highest are:

- The level of direct contact with the supplier during mass manufacturing phase(mean: 4.22)
- The level of direct contact with the supplier during pre-launch phase (mean: 4.05)
- The level of direct contact with the supplier during prototype phase (mean: 3.79)

The least rated factors are:

- The level of involvement of the supplier to design review / DFMEA (mean: 2.11)
- The level of involvement of the supplier to part design (mean: 2.32)
- The level of involvement of the supplier in defining the geometry and position of the parts inside the vehicle (mean: 2.53)

The least three rated factors are all in the second project phase, which is design.

Table 10: Supplier Survey Results

Project Phases	Questions	Mean	Std Dev
1. Introduction to the Project	The level of direct contact with the supplier during concept/ RFQ phase	3.63	1.26
	The level of sharing design knowledge with the supplier during concept/ RFQ phase	3.47	1.35
	The level of sharing manufacturing and assembly knowledge with the supplier	3.16	1.12
	The level of sharing customer requirements with the supplier	3.74	1.19
2. Design	The level of involvement of the supplier to the APQP/product development team	2.68	1.25
	The level of involvement of the supplier in defining the geometry and position of the parts	2.53	1.50
	The level of involvement of the supplier to design review/DFMEA	2.11	1.24
	The level of involvement of the supplier to part design	2.32	1.29
3. Prototype	The level of direct contact with the supplier during prototype phase	3.79	0.98
	Getting feedback from suppliers about design problems during prototype phase	3.32	1.34
	Getting feedback from suppliers about quality problems during prototype phase	3.21	1.13
	The level of acceptance and execution of supplier suggestions during prototype phase	3.32	1.16
4. Pre-Launch	The level of direct contact with the supplier during pre-serial phase	4.05	0.97
	Getting feedback from suppliers about design problems during pre-serial phase	3.33	1.19
	Getting feedback from suppliers about quality problems during pre-serial phase	3.28	0.96
	The level of acceptance and execution of supplier suggestions during pre-serial phase	3.17	1.10
5. Mass Manufacturing	The level of direct contact with the supplier during serial phase	4.22	0.88
	Getting feedback from suppliers about design changes during serial phase	3.22	1.06
	Getting feedback from suppliers about problem solving during serial phase	3.44	1.10
	The level of acceptance and execution of supplier suggestions during serial phase	3.28	1.02

N= 25 Minimum rating= 1 Maximum rating= 5

Figure 14 below represents the average of the total scores suppliers ratedfor each project phase.

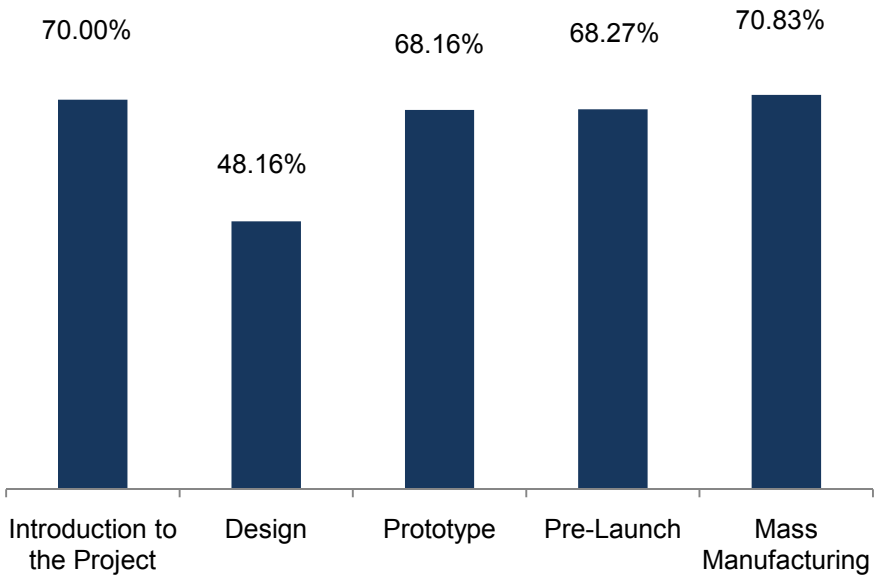

Figure 14: Level of Supplier Involvement in Project Phasesfrom Suppliers' Perspective

It can be observed from the figure that although supplier involvement is observed as nearly 70% at all phases; in the design stage minimum level of involvement takes place which is less than 50%.

3.4.2 OEM Questionnaire Results

The statistical analysis of the OEM questionnaire results are presented in Table 11.

Table 11: OEM Survey Results

Project Phases	Questions	Mean	Std Dev
Introduction to the Project	The level of direct contact with the supplier during concept/ RFQ phase	3.80	0.84
	The level of sharing design knowledge with the supplier during concept/ RFQ phase	3.00	0.71
	The level of sharing manufacturing and assembly knowledge with the supplier	4.00	1.22
	The level of sharing customer requirements with the supplier	4.40	0.55
Design	The level of involvement of the supplier to the APQP/product development team	4.40	0.89
	The level of involvement of the supplier in defining the geometry and position of the parts	3.00	1.00
	The level of involvement of the supplier to design review/DFMEA	3.60	1.14
	The level of involvement of the supplier to part design	3.60	1.14
Prototype	The level of direct contact with the supplier during prototype phase	4.00	0.71
	Getting feedback from suppliers about design problems during prototype phase	4.20	0.45
	Getting feedback from suppliers about quality problems during prototype phase	4.20	0.45
Pre-launch	The level of direct contact with the supplier during pre-serial phase	4.60	0.89
	Getting feedback from suppliers about design problems during pre-serial phase	4.40	0.89
	Getting feedback from suppliers about quality problems during pre-serial phase	4.80	0.45
Mass Manufacturing	The level of direct contact with the supplier during serial phase	4.60	0.89
	Getting feedback from suppliers about design changes during serial phase	4.40	0.89
	Getting feedback from suppliers about problem solving during serial phase	4.40	0.89
	Supplier's overall performance level in the project	4.00	0.71

N= 5 Minimum rating= 1 Maximum rating= 5

The average ratings shown in percentages are represented in Figure 15 for each project phase.

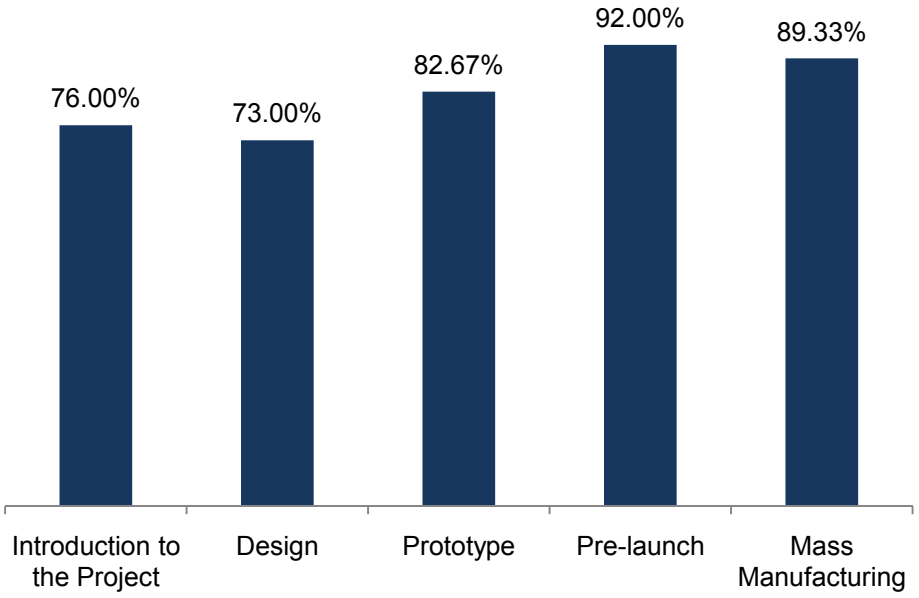

Figure 15: Level of Supplier Involvement in Project Phases from the OEMs'Perspective

The differences between the involvement levels according to each project phase are not significant in the OEM questionnaire results. Although the design phase depicts a slightly lower level of involvement, the difference between the design phase and the introduction phase is not significant.

There are differences between the questionnaire results of suppliers and OEMs. While involvement in the design phase is found as 46% according to the answers given by suppliers, it is found as 77% according to the answers given by the OEM firms. Table 12 represents the comparison between the supplier questionnaire results and the OEM questionnaire results.

Table 12: Comparison between supplier-OEM questionnaire results according to level of involvement in project phases

PROJECT PHASE	SUPPLIER QUESTIONNAIRE	OEM QUESTIONNAIRE
1- Introduction to the Project	67.81%	73.00%
2- Design	46.56%	77.00%
3- Prototype	67.19%	82.67%
4- Pre-launch	69.38%	92.00%
5- Mass Manufacturing	70.31%	89.33%
Average Rating	64.25%	82.80%

The average rating calculated by the answers given by the OEMs represent a higher percentage of supplier involvement at all phases than the average rating of answers given by suppliers. This difference is especially high at the design phase. Reasons for this difference may be the differences in the perspectives of OEMs and suppliers, which is may be defined as the 'perception gap' between buyers and supplier mentioned by Kim et al. (1999). Nevertheless, both questionnaire results show that involvement in design stage is lower compared to the other stages.

The correlations between the questionnaireitems were also analyzed to see the relationships between different practices during product development. A correlation matrix is presented in Table 13. Correlation analysis was done according to Pearson's correlation coefficient (Devore, 2000):

$$0 < |r| < 0.3 \text{ weak correlation}$$
$$0.3 < |r| < 0.7 \text{ moderate correlation}$$
$$|r| > 0.7 \text{ strong correlation}$$

Table 13: Correlations Between the Questions in the Supplier Survey

	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	r	s	t	u
a	-																			
b	0.83**	-																		
c	0.76**	0.87**	-																	
d	0.75**	0.60*	0.70**	-																
e	0.49	0.52*	0.40	0.39	-															
f	0.46	0.47	0.54*	0.45	0.68*	-														
g	0.31	0.50*	0.47	0.36	0.77**	0.62*	-													
h	0.38	0.51*	0.54*	0.38	0.72**	0.85**	0.77**	-												
i	0.34	0.54*	0.64*	0.38	0.08	0.23	0.43	0.28	-											
j	0.17	0.22	0.30	0.37	0.40	0.58*	0.55*	0.55*	0.44	-										
k	-0.02	0.08	0.06	0.25	0.52*	0.26	0.50*	0.26	0.24	0.69*	-									
l	0.24	0.29	0.30	0.38	0.61*	0.67*	0.59*	0.49	0.41	0.79**	0.75**	-								
m	0.47	0.49	0.45	0.44	0.29	0.36	0.32	0.21	0.60*	0.33	0.29	0.58*	-							
n	0.22	0.36	0.36	0.33	0.45	0.30	0.44	0.26	0.29	0.67*	0.81**	0.69*	0.46	-						
o	0.11	0.19	0.27	0.29	0.40	0.26	0.31	0.19	0.22	0.60*	0.80**	0.71**	0.51*	0.90**	-					
p	0.14	0.19	0.19	0.36	0.33	0.30	0.32	0.18	0.21	0.71**	0.82**	0.73**	0.55*	0.90**	0.90**	-				
r	0.47	0.42	0.43	0.53	0.16	0.16	0.24	0.06	0.36	0.11	0.17	0.28	0.76**	0.43	0.41	0.51*	-			
s	0.12	0.06	0.09	0.30	0.05	-0.02	0.02	-0.17	-0.05	0.34	0.39	0.42	0.23	0.68*	0.69*	0.72**	0.45	-		
t	0.15	0.16	0.18	0.35	0.22	0.18	0.21	0.01	0.01	0.46	0.51*	0.54*	0.28	0.74**	0.72**	0.77**	0.44	0.92**	-	
u	0.01	-0.08	0.04	0.32	-0.12	-0.04	-0.03	-0.19	-0.04	0.26	0.24	0.32	0.12	0.45	0.46	0.54*	0.26	0.81**	0.73*	-

* $r \geq 0.5$; ** $r \geq 0.57$

As a result of the evaluation of correlation factors between the questions, strong correlation is found between the following factors:

- If the OEM directly contacted the supplier during the introduction phase, then it shared design knowledge, manufacturing and assembly knowledge, and customer requirements as well;
- If the OEM involved the supplier in the APQP team, then it also involved the supplier in DFMEA studies and part design;
- If the OEM requested suggestions from the supplier duringthe prototype, pre-serial, or mass manufacturing phase then it applied the suggestions made by the supplier.

The correlation between the direct contact during the introduction stage of the OEM with the supplier and the level of design, manufacturing, assembly, and customer requirements shared shows the importance of the introduction stage. The supplier is able to get most of the information it needs during this stage. This can be related to the importance of the concept design stage, where the interaction between the supplier and the OEM about product design is needed the most as discussed previously.

The high positive correlation between the involvement in APQP team and involvement in DFMEA and part design indicates the contribution of APQP in supplier involvement in design. Also, the relationship between DFMEA and part design shows that involvement in DFMEA is a strong indicator for the involvement in part design.

The relationship between the suggestions requested from the supplier and the acceptance of these suggestions show that when the OEM requests suggestions about design problems, quality problems, and problems solving, it has a tendency to trust the suppliers' suggestions and hence accept them.

3.4.3 Open Ended Questions

Open ended questions were used to gain more in-depth knowledge about the suppliers' and OEMs' opinions about supplier involvement in product design and development and to define some areas for improvement in OEM-supplier relations in terms of their partnership during product design. The open ended questions in the OEM questionnaire were analyzed and encounteredkeywords were categorized. All the OEMs responded to the open ended questions and similar replies were received. The open ended question in the OEMquestionnaire is:

Could you define as keywords your expectations from suppliers you consider working with, keeping in mind the contributions of suppliers to new product design and development process?

According to the replies given by OEMs, the properties that a supplier should have in for its involvement in the product design and development process are:

- Having a TS 16949 certificate (4)
- Experience with the OEM firm in previous projects(4)
- Experience of designing/ producing similar parts(3)
- Designer/ co-designer capabilities(3)
- Knowledge of designers about manufacturing process(3)
- Strong engineering capabilities (3D modeling, software, hardware)(2)
- Being customer oriented(2)
- Being transparent and cooperative(2)
- Problem solving capabilities(2)
- Long-term relationship(2)
- Quality, cost, and lead time performance(2)

It can be seen that having TS 16949 certificate and previous experience with the OEM are the factors that have the biggest impact for supplier involvement.

The open ended questions in the supplier questionnaire were studied and key characteristics of supplier OEM relations and suppliers' involvement level are determined.These answers are handled in the discussion section. The open-ended question in the supplier questionnaire is:

How do you evaluate the OEMs' approach to supplier firms about suppliers' involvement in new product development and design?

Eleven out of twenty five suppliers have given their opinions about this question. Among them, 3 stated that OEMs have a positive approach towards suppliers and that the product development activity is carried out together with the OEM without any problems, and 8 stated that they face some problems during product development and design. The suppliers that have mentioned a negative approach in their product development process with the OEM noted that the level of supplier involvement in product design and development is low due to the following reasons, from the most cited to the least cited:

- The lack of information sharing by the OEM during the internal approval process of the part design (3)
- The lack of transparency of the OEM to share technical information with the suppliers due to confidentiality issues (2)
- The strict limitations of the OEM about the technical characteristics of the production process; such as materials, equipment, processes (1)

All these factors are related to the approach of the OEM towards the supplier during the product development process. The lack of sharing technical information due to confidentiality issues and the strict technical limitations of OEMs were also underlined by Wasti (1999), as explained in section 3.2.

According to the similar replies given by suppliers, the level of supplier involvement in product design and development can be improved by increasing:

- The technical support of the OEM during part design(4)
- The financial support of the OEM to compensate the costs bared by the supplier during the product design stage(4)
- The number of designers having the technical knowledge about manufacturing processes(3)
- The involvement of the suppliers to the OEMs product development teams(3)
- Level of information sharing by the OEM (2)

The next section is a discussion of the questionnaire study.

3.5 Discussion of the Survey Results

As discussed in the previous Chapter, design is seen as the most important stage where the majority of the products characteristics, cost, development time, and quality can be improved. The lower level of involvement of suppliers in the design phase compared with other project phases according to questionnaire results implies some potential for improvement. These improvement implications can be found in the answers of the open ended questions.

The answers given to the open ended question in the OEM questionnaire and that are mentioned in section 3.4.3 give clues about the characteristics, skills, and capabilities a supplier should have, from the perspective of OEM firms, in order to enhance supplier involvement. These factors may be classified according to the skills that a supplier has:

- Three properties mentioned are related to the previous experience of the supplier in the automotive industry and especially with the OEM firm,
- Another three are related with suppliers' design and engineering skills and capabilities, and can be considered as the know-how of the supplier,
- The other three show suppliers' attitude towards the OEM, the relationship between the supplier and the OEM,
- One of the properties mentioned represents suppliers' teamwork skills,

- Another response represents suppliers' project management skills; which is about the organizational efficiency of the supplier.

The most mentioned itemabout the expectations of OEMs from suppliers is having a TS16949 certificate and having previous experience with the OEM.These two factors which are related with the previous experience of the supplier in the automotive industry and especially with the OEM firm are important to be in the 'supplier pool' of the OEM. TS16949 is an obligatory quality certificate in the automotive industry; a manufacturer cannot become a potential supplier for an automotive firm without having this certificate. Having previous experience with the OEM is an important criterion to become a potential supplier for new projects, this may be important because the OEMs have more confidence in suppliers with whom they have worked before and who have been successful.

The second most mentioned answers were suppliers' experience of designing and producing similar parts, designer/co-designer capabilities, and knowledge of designers about manufacturing process. These three are all linked with the know-how level of the supplier. One of the OEMs has mentioned this attribute by having 'co-designer' capabilities. One has defined a term called Full Service Supplier (FSS), which means the supplier makes the design and produced the part; compared to build-to-print supplier, which means the OEM makes the design and the supplier produces the part. This OEM has stated that suppliers are encouraged to be FSS suppliers, being a build-to-print supplier is not preferred.

The third most mentioned answer is about the relationship between the OEM and the supplier. This relationship should be developed enough to have a mutual trust between them. Finally, the fourth most mentioned answer is about the organizational efficiency of the supplier. This can be also considered as a general characteristic of successful firm in NPD, as studied in the literature under the concurrent engineering theme.

The answers given to the open ended questionsin the supplier questionnaire, as mentioned in section 3.4.3, underline the importance of the OEMs' technical and financial support, level of information sharing, and cooperative attitude towards the suppliers to enhance the suppliers' contribution to product design and development. The most mentioned thingis about the technical and financial support of the OEM. It can be concluded that during part design and development, suppliers need technical and financial assistance, in order to have technical assistance they need a high level of information sharing by the OEM with a cooperative attitude. This factor relates to the relationship between the OEM and the supplier, having a 'partner' type of relationship based on mutual trust.

Despite the 'perception gap' between the OEMs and suppliers, the answers given to open ended questions can be considered by both parties as means of improvement and as opportunities to achieve higher level of supplier involvement in the Turkish automotive industry. The OEM-supplier relationship is two sided, and in order to reach a better position than the status-quo, each party can make some contributions.

3.6 In-depth Interviews as a Follow-up Study

The preliminary study gave a general view of the Turkish suppliers' participation in the product development process in the automotive industry. Although the results are statistically not meaningful due to the low response rate, they are useful to have a general idea of the OEMs' and suppliers' views about supplier involvement. It was seen that the respondent suppliers' involvement in the design stage is lower compared to other product development stages. It was seen in the preliminary questionnaire study that open ended questions provide more meaningful information; hence a qualitative follow-up study is constructed to understand suppliers' involvement especially in design process. In this follow-up study, one OEM and one supplier representative were selected and in-depth interviews were done with the aim of gaining moreinformation about suppliers' involvement in part design during product development. The main question handled in this follow-up study is:

- How is the product design process carried out in the OEM/supplier firm, and what is the contribution of the supplier to this process?

3.6.1. Background Information about the Follow-up Study

For the interview with an OEM, Tofaş, the biggest automotive manufacturer in 2010 was selected. For the interview with the supplier, a plastics manufacturer was selected, which is also a supplier of Tofaş.

3.6.1.1. Interviewee and Interview environmentof Follow-up Study 1st Part (in-depth interview with an OEM)

The R&D manager of Tofaş was interviewed in order to get the opinions of a representative of one of the biggest Turkish OEMs about buyer-supplier relations and the level of supplier involvement in product design and development in the Turkish automotive industry. A meeting was requested and it was realized at Tofaş R&D center in Bursa on 18.04.2011. The interview was held in a meeting room and lasted an hour. The interview was recorded by a voice recorder, and then it was transcribed and translated to English since it was held in Turkish as it is the native language of both interviewee and the interviewer. The interview schedule can be found in the Appendix D, and the information which is planned to be gathered can be grouped underfour main themes:

1. General information about Tofaş
2. The capabilities of Tofaş in automotive production
3. New product design process at Tofaş
4. Supplier selection criteria
5. Suppliers' involvement in new product development

The last three themes were especially included because more detailed information on them is needed as a result of the preliminary study.

3.6.1.2 Interviewee and Interview environment of Follow-up Study 2nd Part (in-depth interview with a supplier)

An in-depth interview was done with a part supplier in order to look at the concept of suppliers' involvement in product development from a supplier's perspective. Following the supplier's request, the name of the company will be kept confidential in this thesis and the firm will be referred as 'the Supplier'. The R&D manager of the Supplierwas interviewed in order to get the opinions of a representative of a supplier firm member of TAYSAD about buyer-supplier relations and the level of supplier involvement in product design and development in the Turkish automotive industry. The interviewee has 15 years of experience in the Supplierfirm, and 5 years of experience in his current position. The meeting was organized in Istanbul, at the head office of the Supplieron 26.04.2011. The interview was held in a meeting room and lasted an hour. The interview was recorded by a voice recorder, and then it was transcribed and translated in English. The interview schedule can be found in the Appendix E.

3.6.1.3 Analysis of the data gathered

After the transcription and translation of the interview with Tofaş, the answers of the interviewee were grouped according to the five themes indicated above. The grouping was done by collecting keywords and statements, and then the corresponding theme was determined. All the keywords and statements related with each theme were gathered and summarized in the rest of this section; direct quotations were used to clarify certain themes. An example of the coding and grouping of the transcribed text can be found in Appendix F.

The transription of the interivew with the Supplier was analyzed and the answers were grouped in the following themes:

1. Information about the supplier
2. Production and design capabilities

3. Involvement in the product development process

An example of the coding and grouping of the transcribed text can be found in Appendix G.The in-depth interviews are treated in sections 3.6.2 and 3.6.3.

3.6.2 Exploration of TOFAŞ as a case of OEM in Turkish Automotive Industry

Tofaş is the top automotive manufacturer of 2010 according to the industry report distributed by TAYSAD in January 2011. Its production volume is 312 245 vehicles among which 115 720 of them are automobiles and 196 525 of them are commercial vehicles. Its share is 28.5% of the industry's production in 2010. It is the second OEM in export volume among the top 5 Turkish automotive manufacturers, holding 25.6% of total exportation volume. Its production capacity is 400 000 vehicles per year.

The company was founded in 1968 under a license agreement with Fiat Group Automobiles S.p.A. Today 37.85% of the company belongs to Fiat Auto, 37.58% belongs to Koç Holding, one of the largest groups of companies in Turkey, and 24.28% is publicly held. The factory was established in 1969 in Bursa, a city in which the automotive industry is intensely present. The construction of the factory was finished in 1971, and the first automobile manufactured was named as *Murat 124* in 1976. In 2011, the company celebrates its 40th year in manufacturing, and it employs 8500 people. It is among the three strategic production plants of Fiat Group Automobiles S.p.A. The current vehicle productions at Tofaş are Linea, Doblo, and Fiorino which are under the Fiat brand. Also, Fiorino, a medium commercial vehicle, is manufactured under Peugeot and Citroen brands, with a special license agreement. This vehicle is manufactured as Bipper and Nemo, which are the same vehicles as Fiorino, with some minor changes in the logos and parts near the logos. The same type of agreement exists with GM, and the vehicle Doblo will be produced under Opel brand in the near future. Tofaş has around 500 suppliers.

3.6.2.1 Automotive Production at Tofaş

Tofaş itself producesthe body and chassis parts of the vehicles- such as door frames, side frames, ceiling frames- which are produced in the metal casting and forging tool shop. Some of the suspension parts are also produced in house; however some suspension parts outsourced and assembled in the factory. Tofaş doesn't have engine production in Turkey, all the engine and transmission parts are supplied from Fiat's powertrain division. All of the remaining parts, including small metal parts, components, plastic parts, seats, and interior trims are supplied from suppliers. It can be estimated that 70% of an automobile is constructed with suppliers' parts.

3.6.2.2 New product design process at Tofaş

Tofaş is capable of designing a vehicle all by itself- including all the components, but there are some 'strategic' areas in automotive product design which have to be carried out together with Fiat, and Tofaş cannot act on its own.

"The design capabilities we have at Tofaş are enough to design all the parts in a vehicle. However, there are some strategic areas which we have to carry out with Fiat. In the end, we have a partnership with Fiat, although there is a certain share of Koç Holding, we are producing under the Fiat brand."

The first strategic area is the product design brief, which is defined by the sales and marketing departments who are in contact with the end customer and can translate the 'voice of the customer' to a product brief. This process is mainly carried out by Fiat, and for each vehicle concept and target market, a product brief is formed. The sales and marketing departments in Tofaş also participate in this process, as Turkey is also a market for vehicles produced under the Fiat brand. Following this product brief, the second strategic area is the styling of the vehicle, and it is done at the Fiat styling center based in Turin, Italy.Although Tofaş has enough knowledge about this process, it does not conduct any styling work for Fiat. In some cases it participates indirectly in this process by making some suggestions and providing alternatives.

These are the main strategic areas in automotive design in which Tofaş participation is limited and the main activity is carried out by Fiat. During this process, each vehicle has different target markets, concepts, design targets, which are defined by the product brief. Consequently, there may be different criteria to be used in the design of each project: for a commercial vehicle functionality may be important, for a passenger car aesthetics may be a priority, for luxury cars comfort and safety may be more important compared to other factors. To specify the design criteria and to prioritize them, a standard form is used, in which there is a checklist and ratings for about 150 criteria. For each vehicle, the most important criteria are chosen, and the design of all components of the vehicle is formed regarding this prioritization.

The styling of the vehicle is done by industrial designers following the product brief, the design is completed to a certain level, and it is transferred to the engineering departments. At this stage, the styling department is not concerned with the manufacturability of the parts. The engineering department takes the surface design done by styling, and analyses it for the manufacturing technology and the material that will be used, and the conditions of assembly. After this stage, a trade-off between engineering and styling starts, and the requirements in the product brief are used to manage effectively the trade-offs.

After the styling of the vehicle is finished, the detailed design of sub-components can be carried out by Tofaş. In this design process, there are three possibilities:

- the design and manufacture of the part is done by Tofaş as mentioned earlier,
- the design is completed by Tofaş and the part is produced by a supplier, or
- the design is carried out with a co-designer supplier.

In case of co-designer suppliers, the design activity is jointly done by Tofaş and the supplier, and the verification of the design is done by Tofaş.

The design of components in Tofaş can be categorized in relation with the sub-systems inside a vehicle. These sub-systems are (1) body -all the parts exterior of the vehicle); (2) chassis -the suspension systems of the vehicle, tires, and brake systems; (3) interior -all the components that require design inside the vehicle; (4) electrical-electronic equipment; and (5) powertrain which is the engine. This classification is more detailed compared to the classification of the parts inside a vehicle adapted from Laseter and Ramdas (2002) and shown in Figure 2. *"Considering these sub-systems, the design competence of Tofaş is high enough to carry out the design all the parts of body and interior. The level of design competence in chassis parts is lower compared with body and interior parts. However, product development activities can be done of chassis parts for vehicles that are already in the mass manufacturing stage. The design of electrical and electronic equipment is more limited, because these parts are technology intensive parts requiring know-how."* Finally, the design and development of engine parts are not done at Tofaş, only the application of the current engines of Fiat to a specific vehicle can be done, such as developing the interfaces of the engine with the other surrounding parts.

During this detailed design, people from different departments can also participate in the process. The manufacturing technologies department verifies the manufacturability of the vehicle in the assembly lines of the factory. The tool shop works in the analysis of the design to see if it is compatible with the current tooling technologies for the parts that will be manufactured in-house. The purchasing department coordinates the selection of suppliers for parts that will be outsourced, as well as the audits and improvements of these suppliers. Quality and production departments observe the manufacturability of the vehicle and the compliance with the quality targets. Their suggestions are taken into account by the R&D department. Finally, the training department undertakes the training of the people who will be engaged in the production of the vehicle. As it is mentioned in the literature review, interdisciplinary teams are present in the product development process, in order to

eliminate potential problems that may be confronted during the mass manufacturing phase of a vehicle.

3.6.2.3 Supplier selection criteria

The selection of suppliers is done by the purchasing department at Tofaş. The R&D department contributes to this process by determining the firms that will work as co-designers. These firms are involved in supplier development programs. In this development program, technological facilities, human resources should be upgraded and improved to meet the requirements in order to work with Tofaş as a co-designer firm. For suppliers who will not work as co-designers, the selection is done primarily by the purchasing department with audits, which aim to improve the quality infrastructure of the suppliers.

3.6.2.4 Suppliers' involvement in new product development

The importance of suppliers and their integration in the product development process is far and wide recognized by Tofaş:

"There are approximately 700-800 people who work in thenew product development process. If we work on the details of each sub component, get into their know-how and work on their development, we cannot do anything. For this reason, we need our suppliers to support us in the areas we determine as strategic, especially those areas which require designing of parts. We need information about their production processes. We need them to develop, improve themselves, without the improvements in the supplier industry, we cannot do anything on our own."

Suppliers' involvement in product development and design has two forms: the first one iS working with a co-designer firm, and the second one is working with a supplier that is works only as a manufacturer, not as co-designer. The two situationswill be handled separately. Working with a co-designer supplier for a specific part design is a strategic decision that is jointly taken with Fiat:

"We decide with Fiat in order to determine which parts we will design ourselves, which parts will be designed by suppliers. A radio, for example, we never take the time to design a radio. There is someone who already does it. We give them our requirements, and the supplier designs it."

The main goal of using co-designers is to use the know-how of the supplier. As it is named by Tofaş, "co-design parts" are those that require a very high level of know-how that very few suppliers have. These can be considered as 'strategic items' defined in the supply risk portfolio of Kraljic (1983) in Figure 7. The design of such parts is either jointly done by Tofaş and the supplier firm, or the design brief is given to the supplier firm, it carries out the design activity all by itself and Tofaş verifies the design. The concept of co-designer is similar to the grey-box and black-box designed parts defined by Petersen, Handfield and Ragatz (2005) in Figure 10. Currently, Tofaş is using co-designer supplier for parts such as seats, climate control systems, brake systems, radios, insulations, and headlights. Co-designer firms are generally firms that Tofaş has a good relationship background, has worked in several projects, and there is a high level of trust between the supplier and Tofaş.

Apart from the co-designer suppliers, some suppliers participate in the product design process by making suggestions about designs. Although these firms are not co-designers, they have a high level of know-how about their production processes, the materials they are using, and their tooling capabilities. At the early stages of product development, they make suggestions about the design to increase the manufacturability of the part. In order to manage this process more effectively, Tofaş tries to involve these suppliers at the early stages of the product development, especially during the product design stage. However, *"the supplier selection has to be done as early as possible to be able to involve the supplier in design. Therefore, for some critical items, the R&D department asks to the purchasing department to make the supplier selection as early as possible."*This type of design participation can be categorized as white-box design (Figure 10).

The main objective of involving the supplier in the design process is to learn the suppliers' manufacturing technologies' constraints, machine constraints, tooling constraints, and to gain know-how of the supplier in order to make the design more compatible with the suppliers' manufacturing processes. For each vehicle, critical components are selected and the suppliers of these critical components are involved earlier compared with non-critical components. The critical components are selected mainly for two factors, aesthetics and functionality. If a part is visible to the end customer and has some aesthetics requirements, or if it is a functional part, the supplier should be involved earlier in order to gain its know-how to be used in the design stage. Functionality is an important criterion especially for plastic parts.

"In metal parts, there is a good level of know-how in Turkey. We can get enough support from metal part manufacturer suppliers. For plastic parts, the know-how is still developing, especially for big plastic parts such as the instrument panel or bumper. The molds of these big plastic parts were not produced in Turkey; it has recently started. In the case where the supplier doesn't have enough know-how, they can get benefit the know-how of their tool constructor, and inform us."

In order to get some suggestions from the supplier, the design of the part has to be completed to a certain level. The involvement of the suppliers to the design stage can start during the detailed design of the part. During the product development and design process, Tofaş contacts directly its Tier 1 suppliers; it does not involve its Tier 2 suppliers directly to this process.

One of the most important reasons for consulting a supplier either as a co-designer or a manufacturer is technological uncertainty. *"Under conditions of technological uncertainty, a higher level of know-how is needed, and in this case the know-how of the supplier can help the automotive manufacturer in the development and design process."* Tofaş informs its suppliers regularly about technological changes, trends,

and advises them to make investments in those areas. It also supports its supplier to carry out R&D projects under government incentives.

Finally, Tofaş does not have any drawbacks in sharing design and manufacturing information with its suppliers. The confidentiality agreements that cover CAD data exchange requirements have been used for long years. The infrastructures are established for CAD data exchange and in case of any problems violating confidentiality issues, legal precautions are taken.

3.6.3 Exploration of a Part Supplier in Turkish Automotive Industry

The Supplier firm is a manufacturer of plastic parts. It is in the business of plastics manufacturing since 1951. It also produces plastic bottles and it has a division for the automotive industry. It employs 61 white collar and 202 blue collar employees in 3 plants, one in Istanbul, one in Izmit, and one in Balıkesir. It has an R&D department with 6 engineers. It supplies automotive parts to Ford, Oyak Renault, Tofaş, Honda, and Mercedes. The quality certificates hold are TS 16949, ISO 9001, and ISO 140001.

3.6.3.1 Production and Design Capabilities

The main automotive parts produced are plastic air ducts for heating/cooling and ventilation systems, air ducts for engine air intake, and wind screen washer tanks. All these parts are produced by injection blow molding technology. Also the caps of washer tanks can be produced by the supplier with injection molding. Injection blow molding is a manufacturing process in which hollow plastic parts can be formed. The main characteristic of this process is that the plastic is shaped by the air pumped inside the blow mold, pushing the plastic material to the cavities of the mold to retain its final shape. As it is described by the supplier, the process characteristics are more complex compared to injection molding.

"Plastic is itself a raw material difficult to work with. The shrinkage of a plastic part is affected from many parameters; the temperature of the environment, the temperature of the air blown in the mold, the air pressure, machine cycle times. Therefore it is very difficult to keep the process stable in mass manufacturing. It is hard to control."

The special properties of plastic parts are also handled in the literature. The usage of plastic parts is increasing in automotive production by the replacement of steel parts with plastic ones. However, the expertise needed in plastics manufacturing is higher than of steel, primarily because it does not retain its shape as steel, it shrinks and wraps. For these reasons, expertise of the supplier becomes more important (Bidault et al., 1998).

The Supplier is a tier 1 supplier for some projects and a tier 2 supplier for some others. As a tier 2 supplier, it delivers the parts to a tier 1 supplier, who assembles the parts and delivers them to the OEM.

"Tier 1 firms we are working with are large-scale suppliers, global firms which have foreign partnerships. They have plants all over the world, and they have R&D centers. The parts we produced are assembled to the instrument panel and to the console panel of the vehicle. These suppliers are the manufacturers of the instrument and console panels, which are very big injection parts. Recently, there is a tendency in the OEMs to work with fewer tier 1 suppliers. If they used to work with 200 suppliers in the past, today they want to work with 10-15 tier 1 suppliers, and leave the management of tier 2 suppliers to tier 1. The main reason of this is they want to have the assembled system, such as the instrument panel with all its subcomponents. This way, they assemble the system as a whole on the vehicle, they save time on the assembly line. We deliver our parts to the instrument panel manufacturer; they assemble the part and deliver it as a complete sub-system to the OEM."

The Supplier is capable of doing part design, tooling desing, and all the production and control equipment design and production in house.

3.6.3.2 Involvement in the Product Development Process

The Supplier has different roles throughout the product development process:

- starting with the planning stage (1),
- continuing with the design (2),
- prototype (3),
- pre-launch (4) stages and
- ending with the mass manufacturing stage (5).

During the first phase, as it was named as introduction to the project and planning in this thesis, the main interaction between the OEM and the Supplier is part price negotiation. At this stage, design is not primarily important. Customer requirements are given by the OEM firm. After this stage, the supplier is nominated for the project or not. In case of nomination, the activities related to design start.

The involvement of the Supplier in part design can have two forms:

- as a co-designer, or
- as a manufacturer.

Working as a co-designer is a rare case and often the part design is given by the OEM. In either case, the mold design and all the equipment and control devices are designed and produced in-house.

As a co-designer, the firm has the skills and capabilities to design parts when they are given the architectural information of the vehicle. This process starts with a confidentiality agreement signed between the two parties and continues with the design brief of the part. The customer requirements package includes the material specifications, the most important geometric and functional characteristics, which are also called “special characteristics” and “critical characteristics”, other technical

requirements, assembly conditions quality targets, and so on. The most important information needed to co-design a part is the design of the surrounding parts, the space the part will occupy in the vehicle, the interfaces with other parts, the connections and locking mechanisms. To accomplish this, the OEM firm must provide the design, if possible the prototypes of the surrounding parts. After the co-designing activity is finished, the OEM's design validation process starts. During this stage, an information exchange period starts between the OEM and the Supplier, and the design is finalized according to the constraints and priorities of each party. In the co-design process, the involvement should be at the early stages of product development.

When the Supplier is not working as a co-designer, which is more frequently the case, the process starts again with a confidentially agreement and a customer requirements package. In this case the OEM may demand some suggestions about the part design, or the Supplier can make some suggestions without the demand of the OEM. The motivation of this design suggestion is either about the functional characteristics of the part, or the manufacturability. The parts are not visible parts by the end customer, so there are no aesthetic requirements.

"The engineers working in the OEM firms are not knowledgeable enough about our manufacturing process as they are knowledgeable about injection molding. Therefore, they may not know the constraints of our machines, tooling capabilities, and process difficulties. The design has to be feasible with our manufacturing process, our tooling capabilities. If we see some areas for improvement, or some areas that need to be changed completely, we make some suggestions in order to prevent the problems we may face, according to our previous experience. We send them our design proposal either as a 3D model or a presentation. They analyze it and either accept or refuse. When they refuse, they generally have some constraints about the other parts in the vehicle in interaction with our parts. We try to develop a

solution acceptable for both.The most important factor in making design suggestions is the manufacturability of the part."

The involvement of the Supplier starts during the detailed design phase, which means that a detailed design is given by the OEM, and the Supplier can make suggestions.

"When we are not co-designer, we cannot get involved earlier than the detailed design phase, because the designs are too rough before this stage, it is still subject to change. We can only reply to simple consultations."

Although detailed design is seen as the only stage where the Supplier can start to make suggestions, it is stated that in some cases it is too hard to make the OEM accept the suggestions because in the detailed design phase the design of other parts are also done, and a design change in one suppliers part may affect and necessitate changes in other parts. In the Supplier's view, the timing of their involvement in product design may be late compared with other suppliers because their parts, especially air ducts are not critical parts. However, given the difficulty of the manufacturing process and supplier's know how level about its own technology, earlier involvement could be more effective to incorporate possible design changes.
After the necessary design changes are implemented, the mold and other production equipment are produced, the Supplier makes a trial production, the parts produced with this production can be called 'sample parts' or 'prototype parts'. These parts are sent to the OEM and tested on the first vehicles. If there are any problems about quality, assembly, interaction with other parts, according to the severity of the problem the action to eliminate it can result in a design change. These types of problems can also be confronted during pre-launch and mass manufacturing phases. However, as the Supplier indicates, design changes during mass manufacturing are extremely costly; it is not a preferable situation.

According to the Supplier, the main factor that determines the involvement level and timing is the technical properties of the part. For more complex parts, the OEMs tend to cooperate more and ask for more supplier involvement in all project phases. The second important factor is the relationship between the Supplier and the OEM. The intention of the OEM to cooperate with the supplier increases the level of involvement and cooperation the Supplier can give. The level of trust between the two parties becomes very important in order to be successful in supplier involvement.

Another important issue during supplier involvement is that, if the OEM consults the Supplier during the early phases of product development before the nomination of the supplier, and if the Supplier is not nominated for the project, then the information given to the OEM can be used by a different supplier. This may be considered as a confidentiality problem and it is not a preferable situation for the Supplier, and the Supplier can have some drawbacks in being involved before the nomination.

Although there are many factors that affect the level of supplier involvement, in the Supplier's perspective the most important factor is the relationship with the OEM. In effect, this relationship is very important and the characteristics of an OEM the Supplier would like to work with are as follows:

"All OEMs have different approaches, some are more cooperative and open to us and some are less. We expect the OEM to have a positive approach towards us, open to cooperation. The know-how of the OEM's engineers about our process is important. In the end, they design a part that we will produce, if they do not know our process, they cannot understand our constraints. We need them to support us in all the technical information we need to have, such as the functionality, the assembly conditions, and the surrounding parts. The OEMs who have R&D centers here are better."

3.7 Discussions of the Follow up Study

The interviews with Tofaş and the Supplier depict some similar factors about the suppliers' involvement in the product development process. These most outstanding factors affect the level and timing of supplier involvement, and can be grouped under the themes supplier know-how, OEM-supplier relationship, and product characteristics.

Supplier know-how

The high level of know-how the supplier has is a strong indicator for supplier involvement. The expertise of the supplier with its own manufacturing process, and its capability to contribute to design regarding the constraints of its manufacturing process has significant impacts on the manufacturability and quality of the product. This contribution is both important for the supplier and the OEM. For the supplier, the ability to manufacture the product with minimum difficulties is important, and for the OEM reaching the quality, aesthetics, technical, and functional requirements is important. Furthermore, high level of supplier know-how is a critical characteristic for becoming a co-designer.

OEM-supplier relationship

Having a relationship based on mutual trust is crucial for the supplier and the OEM to carry out the product development activity in a collaborative manner. The first condition of a good relationship is the history of previous experience between the two parties. High level of information sharing, openness in sharing confidential knowledge, working cooperatively on possible design problems and their solutions, and high technical support given by the OEM are critical in increasing supplier involvement.

Component and Process Characteristics

Some parts are considered as critical parts and their suppliers' selection is made earlier than othersin order to involve the supplier earlier in the product development

process. The critical parts are those who have important aesthetic and functional characteristics. Critical components and complex systems require high level of contribution from suppliers. On the other hand, some manufacturing processes are difficult because of the part's specifications –such as material- and they also require earlier supplier contribution to design.

CHAPTER 4

CONCLUSION

New product development has become a competition area in all the industries, and product design is one of the most important inputs in the determination of cost, lead time, and quality of a new product, which are the factors that determine project performance. The automotive industry is a high-tech industry in which the development of a new product is highly complicated due to the fact that the level of input and the value added from suppliers are high. For the automotive industry, new product development is a project management activity in which the project performance is an outcome of the joint effort of the OEM and its suppliers. To overcome this challenging process, special emphasis should be given to the relationship between the OEM and the suppliers during the product design and development process.

Suppliers confront pressure while developing products in an increasing pace and at the same time improving quality and decreasing costs. Increasing complexity of products constitute a challenge especially for automotive suppliers. As products are getting more and more sophisticated to meet customer requirements, together with the time pressure to develop them, not only financial risks are confronted; time pressure may cause quality problems (Echtelt, 2004). As Takeishi (2001) states, many studies done before 2000 have shown that Japanese companies have more efficient and effective supplier relations compared with their European and US competitors, and that these supplier networks have played a major role in the competitiveness of the Japanese automobile industry. The pressures to achieve target performances, quality characteristics, and target prices are the major drivers for the involvement of suppliers in the automotive industry (Wagner & Hoegl, 2006).Working concurrently with suppliers may shorten product development time, improve product quality, and reduce costs (Quesada, Syamil& Doll, 2006).

This chapter presents an overview of the research questions stated in Chapter 1 together with the concluding remarks of the research study conducted on the Turkish automotive industry. Limitations of the study and further research opportunities will be given at the end of the chapter.

4.1 Research Questions Revisited

The main research question of this study was the role of the suppliers in the product design and development process in the Turkish automotive industry. The additional questions were:

- What are the benefits of supplier involvement in product development process in terms of project performance?
- How is the product development process managed and how can supplier involvement be integrated into this process?

Concurrent engineering practices provide an effective basis to perform design, engineering and manufacturing functions in inter-disciplinary teams. However, in new development projects where multiple firms work together, additional approaches to concurrent engineering are needed. In order to overcome intra-firm boundaries, buyer-supplier relationships should be examined and the combative nature of buyer-supplier relations should be changed to collaborative approaches. OEM-supplier relationship is a specific type of buyer supplier relationship in which collaboration can lead positive outcomes in project performance, in terms of cost, lead time, and quality.

Considering that product design affects cost, lead time, and quality to a large extent, decisions with the contribution of the supplier who has a great deal of know-how in the manufacturing of a part may help the OEM and the supplier to achieve a better project performance. The “Over the wall design” approach can be eliminated between the supplier and the OEM, problems that may occur during the later phases

of the project can be detected from the design stage and unnecessary back tracking can be avoided.

The Turkish automotive industry has developed since the 1950s to the point to supply the global automotive industry its own production. Due to the foundation of global OEMs, supplier firms also have developed and gained know-how in their own areas of expertise, and become competitive worldwide.

As a part of the research study in this thesis, a questionnaire study was conducted to gather suppliers' and OEMs' opinions about the supplier involvement in the Turkish automotive industry.Theresults of thispreliminary studyshow that although the level of supplier involvement in product development in the Turkish automotive suppliers industry is perceived differently by the OEMs and suppliers,the level of supplier involvement is relatively low in the design stage compared to other stages; which are introduction to the project, prototype, pre-launch, and mass manufacturing. The design capabilities of supplier firms may restricted because Turkish OEMs are joint ventures of foreign firms and do not have R&D centers in Turkey as in the case of European countries. OEM firms in Turkey import design and technology from abroad, and this gives Turkish automotive part suppliers little chance to market their own design and technology.

The second part of the research study analyzed two in-depth interviews, and some overlapping findings were gathered with the literature and the preliminary survey study, and at the same time some additional information was collected. The dimensions of supplier involvement can be concluded from the overlapping findings from the literature review, preliminary study, and the interviews.From the overlapping findings, it can be said that there is a positive relationship between the supplier involvement and the below existence of below mentioned characteristics:

- Supplier know-how and capabilities: Increase in supplier know-how and capabilities will have a positive impact on supplier involvement. These capabilities can be summarized as:

- Suppliers' design and engineering capabilities
- Suppliers' manufacturing expertise in similar parts
- Suppliers' know-how about the manufacturing process
- Suppliers' project management, problem solving, and team work skills; organization efficiency

- Component characteristics: Part characteristics play an important role in suppliers' involvement, such as:

- As technical expertise required by the component increases, suppliers' involvement increases
- As the technical requirements of the component get complex, suppliers' involvement increases
- Manufacturing process and material characteristics can affect suppliers' involvement. Some materials, such as plastics, require earlier supplier involvement
- Suppliers of critical components are involved more often in NPD as opposed to suppliers of non-critical components
- As the technological uncertainty involved in the component increases, suppliers' involvement increases

- OEM-supplier relationship: Level of OEM-Supplier relationship is correlated with suppliers' involvement. As this relationship improves, supplier involvement increases. The improvement of this relationship is related with the following factors:

- Previous relationship and experience between the two parties
- Mutual trust
- Being transparent and having a cooperative approach

- Level of information sharing, including confidential information
- Technical support of the OEM to the supplier

These characteristics affect supplier involvement in new product development. Limitations in these characteristics can lead to limitations in supplier involvement levels, and improvements of these characteristics can foster higher supplier involvement.

4.2Limitations of the Study

The scope of this study is to analyze the relationship between the OEM and the supplier. Suppliers are differentiated as tier 1, tier 2, and tier 3 according to their level of relationship with the OEM in the supply chain. This may affect their level of involvement in product design and development process of an OEM. Differentiation between the suppliers as tier 1, tier 2, and so on is not made in the analysis of the questionnaire results. Although this is a factor that may affect the results of the study, suppliers were considered as equivalent in this study in order to simplify the results.

Also, the product type is a factor that may affect supplier involvement; for some auto-partsa high level of involvement is needed, for some others no involvement is needed at all. This difference may result from the material of the part, its geometry and positioning in the vehicle, its function, or its security level. The product groups and their relationships with the supplier involvement level were considered the same.

Finally, the results derived from the questionnaire represent 10% of TAYSAD member suppliers. The answers given by OEMs represent 30% of OEMs in Turkey.Although the response rate is very low, especially in the supplier questionnaire, in order to conduct a statistical study on the questionnaire results, it can be used as valuable information and can be considered as a thought provoking study for further research.

4.3Further Research

It is observed from the research study conducted on Turkish supplier industry that supplier involvement level in design is low compared to other project stages, although the supplier questionnaire results do not match exactly with the OEM questionnaire results. In this study, no differentiation is made between suppliers or OEMs. The size of the supplier firm, its origins, and its employee profile play an important role in determining its competency in product design. The relationship of the supplier with the OEM in the supply chain, such as being a tier 1 or tier 2 suppliers can also play a role in its relationship with the OEM in terms of its involvement in product development. These factors can be considered in another research study and different and more specific results can be observed.

Also, as indicated previously, product type may be an important characteristic that affects the level of supplier involvement in the product design and development process. The automotive product architecture presented in Figure 2 represents the part clusters according to their position inside the vehicle, function, and performance requirements. The role of the characteristics of a part to suppliers' involvement in the Turkish automotive industry can be the research topic of another study.

Each OEM has a specific approach to product design and development, to its suppliers, to project management and problem solving in general. This difference in approaches may result from their originated countries, backgrounds, and business cultures. This may affect the level of supplier involvement during product design and development; some OEMs may be more open to collaboration with the supplier, some OEMs may have better relations with their suppliers, and so on. The differences between the approaches of OEMs can be considered as further research. The focus can be a single OEM and its relations with its supplier can be analyzed, or multiple OEMs can be analyzed and compared.Also, a case study can be conducted for an OEM and a supplier, and the relationship they have during product development can be analyzed.

4.4 Concluding Remarks

Design and manufacturing are two functions which need to be carried out in parallel especially in the new product development processes. The automotive industry is a technology intensive industry in which design, engineering, manufacturing, and management functions are highly used. Moreover, new product development is highly challenging in this sector not only because the level of input from the suppliers is very high, but also because the output is a complicated product that has high financial value, marketing power, and high risk if any problems are faced; for these reasons errors are less tolerated.

The development of the automotive industry can be source of improvement for many other industries.The technologies used in the automotive industry can be transferred to other industries, and also the suppliers of OEMs represent other industries such as metals, plastics, chemistry, and so on. The improvements in this industry also affect the supply networks of OEM firms.

The Turkish automotive supplier industry has developed significantly following the development of the OEMs. Following these developments, mechanical engineering, industrial engineering, and industrial design disciplines have also developed to be competent enough to supply the industry with a good level of know-how. Suppliers are experts in their own businesses and this gives them the chance to make significant contributions to the OEMs' new product development process. The initiatives taken by OEMs to develop R&D centers in Turkey may provide a basis for suppliers to play a more active role in automotive product development. This will increase the competitiveness of Turkish automotive and supplier industries in the global level.

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APPENDIXA

QUESTIONNAIRE (ORIGINAL VERSION IN TURKISH)

TÜRK OTOMOTİV SEKTÖRÜNDE TEDARİKÇİNİN YENİ ÜRÜN TASARIM VE GELİŞTİRME SÜRECİNE KATILIMI

Giriş

Bu anket Orta Doğu Teknik Üniversitesi Endüstri Ürünleri Tasarımı Bölümü'nde yürütülmekte olan bir yüksek lisans tez çalışması kapsamında gerçekleştirilmektedir. Anketin amacı Türk otomotiv endüstrisinde parça tedarikçilerinin ürün tasarım ve geliştirme sürecine katılım ve katkı düzeyini görmek, ana sanayi firmalarının tedarikçilerle ne oranda işbirliği yaptığını ölçmektir. Yaklaşık 15 dakika sürecek olan ankete vereceğiniz cevaplar sadece akademik amaçlar için kullanılacak, firma ve ankete cevap verenlerin isimleri tamamen gizli tutulacaktır.

Katılımınız için şimdiden teşekkür ederiz.

Açıklamalar

Anket soruları yeni ürün geliştirme sürecinde tedarikçi ve ana sanayi firması tarafından yürütülen ürün geliştirme çalışmaları üzerinedir. Soruları yakın zamanda gerçekleştirdiğiniz ve ön seri ve seri aşamalarında takip ettiğiniz bir proje için cevaplayınız.

Soruları cevaplarken, aşağıda belirtilen proje safhalarını göz önünde bulundurunuz:

- Safha 1: Projeye giriş
- Safha 2: Ürün tasarımı
- Safha 3: Prototip aşaması
- Safha 4: Önseri aşaması
- Safha 5: Seri üretim aşaması

Sorularda, ana sanayi firmalarının tedarikçileri ürün tasarım ve geliştirme sürecine ne kadar dahil ettiklerini değerlendirmek amacıyla bazı kriterler belirlenmiştir. Bu kriterlerin ana sanayi tarafından ne sıklıkla kullanıldığını belirtmek için aşağıdaki puanlama sistemini kullanınız. Puanlama yaparken **- firmanız bakış açısıyla-** şu kriterleri göz önüne alarak uygun kutucuğu işaretleyiniz:

1- Çok düşük seviyede
2- Düşük seviyede
3- Orta seviyede
4- Yüksek seviyede
5- Çok yüksek seviyede

Firma bilgileri
Firma adı:
Firmada çalışan toplam kişi sayısı:
Firmanızın çalıştığı ana sanayi otomotiv üreticileri:
Anketi cevaplayan yetkilinin, Adı, Soyadı ve Görevi:
Kaç senedir bu görevde olduğu:

Türk Otomotiv Sektöründe Tedarikçinin
Yeni Ürün Tasarım ve Geliştirme Sürecine Katılımı
***Firmaların Tavır ve Görüşleri*_ANKET**

Soruları yakın zamanda gerçekleştirdiğiniz ve ön seri ve seri aşamalarında takip ettiğiniz bir proje için cevaplayınız	*Çok düşük seviyede*	*Düşük seviyede*	*Orta seviyede*	*Yüksek seviyede*	*Çok yüksek seviyede*
1. PROJEYE GİRİŞ	**1**	**2**	**3**	**4**	**5**
a. Ana sanayi firması konsept/teklif aşamasında firmanızla ne seviyede direkt kontak kurdu?					
b. Ana sanayi firması konsept/teklif aşamasında ürün tasarım bilgisini ne seviyede paylaştı?					
c. Ana sanayi firması üretim ve montaj bilgilerini ne seviyede paylaştı?					
d. Ana sanayi firması müşteri gerekliliklerini ne seviyede paylaştı?					
2. ÜRÜN TASARIMI AŞAMASI	1	2	3	4	5
e. Ana sanayi firması tarafından ürün geliştirme/ APQP takımına dahil edildiniz mi?					
f.Ana sanayi firması tarafından yeni ürünlerin geometri ve araç içindeki konumlarının tanımlanması aşamasına dahil edildiniz mi?					
g.Ana sanayi firması tarafından tasarım gözden geçirme ve DFMEA çalışmalarına dahil edildiniz mi?					
h.Ana sanayi firması tarafından ürün tasarım çalışmalarına dahil edildinizmi?					
3. PROTOTİP AŞAMASI	1	2	3	4	5
i. Ana sanayi firması prototip aşamasında firmanızla ne seviyede direkt kontak kurdu?					
j.Ana sanayi firması prototip aşamasında yaşanan tasarım problemleri ile ilgili öneri talep etti mi?					
k.Ana sanayi firması prototip aşamasında yaşanan kalite problemleri ile ilgili öneri talep etti mi?					
l. Bu aşamada önerileriniz ne ölçüde kabul edildi/uygulandı?					
4. ÖNSERİ AŞAMASI	1	2	3	4	5
m. Ana sanayi firması önseri aşamasında firmanızla ne seviyede direkt kontak kurdu?					
n. Ana sanayi firması önseri aşamasında yaşanan tasarım problemleri ile ilgili öneri talep etti mi?					
o. Ana sanayi firması önseri aşamasında yaşanan kalite problemleri ile ilgili öneri talep ettti mi?					
p. Bu aşamadaönerileriniz ne ölçüde kabul					

edildi/uygulandı?					
5. SERİ ÜRETİM AŞAMASI	1	2	3	4	5
r.Ana sanayi firması seri üretim aşamasında firmanızla ne seviyede direk kontak kurdu?					
s.Ana sanayi firması tasarım değişiklikleri ile ilgili öneri talep etti mi?					
t.Ana sanayi firması problem çözme sürecinde öneri talep etti mi?					
u. Bu aşamadaönerileriniz ne ölçüde kabul edildi/uygulandı?					

Yeni ürün tasarım ve geliştirme sürecine tedarikçinin katkılarıyla ilgili olarak, ana sanayi firmalarının tedarikçiye yaklaşımları ile ilgili görüşlerinizi belirtir misiniz?

_____

_____

_____

_____

Çalışmamız için değerli olacağını düşündüğünüz ve eklemek istediğiniz bilgiler varsa lütfen belirtiniz:

_____

_____

_____

Katılımınız için tekrar teşekkür ederiz.

Aşağıya iletişim bilgilerinizi yazarsanız, çalışmamızın sonuçları sizinle paylaşılacaktır.

.....

.....

.....

QUESTIONNAIRE (ENGLISH TRANSLATION)

Introduction

This questionnaire will be used as a part of a thesis conducted at Middle East Technical University Industrial Design Department. The goal of this questionnaire is to understand the level of supplier involvement and contribution to part design in the Turkish automotive industry.

This questionnaire will only take 15 minutes and your answers will be confidential and anonymous. Thank you for participating.

Explanations

The following questions ask about product development practices applied by you and the buyer firm in a new product development project. Please complete this questionnaire about a recent project that you have managed during the pre-serial phase and carried to serial phase. Consider the following project phases while answering the questions:

- Phase 1: Introduction to the project
- Phase 2: Design
- Phase 3: Prototype
- Phase 4: Pre-launch
- Phase 5: Mass Manufacturing

Some criteria are determined in the questions in order to analyze the level of supplier involvement. Answer the following questions to rate the extent of use of following practices by the OEM firm, where 1 means not used and 5 means used to a great extent.

1- Very low level
2- Low level
3- Medium level
4- High level
5- Very high level

Company information
Name of the company:
Total number of employees:
OEM firms the company is working with:
Name and title of the person answering the questionnaire:
Experience in this position:

Supplier Involvement in Product Design and Development in the Turkish Automotive Industry
***The Opinions and Attitudes of Firms*_QUESTIONNAIRE**

Please complete this questionnaire about a recent project that you have managed during the pre-serial phase and carried to serial phase	*Very low level*	*Low level*	*Medium level*	*High level*	*Very high level*
1. INTRODUCTION TO THE PROJECT	**1**	**2**	**3**	**4**	**5**
a. The level of direct contact with the supplier during concept/ RFQ phase					
b. The level of sharing design knowledge with the supplier during concept/ RFQ phase					
c. The level of sharing manufacturing and assembly knowledge with the supplier					
d. The level of sharing customer requirements with the supplier					
2. DESIGN	1	2	3	4	5
e. The level of involvement of the supplier to the APQP/ product development team					
f. The level of involvement of the supplier in defining the geometry and position of the parts inside the vehicle					
g. The level of involvement of the supplier to design review / DFMEA					
h. The level of involvement of the supplier to part design					
3. PROTOTYPE	1	2	3	4	5
i. The level of direct contact with the supplier during prototype phase					
j. Getting feedback from suppliers about design problems during prototype phase					
k. Getting feedback from suppliers about quality problems during prototype phase					
l. The level of acceptance and execution of supplier suggestions during prototype phase					
4. PRE-SERIAL	1	2	3	4	5
m. The level of direct contact with the supplier during pre-serial phase					
n. Getting feedback from suppliers about design problems during pre-serial phase					
o. Getting feedback from suppliers about quality problems during pre-serial phase					
p. The level of acceptance and execution of supplier suggestions during pre-serial phase					

5. SERIAL	1	2	3	4	5
r. The level of direct contact with the supplier during serial phase					
s. Getting feedback from suppliers about design changes during serial phase					
t. Getting feedback from suppliers about problem solving during serial phase					
u. The level of acceptance and execution of supplier suggestions during serial phase					

Could you provide your opinions about the attitudes of OEMs towards supplier about the contribution of supplier to new product design and development process?

_____

_____

_____

_____

Please indicate any information that you think might be useful for our study:

_____

_____

_____

_____

Thank you for your participation.

If you share your contact information, the questionnaire results will be sent to you.

.....

.....

.....

APPENDIX B

VEHICLE PRODUCTION AND EXPORT VOLUMES IN 2010 IN TURKISH AUTOMOTIVE INDUSTRY

PRODUCTION IN 2010

FIRM	PASSENGER CAR	MINIBUS	MIDIBUS	BUS	PICK-UP	TRUCK	TRUCTOR	TOTAL
Anadolu Isuzu			1.090		693	1.509		3.292
BMC				575	0	2.767		3.342
Ford Otosan		14.895			222.303	4.872		242.070
Hattat							2.148	2.148
Honda Türkiye	20.305							20.305
Hyundai Assan	77.000							77.000
Karsan		1.797			21.702	1.220		24.719
Mercedes Benz Türk				2.462		12.018		14.480
MAN				1.132				1.132
Otokar		286	989	379	582			2.236
Oyak-Renault	307.083							307.083
TEMSA			579	720	603	1.465		3.367
TOFAŞ	115.720				196.525			312.245
Toyota	83.286							83.286
Türk Traktör							28.277	28.277
TOTAL	**603.394**	**16.978**	**2.658**	**5.268**	**442.408**	**3.422**	**30.425**	**1.124.982**

(http://www.taysad.org.tr/www/tr/default.asp?x=dosya_detay&did=332)

EXPORT IN 2010

Firm	2008	2009	2010
Oyak-Renault	252.232	222.278	233.057
Tofaş	209.443	168.353	193.737
Ford Otosan	217.876	128.388	175.754
Toyota	119.586	69.097	73.163
Hyundai Assan	61.000	17.136	42.249
Karsan	482	7.287	19.441
Others	60.144	25.316	26.269
TOTAL	920.763	637.855	763.670

(http://www.taysad.org.tr/www/tr/default.asp?x=dosya_detay&did=332)

APPENDIX C

E-MAIL SENT TO QUESTIONNAIRE PARTICIPANTS

Sayın Üyemiz,

Ekte bulacağınız anket; ODTÜ Endüstri Ürünleri Tasarımı Bölümü'nde üyelerimizden birisinin beyaz yaka çalışanı tarafından yürütülen yüksek lisans tezinin alan çalışmasını oluşturmaktadır.
Tez konusu Türk otomotiv endüstrisinde parça tedarikçilerinin ürün tasarım ve geliştirme sürecine katılım ve katkı düzeyini görmek, ana sanayi firmalarının tedarikçilerle ne oranda işbirliği yaptığını ölçmektir.
Bu ankete vereceğiniz cevaplar, Türk Otomotiv Yan Sanayinin son yıllarda gösterdiği gelişimi akademik bir çalışma ile gösterecek ve destekleyecektir.
Anket sadece 15 dakikanızı alacak olup, anketi doldurup göndermeniz halinde anket sonuçları sizinle paylaşılacaktır. Katılımınız için şimdiden teşekkür ederiz.

Saygılarımızla,

Dear Members,
The questionnaire you will find in the attachment is part of a thesis study conducted at METU Department of Industrial Design, by the employee of one of our members.
The research area of the thesis is the involvement of suppliers in product design and development process, and the level of cooperation the OEMs have with suppliers in the Turkish automotive industry.
The answers you will provide will show the development of the Turkish Automotive Suppliers Industry supported by an academic study.
The questionnaire will take 15 minutes to complete, the results will be sent to you if you complete and send the questionnaire. Thank you in advance for your participation.

Best Regards,

TAYSAD
TAŞIT ARAÇLARI YAN SANAYİCİLERİ DERNEĞİ
ASSOCIATION OF AUTOMOTIVE PARTS & COMPONENTS MANUFACTURERS

APPENDIX D

INTERVIEW SCHEDULE WITH TOFAŞ
(ORIGINAL VERSION IN TURKISH)

Merhaba,

Bu görüşme Orta Doğu Teknik Üniversitesi Endüstri Ürünleri Tasarımı Bölümü'nde yürütülmekte olan bir yüksek lisans tez çalışması kapsamında gerçekleştirilmektedir. Çalışmanın amacı Türk otomotiv endüstrisinde parça tedarikçilerinin ürün tasarım ve geliştirme sürecine katılım ve katkı düzeyini görmek, ana sanayi firmalarının tedarikçilerle ne oranda işbirliği yaptığını ölçmektir. Yaklaşık bir saat sürecek olan görüşmede vereceğiniz cevaplar sadece akademik amaçlar için kullanılacak, firma ve görüşme yapılan kişinin ismi -istenmediği takdirde- tamamen gizli tutulacaktır.

Yapılacak görüşmeyi ses kayıt cihazı ile kaydetmem sizin icin uygun mudur? Kayıdı görüşmemiz esnasında istediğiniz zaman kesebilir, görüşme sonunda iptal edebilirsiniz.

Katkılarınız için şimdiden çok teşekkür ediyorum.

Gökçe Kanmaz
ODTÜ EÜTB Yüksek Lisans Öğrencisi

Firma Bilgileri

Kaç model araç üretiliyor?

Yaklaşık kaç tedarikçisi var? Tedarikçilerin araçtaki tüm parçalar göz önünde bulundurulduğunda yarattığı katma değer ne?

1. **Firmanızda "ürün tasarımı" ne düzeyde yapılmaktadır? Ar-Ge Bölümünün tasarıma dair ilgi, sorumluluk ve etki alanları nelerdir?**

Probe1.1 Firmanızda "sıfırdan ürünler tasarlanıyor" başka bir deyişle "yeni ürünler tasarlanıyor" denebilir mi; yoksa, firmanızdaki tasarım aktivitesini

“tasarımı halihazırda yapılmış ürünlerin tasarımının geliştirilmesi ya da iyileştirilmesi” olarak mı tanımlamalıyız?

Probe1.2 Daha çok ne tür bölümlerin/parçaların tasarımı/geliştirilmesi üzerinde çalışılıyor?

Probe1.3 Tasarımlarını yaptığınız ya da tasarımlarının gelişimine katkıda bulunduğunuzu belirttiğiniz bölümler/parçalar düşünüldüğünde, bunların üretildikleri malzemeler ve/veya üretim metodları açısından “tasarım müdahalesine yatkın” olmaları bir sebep olarak gösterilebilir mi? Varsa diğer etmenler nelerdir?

Probe1.4 Tasarımlarını yaptığınız ya da tasarımlarının gelişimine katkıda bulunduğunuzu belirttiğiniz bölümler/parçalar düşünüldüğünde, firmanızın katkısı ne yönde oluyor? Daha ekonomik olması, daha kolay üretilebilir olması, daha işlevsel olması, daha estetik olması ve benzeri hedeflerden ön plana çıkan var mı?

2. Firmanızdaki tasarım sürecini anlatabilir misiniz?

Probe2.1 Herhangi bir bölüm/parça için tasarım talebi kimden geliyor? Süreç nasıl işliyor?

Probe2.2 Talep gelmese de Firmanız proje üretiyor mu? Süreç nasıl işliyor?

Probe2.3 Süreçte kimler görev alıyor?

3. Tasarım süreçlerine tedarikçilerin etkisi oluyor mu? Ne düzeyde?

Probe3.1 Firmanız tedarikçilerden tasarım talebinde bulunuyor mu? Süreç nasıl işliyor?

Probe3.2 Firmanızın tedarikçileri ürün tasarım ve geliştirme sürecine dahil etme konusunda çekinceleri var mıdır, varsa nelerdir?

Probe3.3 Yeni ürün geliştirme/ürün geliştirme proje sürecinde tedarikçinin hangi aşamalara katılım göstermesini talep ediyorsunuz?

a. Projeye giriş/ planlama

b. Ürün tasarımı
c. Prototip aşaması
d. Önseri üretim
e. Seri üretim

Probe3.4 Talep edilmese de herhangi bir tedarikçi proje üretiyor ve teklif getiriyor mu? Getiriyorsa bunun gerçekleştiği belirli aşamalar var mı? Süreç nasıl işliyor?

4. **Firmanız açısından tasarım süreçlerinin hangi aşamalarında tedarikçinin katılım göstermesi projenin daha etkin bir şekilde yürütülmesi için faydalı olur?**
   Tasarım spesifikasyonlarını belirleme
   Konsept tasarım
   Detaylı tasarım
   Üretim için tasarım

5. **Üretilen parçanın özellikleri ile Tedarikçisinin o parçanın tasarımına olan katkısı ilişkili midir? Bu olası katkıyı etkileyen ürün özellikleri nelerdir ? (teknik özellikler, üretim teknolojisi, parça geometrisi, araç içindeki konumu, vs.) Örneklendirebilir misiniz?**

6. **Tedarikçilerin yeni ürün tasarım ve geliştirme sürecine katılım zamanlaması ve aldığı sorumluluk miktarını etkileyen faktörler nelerdir?**
   - Proje özellikleri, ör. Yenilikçi proje / standart proje
   - Parçanın gerektirdiği teknik beceri
   - Tedarkçinin tasarım/ teknik konularda becerileri
   - Proje/parçada yer alan teknolojik belirsizlik
   - Ana sanayi-yan sanayi firmaları arasındaki ilişki derecesi

7. **Otomotiv sanayicileri için "birlikte çalışılması tercih edilen tedarikçi"in özellikleri nelerdir?**

Probe7.1 Çalıştığınız tedarikçilerin seçiminde kullandığınız metotlar var mı; nasıl bir yol izleniyor?

INTERVIEW SCHEDULE WITH TOFAŞ
(ENGLISH TRANSLATION)

Hello,

This interview is part of a thesis conducted at Middle East Technical University Industrial Design Department. The goal of this interview is to understand the level of supplier involvement and contribution to part design in the Turkish automotive industry, and to understand the level of collaboration OEMs are having with their suppliers. The interview will last about an hour and the answers you will give will be kept strictly confidential, your name and the name of your firm will not be mentioned without your approval.

Is it appropriate to record this interview with a voice recorder? You can stop the voice recorder during the interview, or cancel it at the end of the interview.

Thank you in advance for your contribution.

Gökçe Kanmaz
METU ID Graduate Student

Information about the company

How many models of vehicles are manufactured?

How many suppliers does you company have, approximately? What is the level of input made by the suppliers, considering all the components inside a vehicle?

1. To what extent "product design" is made in your company? What is the responsibility of the R&D department in product design?

Probe1.1 Can we say that "new products are designed" in your company, or does the design activity correspond to the improvement and development of products that have already been designed?

Probe1.2 What kind of parts/systems are designed/ developed in general?

Probe1.3 Considering the parts and systems you design or develop, are these parts open to design improvement, in terms of their materials or manufacturing processes? Are there any other factors that make these parts open to improvement?

Probe1.4 Considering the parts/systems you contribute to the design and development, what is the contribution of your company? Are there any priorities such as making a design more economical, more manufacturable, functional, or aesthetic?

2. Can you describe the design process at your company?

Probe2.1 From whom comes the design request for a part/system? How does the process function?

Probe2.2 Does your company realize some project even if there is no demand? How does this process work?

Probe2.3 Who are the people who have responsiblities during this process?

3. Do the suppliers have any effect on the design process? To what extent?

Probe3.1 Does your company demand to make product design from the suppliers? How does this process work?

Probe3.2 Does your company have any drawbacks to involve suppliers in the new product development and design process? If yes, can you explain?

Probe3.3 To which stages during product development do you ask for the involvement of the supplier?

f. Introduction to the project/planning
g. Product Design
h. Prototype
i. Pre-launch
j. Mass production

Probe3.4 Do the suppliers make you some suggestions or develop project even if you do not ask for any involvement? If yes, when exactly does this happen? How does this process work?

4. **To what stage of product design do you think it would be effective to involve suppliers?**

   Setting design specifications

   Concept design

   Detailed design

   Design for production

5. **Is there a relationship between the chacteristics of a part and the level of involvement made by the supplier? What are the factors that affect this contribution? (technical characteristics, manufacturing technology, part geometry, position in the vehicle, etc.) Can you give some examples?**

6. **What are the factors that affect the timing of supplier involvement and the level of responsbility the supplier undertakes?**

   - Project type : innovative project/ standad project
   - Level of technical complexity of the part
   - The capabilities of the supplier on design/technical issues
   - The level of technological uncertainty involved in the project
   - The relationship between the OEM and the supplier

7. **For OEMs, what are the characteristics of suppliers that are preffered to work with?**

Probe7.1 Do you follow a methodology to select suppliers that you work with?

APPENDIX E

INTERVIEW SCHEDULE WITH THE SUPPLIER (ORIGINAL VERSION IN TURKISH)

Merhaba,

Bu görüşme Orta Doğu Teknik Üniversitesi Endüstri Ürünleri Tasarımı Bölümü'nde yürütülmekte olan bir yüksek lisans tez çalışması kapsamında gerçekleştirilmektedir. Çalışmanın amacı Türk otomotiv endüstrisinde parça tedarikçilerinin ürün tasarım ve geliştirme sürecine katılım ve katkı düzeyini görmek, ana sanayi firmalarının tedarikçilerle ne oranda işbirliği yaptığını ölçmektir. Yaklaşık bir saat sürecek olan görüşmede vereceğiniz cevaplar sadece akademik amaçlar için kullanılacak, firma ve görüşme yapılan kişinin ismi -istenmediği takdirde- tamamen gizli tutulacaktır.

Yapılacak görüşmeyi ses kayıt cihazı ile kaydetmem sizin icin uygun mudur? Kayıdı görüşmemiz esnasında istediğiniz zaman kesebilir, görüşme sonunda iptal edebilirsiniz.

Katkılarınız için şimdiden çok teşekkür ediyorum.

Gökçe Kanmaz
ODTÜ EÜTB Yüksek Lisans Öğrencisi

Firma Bilgileri

a. **Firmanızda üretilen otomotiv parçaları nelerdir?**
b. **Çalışan kişi sayısı?**
c. **Firmanız hangi ana sanayi firmaları ile çalışıyor?**

1. **Firmanızda "ürün tasarımı" ne düzeyde yapılmaktadır? Ar-Ge Bölümünün tasarıma dair ilgi, sorumluluk ve etki alanları nelerdir?**

Probe1.1 Firmanızda "sıfırdan ürünler tasarlanıyor" başka bir deyişle "yeni ürünler tasarlanıyor" denebilir mi; yoksa, firmanızdaki tasarım aktivitesini "tasarımı halihazırda yapılmış ürünlerin tasarımının geliştirilmesi ya da iyileştirilmesi" olarak mı tanımlamalıyız?

Probe1.2 Tasarımlarını yaptığınız ya da tasarımlarının gelişimine katkıda bulunduğunuzu belirttiğiniz bölümler/parçalar düşünüldüğünde, bunların üretildikleri malzemeler ve/veya üretim metodları açısından "tasarım müdahalesine yatkın" olmaları bir sebep olarak gösterilebilir mi? Varsa diğer etmenler nelerdir?

Probe1.3 Tasarımlarını yaptığınız ya da tasarımlarının gelişimine katkıda bulunduğunuzu belirttiğiniz bölümler/parçalar düşünüldüğünde, firmanızın katkısı ne yönde oluyor? Daha ekonomik olması, daha kolay üretilebilir olması, daha işlevsel olması, daha estetik olması ve benzeri hedeflerden ön plana çıkan var mı?

2. Firmanızdaki tasarım sürecini anlatabilir misiniz?

Probe2.1 Herhangi bir bölüm/parça için tasarım talebi kimden geliyor? Süreç nasıl işliyor?

Probe2.2 Talep gelmese de Firmanız proje üretiyor mu? Süreç nasıl işliyor?

Probe2.3 Süreçte kimler görev alıyor?

3. Tasarım süreçlerine etkiniz oluyor mu? Ne düzeyde?

Probe3.1 Ana sanayi firmaları sizden parça tasarım talebinde bulunuyor mu? Süreç nasıl işliyor?

Probe3.2 Sizce ana sanayi firmalarının tedarikçileri ürün tasarım ve geliştirme sürecine dahil etme konusunda çekinceleri var mıdır, varsa nelerdir?

Probe3.3 Yeni ürün geliştirme/ürün geliştirme proje sürecinde firmanız hangi aşamalara katılım gösteriyorsunuz? Hangi aşamalarda daha aktif rol almanız firmanızdaki ürün geliştirme süreci için daha etkin olur?

1. Projeye giriş/ planlama

2. Ürün tasarımı
3. Prototip aşaması
4. Önseri üretim
5. Seri üretim

Probe3.4 Talep edilmese de herhangi bir öneri veya değişiklik talebi getiriyor musunuz? Getiriyorsanız bunun gerçekleştiği belirli aşamalar var mı? Süreç nasıl işliyor?

4. Firmanız açısından tasarım süreçlerinin hangi aşamalarında katılım göstermek projenin daha etkin bir şekilde yürütülmesi için faydalı olur?

Tasarım spesifikasyonlarını belirleme

Konsept tasarım

Detaylı tasarım

Üretim için tasarım

5. Üretilen parçanın özellikleri ile firmanızın o parçanın tasarımına olan katkısı ilişkili midir? Bu olası katkıyı etkileyen ürün özellikleri nelerdir ? (teknik özellikler, üretim teknolojisi, parça geometrisi, araç içindeki konumu, vs.) Örneklendirebilir misiniz?

6. Firmanızın yeni ürün tasarım ve geliştirme sürecine katılım zamanlaması ve aldığı sorumluluk miktarını etkileyen faktörler sizce nelerdir?

- Proje özellikleri, ör. Yenilikçi proje / standart proje
- Parçanın gerektirdiği teknik beceri
- Firmanızın tasarım/ teknik konularda becerileri
- Proje/parçada yer alan teknolojik belirsizlik
- Ana sanayi-yan sanayi firmaları arasındaki ilişki derecesi

7. Yan sanayi olarak "birlikte çalışılması tercih edilen ana sanayi "in özellikleri nelerdir?

INTERVIEW SCHEDULE WITH THE SUPPLIER
(ENGLISH TRANSLATION)

Hello,

This interview is part of a thesis conducted at Middle East Technical University Industrial Design Department. The goal of this interview is to understand the level of supplier involvement and contribution to part design in the Turkish automotive industry, and to understand the level of collaboration OEMs are having with their suppliers. The interview will last about an hour and the answers you will give will be kept strictly confidential, your name and the name of your firm will not be mentioned without your approval.

Is it appropriate to record this interview with a voice recorder? You can stop the voice recorder during the interview, or cancel it at the end of the interview.

Thank you in advance for your contribution.

Gökçe Kanmaz
METU ID Graduate Student

Information about the company

Which automotive parts are manufactured?

Which OEMs does your firm work with?

1. To what extent "product design" is made in your company? What is the responsibility of the R&D department in product design?

Probe1.1 Can we say that "new products are designed" in your company, or does the design activity correspond to the improvement and development of products that have already been designed?

Probe1.2 What kind of parts/systems are designed/ developed in general?

Probe1.3 Considering the parts and systems you design or develop, are these parts open to design improvement, in terms of their materials or manufacturing processes? Are there any other factors that make these parts open to improvement?

Probe1.4 Considering the parts/systems you contribute to the design and development, what is the contribution of your company? Are there any priorities such as making a design more economical, more manufacturable, functional, or aesthetic?

2 Can you describe the design process at your company?

Probe2.1 From whom comes the design request for a part/system? How does the process function?

Probe2.2 Does your company realize some project even if there is no demand? How does this process work?

Probe2.3 Who are the people who have responsiblities during this process?

3 Do you have any contribution to the design process? To what extent?

Probe3.1 Do OEMs demand to make product design from your firm? How does this process work?

Probe3.2 Do you think that OEMs have some drawbacks in involving suppliers in the desing process? If yes, can you explain?

Probe3.3 To which stages during product development do OEMs ask for the involvement of the supplier?

k. Introduction to the project/planning
l. Product Design
m. Prototype
n. Pre-launch
o. Mass production

Probe3.4 Do you makesome suggestions or develop project even if OEMs do not ask for any involvement? If yes, when exactly does this happen? How does this process work?

4 To what stage of product design do you think it would be effective to involve suppliers?

Setting design specifications

Concept design

Detailed design

Design for production

5 Is there a relationship between the chacteristics of a part and the level of involvement made by the supplier? What are the factors that affect this contribution? (technical characteristics, manufacturing technology, part geometry, position in the vehicle, etc.) Can you give some examples?

6 What are the factors that affect the timing of supplier involvement and the level of responsbility the supplier undertakes?

- Project type : innovative project/ standad project
- Level of technical complexity of the part
- The capabilities of the supplier on design/technical issues
- The level of technological uncertainty involved in the project
- The relationship between the OEM and the supplier

7 For suppliers, what are the characteristics of OEMs that are preffered to work with?

APPENDIX F

SAMPLE ANALYSIS PAGE OF THE DATA GATHERED FROM TOFAŞ INTERVIEW

Öncelikle Tofaş'taki tasarım süreci ile ilgili birkaç soru sormak istiyorum. Tofaş'ta şu anda üretilen araç modelleri hangileri? En çok Doblo biliniyor, diğer modeller nelerdir?

Information about Tofaş

Doblonun dışında Linea var şu anda, binek araç olarak ürettiğimiz. Yine hafif araç sınıfında Fiorino var, ama Fiorinoyu Bipper ve Nemo olarak Peugeot'ya Citroen'e de üretiyoruz. Aynı araç, sadece ufak tefek farklılık var, araç marka ve logoları farklı ve o logolar civarındaki bazı parçalar farklılaşıyor ama araç genel itibariyle aynı araç.

O zaman Peugeot ile aranızda bir lisans anlaşması var?

Var, özel bir anlaşma var. Hem Peugeot ile hem Citroen ile var. Şimdi benzer bir çalışmayı GM için de yapıyoruz, Doblo da Opel olarak üretilecek.

Tofaş'ın yaklaşık kaç tedarikçisi vardır?

Valla hiç bir fikrim yok ama heralde bir 500 falan vardır.

Literatür araştırmasından edindiğim bazı bilgiler var; örneğin bir otomobil tüm komponentleriyle birlikte yaklaşık 30 000 parçadan oluşuyor,

Tabi, vida-somun detayına kadar girerseniz evet.

Tofaş'ta otomobil üretimi yetkinlikleri

G: Ve bu 30 000 parçanın %70'ine kadar yaratılan katma değer tedarikçilerden geliyor. Pratik te bu bilgiler gerçekçimidir?

Yüzde 70 aslında gerçekçi gibi görünüyor.Biz şu anda araçlarımızdaki büyük ebatlı saç parçaları kendi kalıp pres atölyemizde kendimiz üretiyoruz, bunun dışındaki diğer ufak saç parçalar, diğer komponentler, plastikler olsun, koltuklar olsun, halılar olsun bunların hepsini yan sanayiden alıyoruz. Powertrain yani motor-şanzıman tedariğini de Fiat'ın powertrain bölümünden yapıyoruz yani burda gene kendi içimizde motor veya şanzıman üretme bölümümüz yok. Sadece bir de süspansiyon, arka süspansiyonun üretimi burda oluyor ama tabi orda da yine bazı komponentleri tedarikçilerden alıp burda birleştiriyoruz. Yani, burda motor şanzıman üretim yok, çok büyük ebatlı saç parçaları işte arabanın yan çerçevesi gibi, kapılar gibi, tavan gibi, bunları kendi içimizde üretiyoruz, dolayısıyla çok yanlış bir oran değil.

G: Tofaş ta "ürün tasarımı" ne düzeyde yapılıyor? Yani sıfırdan bir ürün tasarlanıyor mu, yoksa mevcut tasarımlar Fiat'dan geliyor – sonuçta Fiat'la bir ilişkiniz var - ve siz burda geliştirme çalışmaları mı yapıyorsunuz, nasıl gelişiyor bu süreç?

New product Design

Şimdi bu süreç, şu anki durum soruyor iseniz, biz şu anda kendi başımıza tasarlayabilecek durumdayız. Ancak tabi stratejik bazı alanlar var, dediğimiz gibi Fiat'la beraber çalışmamızdan kaynaklanan stratejik bazı alanlar var, bu alanlarda mutlaka Fiat'la birlikte olmak zorundayız, biz zaten sonuçta bir Fiat kurumuyuz, belli bir oranda Koç grubunun hissesi var ama marka olarak biz bir Fiat markasıyız.

Dolayısıyla yetkinlik olarak soruyorsanız yetkinlik olarak biz bu geliştirme işlemini burda yapabilecek düzeydeyiz. Ancak bazı stratejik alanlar dediğimiz, mesela ürün tanımlama dediğimiz kısmı, ürün brief inin hazırlanması tamamen stratejik bir konu, ürün departmanlarının satış ve pazarlamadan bilgi alarak hazırladığı bir dokümandır bu. Dolayısıyla o kısım mesela Fiat'ın kendisi oluşturur, ama orada Türkiye de bir pazardır, Türkiye deki ürün departmanları da işin içindedirler, ama orayı Fiat geliştirir. Mesela stil faaliyetleri, yani endüstriyel tasarım kısmı biz orada her zaman işin içindeyizdir ama stil tamamen stratejik bir nokta olduğu için Fiatın stil merkezinde geliştirilir, ve oradaki oluşturulan fikirlere konseptlere göre geliştirilir, ama biz o sürece katılırız, sürecin nasıl çalıştığını nasıl işlediğini biliyoruz ancak hiçbir zaman burda oturup Fiat için stil tasarımı yapmıyoruz, sadece alternatifler üretebiliyoruz, bakın bizim de şöyle bir fikrimiz var diyoruz. Dolayısıyla bu tür stratejik bazı noktalar var, bunları Fiat la birlikte yapmak durumundayız bir de bazı altyapı eksiklikleri olabiliyor, bizim çok büyük bir altyapı eksikliğimiz kalmadı, ancak Türkiye çapında altyapı eksiklikleri var, örneğin araçların test edileceği pistler, dünyada otomobil üreten büyük ülkelerdekilere benzer test pistleri yok, hükümet böyle bir test pistinin Antalya civarında kurulması için bir çaba içinde, OSD ile birlikte, öyle bir altyapı eksikliğimiz var.

Arabanın konspet tasarımı bittikten sonra, daha küçük parçaların tasarımı tamamen burada yapılıyor mu?

Yapılıyor, şu anda, orada da şöyle 2 tür çalışma şeklimiz var, bir yan sanayiyi üretici olarak kullandığımız parçalar var, örneğin arabanın içindeki plastik bir direk kaplama, herhangi bir saç parçayı örten bir parça, ya da bir kapı paneli tasarım işlemi tamamen yapılıyor bunların, bir de yan sanayi ile tasarı sanayiler oluşturduk, co-designer yan sanayiler. Bunlarla tasarımın bir b paylaşıyoruz, mesela koltuklar, Martur firması ile koltukları beraber belli bir seviyeye kadar getiriyoruz bir süre sonra onlar co-designer olarak çalışıp ürünün tasarımını tamamlıyorlar, biz de onların testlerini verifikasyonlarını yapıyoruz. Dolayısıyla sorduğunuz soruya gelirsek, evet yapabiliyoruz.

Supplier involvement in design

Peki bu kendi başınıza tasarladığınız kısımlar daha çok arabanın iç kısmıdır diyebilir miyiz? Yani stil tasarımı İtalya dan geldiğine göre saç parçalar İtalya da mı tasarlanır?

Hayır, arabayı şöyle düşünebilirsiniz, araba 5 alt sistemden oluşur. Bir tan dediğimiz dış gövde ve arabanın dışındaki plastikler, bir tanesi interior d arabanın içindeki bütün tasarım gerektiren komponentler, elektrik elektronik parçalar, şasi parçaları, yani arabanın süspnasiyon sistemleri, amortisörleri, lastikleri, frenler, ve birde motor, powetrain. Bizim bu sistemlere göre yetkinliğimize bakacak olursanız biz gövde ve interior da çok ileri bir aşamadayız. Yani nerdeyse artık biz bütün parçaları tasarlayabilelcek durumdayız. Elektrik elektronikte kısmen, çünkü bu çok hızlı gelişen ve çok derin uzmanlık gerektiren bir konu, burda belli bir seviyeye kadar yetkinliğimiz var ama tümüyle bağımsızız diyemeyeceğim. Şasi de yine aynı şekilde ama şaside biraz da yetkiniz, mesela şu anda üretilen araçların geliştirilmesi, iyileştirilmesi gibi faaliyetlerde tamamen bağımsız olarak çalşıyor arkadaşlar. Motor ve şanzıman dediğimiz zaman bunlar tamamen powertrain konusu.

Design capabilities

APPENDIX G

SAMPLE ANALYSIS PAGE OF THE DATA GATHERED FROM SUPPLIER INTERVIEW

Firmanızda üretilen otomotiv parçaları hangileri?

Production capabilities

Otomotiv parçası olarak plastik tüm hava kanalları, motor temiz hava kirli hava çıkış boruları, cam yıkama deporları ve bunların varsa kapaklarını üretiyoruz. Hava kanalları genelde klima hava boruları oluyor, klimadan havayı alıp sürücü ve yolculara taşıyan parçalar yani. Motor hava çıkış boruları ise bunlara göre biraz daha kompleks parçalar, motor filtre sisteminde temiz havayı içeri almak veya kirli havayı dışarı atmak için kullanılıyor, motor bölgesi parçaları oldukları için hammaddeleri ve teknik özellikleri daha farklı olabiliyor. Bir de cam yıkama ve far yıkama su depoları var. Bunlar bildiğimiz arabanın ön ve arka camına su püskürten sistemlerin su tankı. Bu parçaların ayrıca su doldurmak için hunileri ve kapakları oluyor. Bunları da üretebiliyoruz. Bütün bu parçalar plastik şişirme dediğimiz bir proses ile üretiliyor. Sadece su tanklarının kapakları plastik enjeksiyon ile üretiliyor.

Şişirme prosesinin enjeksiyondan farkı tam olarak nedir?

Plastik enjeksiyon plastik imalat teknolojileirnde en bilinen imalat prosesidir. Enjeksiyon kalıbına plastik hammade aktarılır, kalıbın erkek ve dişi parçalarının arasını dolduran plastik şekillenir. Şişirme kalıbında ise durum çok farklı. Akan plastik şişirme kalıbının arasından akar, kalıp kapanır ve şişirme aparatı dediğimiz bir aparat hava üfleyerek plastiğin kalıbın çeperlerine yapışarak şekil almasını sağlar. Bu nedenle parçanın et kalınlğı her yerde aynı olmaz, enjeksiyondan farklı olarak parça kalıptan çapaklı çıkar. Parça hava ile şekil aldığı için enjeksiyondan kontrol edilebilinmesi açısından daha zor bir prosestir. Kalıp yapımı kolaydır fakat prosesi kontrol etmek ve seri imalat şartlarında stabil tutmak zordur. Plastik kendi başına zor bir hammaddedir, birçok etkenden etkilenir. Sıcaklık, basınç bunların hepsi plastiğin çekme payını etkiler, ve bu nedenle prosesi kontrol etmeniz güçleşir. Yaz ve kış mevsimleri arasında bile hava sıcaklık değiişmlerinden kaynaklı zorluklar çıkabilir.

Firmanızda çalışan kişi sayısı kaç?

Information about the company

Toplam 3 tesiste 61 beyaz yaka 202 mavi yaka çalışanımız var.

Türkiyede hangi ana sanayi firmaları ile çalışıyorsunuz?

Information about the company & Tier strcture

Türkiye'deki ana sanayi firmalarından Ford, Oyak Renault, Tofaş, Honda, [illegible]. Bunun dışında tier 2 olarak çalıştığımız parçalarda var, bunları tier 1 firmalara veriyoruz, onlar montaj yapıp ana sanayiye veriyorlar. Çok büyük yan sanayi firmaları bunlar, dünya çapında. Torpido üreticileri. Bizim ürettiğimiz hava kanalları genelde torpidoya monte edilir. Torpido parçaları çok büyük enjeksiyon parçalarıdır. Türkiyede bu işi yapan firmalar hep yabancı ortaklı firmalar, çok büyük yan sanayi

Design capabilities

Firmanızda "ürün tasarımı" ne düzeyde yapılıyor? Sıfırdan ürünler tasarlanıyor mu?

Otomotivde 2 tip durumla karşılaşıyoruz. Birincisi co-designer olma, tasarım aktivitesini belli bir oranda bir yürütebiliyoruz. Ancak bu şu anda çalıştığımız firmalar ve yürüttüğümüz projelerde düşük bir oranda. Bir de tasarımın tamamen ana sanayiden gelme durumu var, şu anda biraz daha sık rastlanıyor, bizim firma ölçeğinde tabi. Diğer taraftan bütün kalıp tasarımlarını,ve prosesten kullanılacak diğer ekipmanların, kontrol aparatlarının tasarımını biz yapıyoruz.

Involvement in design

Co-designer olarak çalıştığınız da süreç nasıl işliyor, anlatabilirmisiniz?

Co-desingner olarak çalışabilmek için ana sanayi firmasının bize bizim üreteceğ parçanın çevresinde bulunan parçalarla ilgili bilgi vermesi lazım. Varsa parçanın çevre datasını vermesi lazım, bizim parça naasıl bir boşluğu dolduracak, hangi parçalarla temas edecek, bunları vermezse zaten birşey yapamayız. Hava kanalları mesela. Bunlar üfleç dediğimiz enjeksiyon parçalara takılması lazım. İkisi birbirne nasıl monte olacak, nasıl kilitlenecek? Ya da cam yıkama deposu. Cam yıkama deposu mesela araç içinde diğer parçalardan açılan yere yerleştirilir, bu nedenle düzgün bir şekli olmaz. O yerleştirileceği bölgenin bize verilmesi lazım.

Yani bu sizin üretmediğiniz parçaların tasarımlarını sizinle paylaşmaları gerektiği anlamına geliyor?

Evet. Biz tasarımı bitirdikten sonra onlar yine kontrol eder. Diğer parçalarla çakışıyormu, diğer parçalarla uyumunda bir sorun var mı... Sorun yoksa kalıp yapımına başlarız.

Peki co-designer olmadığınız durumlarda tasarıma müdahale ediyormusunuz, ve tasarıma önerisi yapmanızı gerektiren durumlar nelerdir?

Genelde ana sanayi firmaları tasarım yaptıkları zaman bizden emin olmadıklar yerlerde öneri talep edebiliyorlar. Bizim prosesimizi iyi bilmedikleri için. Bu değişiklik talebi genelde parçanın fonkskiyonuyla ilgili oluyor, zaten bizim parçalarımız görsel parçalar değil, arabanın iç kısmında kalıyor. Onlar öneri talep etmeseler bile biz bazen değişiklik talebinde bulunabiliyoruz. Dediğim gibi prosesimizi bilmedikleri için yaptıkları tasarımlarda bazı uygun olmayan kısımlar olabiliyor. Biz uyarıyoruz, bakın bunu böyle yaparsanız şöyle bir hata çıkabilir, şöyle bir durumla karşılaşabiliyoruz diyoruz. Bizim önerilerimizi genelde dinlemeye çalışıyorlar, ama bazı çok ciddi kısıtlar varsa kabul etmeyebiliyorlar. İki durumda yaşanıyor. Kabul etmedikleri zaman gerçekten problem çıkabiliyor, problem çıktığını gördükten sonra bazen kabul ediyorlar. Her ana sanayinin tedarikçi ilişkileri farklı.

Peki bu süreç nasıl işliyor? Kimler görev alıyor?

Bizde bu süreç arge bünyesinde gerçekleşir. Gerekli tasarım değişikliğini biz yaparız, üretimden ve kaliteden gerektiğinde bilgi alırız ama bizim proses ile ilgili bilgimiz oldukça iyi. Tasarım değişkliği önerisini 3D olarak veya bir sunum şeklinde göndeririz, mühendislik tarafına. Onlar değerlendirir, kabul eder veya etmez.