Firm size determinants and their impact on supplier selection and evaluation

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PROJECT ACCEPTANCE CERTIFICATE

It is certified that final copy of MS LSCM project written by Rabie Aamir Dar Registration No. 00000238861 of MS-L&SCM has been vetted by undersigned, found complete in all aspects as per NUST Statutes/Regulations/MS Policy, is free of plagiarism, errors, and mistakes and is accepted as fulfilment for award of MS degree. It is further certified that necessary amendments as pointed out by GEC members and foreign/local evaluators of the scholar have also been incorporated in the said project.

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I hereby state that no portion of the work rerred to in this project has been submitted in support of an application for another degree or qualification of this or any other University or other institute of learning.

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Abstract

In today's competitive and interconnected business world supply chains and buyer supplier relationship has gained strategic importance. The supplier selection and evaluation part are no longer taken for granted and proper implementation of special tools and methods is applied for this process by buyer firms. This project has identified a few determinants of firm size that are of utmost importance to the procurement managers and should be considered in their selection and evaluation process. The seven firm size factors are both quantitative and qualitative in nature and this project takes into consideration some subjective terms that are otherwise ignored by practitioners. The competitive and growing paint industry of Pakistan was selected for this study and their suppliers were categorized into two groups. The procurement managers of the selected paint companies ranked the seven determinants identified according to their preference and AHP method was used for pairwise comparison of these factors. The next step was to rank the alternatives, which in this case are the chemical and packaging suppliers. After the ranking of criteria identified and choosing the best alternative, a qualitative study was conducted to validate the results. In addition to results validation, the years of experience of respondents and the years of relationship of buyer firms with the supplier firms was taken into consideration for further analysis of results. The results obtained from quantitative data and findings of qualitative study helps to establish a useful method for supplier selection based on firm size.

Contents

List of Figures

List of Tables

CHAPTER 1: INTRODUCTION

The first chapter of this project aims to introduce the industry that we are focusing on to finalize the criteria for supplier selection and evaluation.

1.1 Paint industry of Pakistan

The paint and coatings industry of Pakistan is estimated to grow at a CAGR of more than 3% in the next 5 years. As the construction industry is growing with increasing infrastructural activities in the country, the demand of paints and coatings is expected to grow. The country witnessed around 10.5% surge in the contribution of the construction sector to the country's GDP in year 2019. Although COVID19 has affected the growth of this sector but it is expected to recover soon. Some major players in the market who are dominating are Berger paints, Brighto paints, AkzoNobel, Nippon paints, Diamond paints and a few others. (Pakistan Paints and Coatings Market - Growth, Trends, and Forecast (2020 - 2025), 2020)

The paint industry of Pakistan can be categorized into two sectors, one is the organized sector while the other is unorganized. Some major players are dominating the industry out of which a few are multinational companies while some are national. Kansai, AkzoNobel, Jotun and Nippon are the major multinational players in the market while Brighto, Nelson, Diamond, Happilac and Master are a few national players in the industry (Zahid, 2017). The unorganized sector of the paint industry has around 350 paint producing units. These units are mostly not registered to avoid the taxation system. This is the reason that they are offering low prices in the market but the quality of these paints is definitely compromised (Shami, Ali, & Rehman, 2015).

The construction industry of Pakistan has shown impressive growth and this progress has given some breakthrough opportunities to the major players in the industry. On one hand new construction is increasing and on the other side a major portion of decorative paints is being used for renovation of the existing houses. The national companies have also seen this as an opportunity and are competing with the international players making this market highly competitive (Rizvi, 2017). As the industry is growing so a lot of work could be conducted to help the paint manufacturers prosper in the market.

The recent growth rate of construction sector and the growing opportunities shows that a lot of work should be done for this market to help it function systematically. The area for supplier selection and evaluation based on firm size factors is most suitable for the paint industry as multiple companies can easily be involved to better understand the relationship dynamics between buyer and supplier. While conducting AHP analysis in multiple companies it was most important to choose the companies where multiple players are dealing with the same list of suppliers. These buyer companies are manufacturing the same product so their basic requirement and expectations from the suppliers is common. Some major national and multinational paint companies were selected for this project that are competing at almost same level. The selection of companies was further based on the mutual suppliers. Since we had to rank the alternatives through AHP method so only those companies could be involved in the project that are working with some common suppliers. Considering all the basic criteria for this project six paint companies (Berger paints, Kansai paints, Diamond, Jotun, AkzoNobel and Nippon paints) were selected and their eight common suppliers were taken into consideration.

1.2 Problem statement

How do the leading paint companies of Pakistan perceive the firm size factors while selecting and evaluating their suppliers?

Supplier selection and evaluation has gained much significance as it affects the overall performance of the supply chain and profitability of the buyer companies as well as the suppliers. This project focuses on the firm size of suppliers of paint manufacturers and how the buyers consider these factors. When we investigate literature, the firm size is mostly discussed in terms of number of employees and annual sales of companies, however these objective terms are not enough to define the firm size. The gap that has been identified in this project focuses on subjective factors of firm size as well in addition to the objective factors of sales and number of employees.

As the paint industry is a growing industry in Pakistan so the leading paint companies were selected for this project. The chemicals and packaging suppliers of these leading paint manufacturers were taken into consideration for the data collection and analysis. The main idea is to provide a list of criteria to practitioners so that they can use it in their supplier selection and evaluation process and can easily reach a consensus in group decision making. As multiple actors

are involved in supplier selection process so it often becomes difficult to decide and consider the perspective of each individual so this project will help the industry in group decision making.

1.3 Objectives

The main objectives of this project are as follows:

- Identify the gap in literature regarding the firm size of suppliers.
- Identify the multiple criteria of firm size including both objective and subjective factors.
- Prioritization of firm size determinants that are identified through study of literature.
- Assist the practitioners of paint industry to rank their suppliers according to the firm size factors.
- Development of decision tool for firms to select and evaluate their suppliers.

1.4 Questions

The questions that will be answered through this project study are as follows:

- What are the firm size determinants that are to be considered while selecting and evaluating the suppliers?
- How does the determinants of firm size impact the decision of supplier selection and evaluation?
- How does the manager's years of experience in the company impact their preference level while categorizing the firm size determinants?
- How does the duration of relationship with the supplier impact the ranking of suppliers?

CHAPTER 2: LITERATURE REVIEW

2.1 Buyer supplier relationship

The growing importance of buyer-supplier strategic alliance is the focus of all manufacturing firms in recent years as many activities are outsourced and no firm can work in isolation without building a network of suppliers (Thongrawd, Skulitsariyaporn, Sirisopana, & Chomchom, 2020). The strategic outsourcing and strategic partnerships have become way more important now as it has become highly important for manufacturing firms to respond to customer demands in time. There is a growing trend in the market where buyers not only need to collaborate with their supplier partners on operational levels but they have to focus on building strategic alliances where they have mutual goals and objectives (Kannan & Tan, 2006). A research conducted by (Liu, Yan, Si, Xie, & Wang, 2020) shows that operating performance of both buyer and supplier firms improves when strategic alliances are made. The buyer and supplier firms can aim to build strong alliances and have a competitive edge in the market through these long-term bonds and relationships.

A research conducted by (Lascelles & Dale, 1989) concludes that total quality can be achieved if there is a strong bond and open communication between buyer and supplier. A number of factors like trust, communication and commitment from both parties in a buyer supplier relationship play a significant role in the relationship dynamics (Ambrose, Marshall, & Lynch , 2010). Another study conducted in multiple countries shows that there is a strong link between relationship strength and information sharing between buyer and supplier companies (Liu, Yan, Si, Xie, & Wang, 2020). The same study focuses on performance improvement when relationship becomes stronger and better with open communication. Another study shows similar results that firm performance is positively linked to relationship strength (Autry & Golicic, 2009). The buyer supplier relationship strength is based on trust, communication, commitment, interdependence, adaptation, satisfaction and cooperation according to a research conducted by (Fynes & Voss , 2002).

The concept of strategic alliance in buyer supplier relationship proposes new network of relationship that focuses more on collaboration rather than competition (Todeva & Knoke, 2005). Previously there used to be a concept of complexity in terms of opportunism, conflict of interest and negative perceptions regarding buyer supplier relationships but the trend has changed as both the parties have realized their interdependence and want to collaborate at all levels to achieve

mutual benefits. A research conducted on the types of inter-organizational relationships while taking into account the manufacturers and their logistics providers' focuses on arm's length relationship, strategic alliances, joint ventures and vertical integration (Cooper & Gardner, 1993). A longitudinal study on buyer-supplier relationship was conducted by (Stuart & McCutcheon, 1996) to discuss the type of alliances build with the supplier starting from the point of relationship initiation to the point of maintenance.

2.2 Supplier selection and evaluation

Supplier selection has gained much significance as businesses tend to form strategic partnerships with their suppliers in the market and with the growing competition and uncertainty in the market the supplier selection process cannot be taken for granted (Su & Gargeya , 2016). A research conducted by collecting data from high level purchasing executives shows that firms perform better financially if they focus on strategic purchasing and supplier evaluation (Carr & Pearson, 1999). The links and partnership with the suppliers is no longer short term and has to be continued for years so the selection process has become the top priority of purchasing managers. The complexity of this supplier selection process is apparent from a project conducted by (Verma & Pullman, 1998) to show that actual preferences of decision making buyers is quite different from their stated preference criteria. The respondents in the research ranked the supplier selection attributes but their actual supplier choice was not based on these attributes. This research shows that supplier selection criteria is quite subjective in nature and a number of underlying factors actually play a vital role in the final decision.

A recent research and review of literature by (Junyi, Ngai, & T., 2020) shows that hybrid techniques should be used for supplier selection because this is a complex problem that should be solved by breaking the task into simpler steps. The preferences by individuals from buyer companies can be biased and subjective so hybridization is important to ensure uniqueness and credibility. As the purchasing function has become way more important in recent years so the supplier selection and evaluation has become a rather strategic function and a lot of factors, not only operational, have been included in this decision (Sarkis & Talluri, 2006). In addition to the growing factors and criteria being involved it has also become important to involve more people from the organization to contribute to this decision.

The purchasing decision is a major determinant of profitability and with the changing customer demands the supplier selection process has to be more systematic and flexible so that the

buyers can gain a competitive edge in the market (Boer, Labro, & Morlacchi, 2001). This project also discusses that supplier selection process has to be according to the items being purchased like routine items or bottleneck items and companies should select different criteria for the selection of suppliers based on the critical factors involved and the duration of relationship expected. A different perspective related to supplier performance and strength of buyer supplier relationship focuses on socialization trends in addition to formal supplier evaluation practices (Cousins, Lawson, & Squire, 2008).

2.3 AHP

Several different techniques and methods have been used in supplier selection, evaluation, and development process by researchers and AHP (analytical hierarchy process) has been one of the important tools that has been used repeatedly. A research conducted by (Chan, Kumar, Tiwari, Lau, & Choy, 2008) discusses the complexity of global supplier selection and has used the AHP method to deal with this complicated situation. The researchers have focused on the risk factors involved when going global for purchasing requirements and have AHP to set the criteria and select the best global supplier. Another research conducted by (Kilincci & AslıOnal, 2011) used fuzzy AHP technique to evaluate the suppliers based on supplier criteria and a set of product performance criteria in a washing machine company. A research conducted on automotive industry of Pakistan by (Dweiri, Kumar, Khan, & Jain, 2016) uses AHP method to rank the selected criteria for supplier selection. The research also identified some sub-criteria and ranked them in accordance with the main criteria.

A research conducted on fashion industry by (Chan & Chan, 2010) has also used AHP to select the most suitable supplier. The paper proposes some main criteria and then sub-criteria to select the best supplier in the industry. A study conducted by (Nydick & Hill, 1992) states that AHP method provides a simplified solution for supplier selection problem that has gained significance in recent years. The paper explains a framework which makes it easier to break down the task of supplier selection into simpler steps by identifying the criteria and then comparing these criteria and using them to choose the best alternative. Another paper used AHP method to evaluate seven criteria and some sub-criteria related to corporate social responsibility and a useful method is proposed for selecting the best supplier based on these factors (Xu, Kumar, Shankar, Kannan, & Chen, 2013). A case study for a railway manufacturer was conducted by (Bruno, Esposito,

Genovese, & Passaro, 2012) and AHP tool was used to build the hierarchal structure based on multiple criteria and suppliers for a particular component was selected. AHP method is recently being explored while combining it with other decision-making models and approaches. A recent research conducted by (Tusnia, Sharma, Dhingra, & Routroy, 2020) has used QFD and AHP for supplier selection criteria and then TOPSIS method was used to select the best alternative.

2.4 Firm size determinants

The firm size determinants that were identified for this project are described below with reference to the already existing literature.

2.4.1 Annual sales & Number of employees

Annual sales and number of employees are the two most used classifying firm size factor used in literature. These two factors are mostly used in combination and researchers find it easy to classify the firms based on these quantitative factors hence these factors are used repeatedly. A study conducted by (CAI & YANG, 2008) on cooperative norms between buyer and supplier firms has used two main factors of sales and number of employees for classifying the respondent firms. Another research conducted by (Wagner, 2011) used annual sales along with the relationship length factor to classify the respondent firms to study the supplier's development phases. A study conducted on communication and conflict resolution between buyer and supplier uses four contingency factors to develop the hypothesis and one of those factors is the firm size of buyer. The classification of data for this factor is done based on annual sales of buyer firm to understand the different relationship stages (Cindy Claycomb & Gary L. Frankwick, 2006). The firm size of buyer has been concluded to be a significant factor in buyer supplier collaboration in a research conducted by (Claro & Claro, 2010). Again, in this research annual sales has been used to study the effect of this factor on the collaborative behavior and relationship dynamics.

A study that defined the types of buyer supplier relationships also used annual sales and number of employees to classify the supplier firms (Yusoon Kim & Choi, 2015). Another study focused on sustainable supplier management practices in terms of supplier selection and buyer supplier relationship has used certain factors for classification of respondent firms. While using firm size as a control variable in the research (Yang & Xiongfei Zhang, 2017) has used annual sales and number of employees to categorize the respondent manufacturing firms. The role of firm size has been studied in terms of supplier integration and embeddedness in new product development by (Kouftero, Edwin Cheng, & Lai, 2007). The research considers number of

employees and sales volume of buyer firms to analyze the impact of firm size on supplier selection when considering new product development. Another study conducted on supplier selection practices has used the factor of number of employees to categorize the direct and indirect suppliers (Choi & Hartley, 1996). The same research has used the financial conditions criteria that is considered by the buyer firms while selecting their suppliers. The annual sales volume is used to categorize the suppliers based on this criterion. A research was conducted on manufacturing firms of Sri Lanka and the aim was to find out the impact of firm size on the profitability factor. This research used total sales as an indicator of firm size (Niresh & Thirunavukkarasu, 2014). A study focused on the impact of innovation on the performance of small and medium sized enterprises considers the firm's age and size to determine the results. This research also uses number of employees and annual sales factor to determine the firm size of SMEs (Mabenge, NgororaMadzimure, & Makanyeza, 2020).

2.4.2 Production capacity

The concept of production capacity has gained significance in recent decades as the demand uncertainty increases and there is a growing trend towards decreasing the overstocking and understocking costs (Kim, Leung, Park, Zhang, & Lee, 2002). The manufacturers are not only focused on their own capacity but consider the supplier's capacity constraints as well. On the other hand, the supplier must consider the buyer's production capacity to complete the demand in time and for this purpose it is highly important to integrate completely in terms of capacity planning. Some companies look for dual sourcing option in order to reduce the supply risk based on capacity constraints (Jain & Hazra, 2017). On the other hand, supplier's take some capacity investment decisions to win the trust and confidence of influential buyers in the market. However, they might have to face a lot of challenges in terms of cost and pricing strategy to yield enough profit from these investments.

Another research advocates that supplier's manufacturing capabilities and flexibility directly impacts buyer firm's responsiveness (Squire, Cousins, Lawson, & Brown, 2009). The research emphasizes the importance of supplier selection and evaluation and suggests that multiple criteria should be considered and not only cost, quality and delivery while choosing the right supplier to gain competitive edge in the market. The main idea is to promote the vertical flexibility in the supply chain so that customer demands can be fulfilled in a timely manner. The paper focuses

on the supplier's production capacity and flexibility as it directly impacts the buyer's performance in the market. The impact of firm size on transaction costs explains that small firms have limited scope and scale of production (Nooteboom , 1993). Scope is defined in terms of variety of products being produced whereas scale is defined in terms of volume. The two terms are further linked with learning and experience as it is believed that smaller firms may have little experience in the market and have limited acquisition of knowledge or experience. The firm size has also been linked with production capacity by (Abiodun, 2013) and the growing size has been linked with the maturity of the firm as they are now more stable and are generating more sales and achieving economies of scale. This project concludes that firm size is positively linked to firm's profitability and this is mainly achieved through production capacity which increases with size.

2.4.3 Production flexibility

The ability of a supplier to adjust their running operations in order to meet the manufacturer's request is termed as supplier's flexibility. Flexibility in order quantity and customization of product both are equally important for manufacturer as the manufacturer is continuously working on better product development (Jin, Vonderembse, Ragu-Nathan, & Smith, 2014). Another research highlights that smaller firms are better able to adapt flexible manufacturing technologies as compared to bigger firms as their organization structure supports this implementation. However, the bigger firms are also striving to implement flexible manufacturing technologies (Elango & Fried, 1993).

The supplier's flexibility is described as a key asset as well as a major source of risk for the focal buyer companies by (Moretto, Grassi, Caniato, Giorgino, & Ronchi, 2019). The credit rating for supply chain has been declared to be very beneficial for buyer companies as well as their strategic suppliers. The flexibility of suppliers is defined in terms of the capability of suppliers to respond to changes in request for volume, mix and time (LIAO, HONG, & RAO, 2010). A study conducted by (Sánchez & Pérez, 2005) focuses on the significance of supply chain flexibility on buyer firm's performance and a number of variables and their effect were studied in this project. These factors include environmental uncertainty, technical complexity, supplier dependence, mutual understanding, ICT use and company size. The respondent companies were classified based on the number of employees and the impact of this factor was studied to understand the importance of flexibility in the supply chain.

Supply chain flexibility has been studied in terms of volume flexibility, delivery flexibility, logistics flexibility, mix flexibility, supply network flexibility and spanning flexibility by (Liao , 2020). This project article proves that supply chain flexibility is only possible if the buyers and suppliers work together and share timely information and share their production plans to fulfill the customer demands in a timely manner. According to a project conducted by (Bhagwat, Wadhwa, & Chan, 2008) low cost and quality are no longer the only important factors in effective supply chain management but the flexibility of suppliers has now become a new trend to obtain competitive advantage in the market.

A research conducted on supplier selection and evaluation in detergent production industry has used flexibility as a criteria for supplier selection (Roshandel, Miri-Nargesi, & HatamiShirkouhi, 2013). The sub criteria that helps in defining this main criterion of flexibility considers the production capacity of supplier so that they can make-to-order and fulfill the buyer's demand in time.

2.4.4 Availability of finance

A research conducted by (Görg & Kersting, 2017) focuses on the availability of credit by suppliers on the basis of its vertical integration in the supply chain. The paper focuses on the suppliers that are working with multinational enterprises and how they manage their access to credit. According to another research conducted on different firms from 80 countries it has been confirmed that larger and older firms face less financial obstacles (Beck, Demirgüç-Kunt, Laeven, & Maksimovic, 2006). This research focuses on the factors of size, age and ownership that determines the access to finance by firms. The idea behind this concept is that bigger and older firms are believed to be more reliable by financial institutions and they are more willing to lend them money for investments but in case of smaller firms there is a lot of doubt regarding repayments. Another research conducted by (Oliner & Rudebusch, 1992) has used size as a criteria to categorize firms into financially constrained and unconstrained firms. A research conducted by (Chittenden, Hall, & Hutchinson, 1996) focused on the factors that affect the financial status of small firms. This research concluded that the size of firms, asset structure, age of firm, profitability and its access to capital market does affect its financial status.

2.4.5 Size asymmetry

A research conducted on size asymmetry takes into consideration a variety of relationship characteristics like mutuality, conflict, cooperation, power and dependence, etc and the small supplier's perspective is being taken into consideration (Johnsen & Ford, 2008). The results of this project shows that smaller suppliers do not critically take into consideration their role in the buyer supplier network and are under the influence of their bigger supplier partner as the larger firms control and limit the smaller supplier's activities and decisions.

Asymmetry in a supply chain has been discussed in a variety of context and while studying each dimension the positive and negative influences were discussed. Asymmetry in buyer supplier relationship has been discussed by (Michalski, Montes, & Narasimhan, 2019) and how it impacts small and medium enterprises and larger firms. The aspects of trust and innovation have also been discussed in this paper and the aim of the paper was to explore all aspects of asymmetric relationships and not just the negative opportunistic phases of this partnership. Another paper discusses asymmetry in buyer supplier relationship based on the level of commitment, trust factor between the two parties and the power being exercised by both buyer and supplier (Gulati & Sytch, 2007). Another research focused on the factors of trust and perception in a buyer supplier relationship to analyze the asymmetric relationships (Thomas & Esper, 2010). This study stated that not all asymmetric relationships are negative and, in some relationships, where smaller vendors are dealing with larger retailers there is a satisfactory asymmetric relationship. The small vendors in this case usually do not want to change the relationship dynamics and are quite satisfied with the situation.

Size asymmetry has been studied in literature repeatedly and has been linked with multiple other factors like power asymmetry which is directly linked to organization's size (Lashley & Pollock, 2020). The asymmetry in size is linked with power asymmetry by (Talay, Brindley, & Oxborrow, 2020) in a study conducted between small fashion suppliers and their buyers who were bigger in size, hence had strong position in the relationship. Another research based on case studies examined that how the relationship changes between buyer and supplier at different stages of development when asymmetry exist between them (Lee & Johnsen, 2012). Again, the relationship was studied when smaller suppliers were dealing with bigger buyer firms and five case studies were considered.

2.4.5 Networking in the market

A paper focuses on the connection of firm size based on the number of buyer and suppliers in the market network and classifies the firms in the production network based on the number of buyers and suppliers they interact with (Ojala & Hallikas, 2006). A study conducted by (Babakus, Yavas, & Haahti, 2006) explores that how firm size impacts their networking decisions in the market. Smaller SMEs often look for opportunities to build networks in the foreign market as they believe that it is important for them to compensate their size disadvantage. A study focused that how size of a company affects their ability to develop a network internationally (Calof, 1993) and how size acts as a barrier to international activity.

Firm size and the types of networks created in the market is discussed by (Huggins & Johnston, 2010) in their research that focuses on the formal and informal nature of these networks. The concept of networks has been studied in terms of innovation and how firm size impacts the nature of these networks has been discussed in this research. A research conducted by (Villa, 1998) states that it is often beneficial for smaller and medium sized firms to join a network to gain stability that they lack because of their size. This research focuses on the importance of alliances as they are preferred by differently sized firms to change their status in the market.

Developing a network internationally through export has been studied in terms of firm size by (Wolff & Pett, 2000) and it was concluded that small firms are suitable for exports because of the flexibility that they offer in the international market. Another study conducted by (Dubois, 2015) states that networks in the market by small firms give them a strong competitive position in the market. The paper describes that how small firms are more inclined towards network building as compared to larger firms. The larger firms mostly have an established position in the network in the market and are not looking forward to every opportunity that comes in their way whereas smaller firms always want to link themselves with industry giants to gain a strong position in the market.

Table 1: Summary of Literature Review

Firm Size Factors	**Author**	**Framework**
Annual sales	Mabenge, Madzimure, & Makanyeza, (2020)	Firm's age and size being considered while studying the impact of innovation on SMEs. Size being considered in terms of annual sales.
Number of employees	Yang & Xiongfei Zhang, (2017)	Number of employees used as control variable while studying supplier selection and buyer supplier relationship.
Production capacity	Abiodun, (2013)	Firm size has been linked with production capacity and the growing size has been linked with the maturity of the firm as they are now more stable and are generating more sales and achieving economies of scale.
Production flexibility	Diez-vial, (2019)	A research conducted on vertical integration discusses the flexibility of firms in terms of its size. The study concludes that firms are less likely to stay flexible when they grow in size.
Size Asymmetry	Michalski, Montes, & Narasimhan, (2019)	Asymmetry in buyer supplier relationship has been discussed and how it impacts small and medium enterprises and larger firms. The aspects of trust and innovation have also been discussed in this paper.
Availability of finance	Görg & Kersting, (2017)	Availability and access to credit in supply chain network.
Networking	Dubois, (2015)	Difference between small and large firms in their preferences to build networks in the market.

2.5 Research Gap

The main gap that has been addressed in this project is the firm size determinants that are identified through detailed literature review. All the above-mentioned determinants are already present in existing literature, but the context of these factors is quite different. In this project we have focused on these factors in terms of firm size. Firm size in general is a prominent factor that plays a critical role in any organization's existence. This factor becomes even more important when inter organization relationships are discussed in supply chains. The size of one firm impacts the decision of the other well-connected firms in a supply chain. The main idea behind this project was to take into consideration this firm size of supplier in selection and evaluation process.

The factors of annual sales and number of employees are the most obvious ones and are directly used in numerous projects to determine the firm size. However, in this project we have identified five additional determinants that play a vital role in supplier selection. The criteria of production capacity have also been derived from literature as this criterion was discussed in reference to firm size. The reason for undertaking this criterion into consideration is that buyer firms often consider the capacity constraints of suppliers before getting into contracts with them. The buyer firms must fulfill a certain demand level in the market and for this purpose they have to assure the capacity constraints of their suppliers which is directly linked with their size.

The next criteria that has been included in this project is the production flexibility. In today's competitive market where demand is highly uncertain, the role of flexibility cannot be ignored. So, after deep analysis of a few papers we have concluded that production flexibility is directly linked to firm size. A few papers have discussed that how flexibility of organization's change with the change in their size. Buyers are particularly concerned with flexibility in terms of production, delivery, etc. It is not only important for supplier firms to deliver a particular product in bulk, but the supplier must be flexible enough to deal with the uncertainty so that buyer firms do not have to think about inventory storage and management.

Another criterion that has not been used as a firm size determinant in literature is the availability of finance by suppliers. We have identified this criterion to be directly linked with firm size as many papers have discussed that firm size and financial constraints are directly linked to one another. Again, the buyer firms do consider if a particular supplier will be able to cope up with investment opportunities or if some innovation project comes across. In today's market no firm is

working in isolation and manufacturers are directly collaborating with their suppliers as well as customers to come up with new products and technologies. For this reason, the buyer firms must be conscious about the supplier firm's availability/ access of finance. It has been noted through study of literature that bigger firms often have easy access to external funds so they can easily adopt to investment opportunities that come across.

Another factor that has been identified is the size asymmetry. This factor is very common in literature and size asymmetry has been discussed repeatedly in terms of relational asymmetry, trust asymmetry, information asymmetry but it has not been used in terms of supplier selection criteria when firm size is being considered. The last factor that contributes to our gap is the networking in the market. Literature has focused on networking concept as linked to firm size as the number of firms in the network can be regarded to note the firm size of suppliers. This concept has also been discussed in terms of inclination of small firms to develop a wide network in the market to be in a better position. All these criteria that have been identified are believed to be directly linked with the firm size of suppliers. The factors identified through research were also discussed with some industry experts to get a feedback on their perception about these criteria and then the framework for this project was designed accordingly.

CHAPTER 3: METHODOLOGY

This project has used AHP method to help in group decision making when it comes to supplier selection and evaluation in terms of firm size of suppliers. Analytic hierarchy process is a method used in ranking the alternatives while using multiple criteria (Lai, Wong, & Cheung, 2002). This method was introduced by Professor A. L. Saaty in 1970s to help individuals in complex problem solving when multiple criteria is involved (Taylor, 2002). In this project the firm size of suppliers has been categorized into multiple criteria and the questionnaire is designed using these criteria. The aim is to use the pairwise comparison method to rank the importance of each criteria. The second part of the questionnaire helps in ranking the alternative using each chosen criteria of firm size.

Saaty's scale of preference for AHP method is given in Table 2.

Table 2: Saaty's scale

Preference level	**Numerical value**
Equally preferred	1
Equally to moderately preferred	2
Moderately preferred	3
Moderately to strongly preferred	4
Strongly preferred	5
Strongly to very strongly preferred	6
Very strongly preferred	7
Very strongly to extremely preferred	8
Extremely preferred	9

However, in the questionnaire designed for this project linguistic scale is used which is given in table 3. The AHP method is based on both linguistic and numerical scale however linguistic scale is more feasible to use as a research conducted by (Miller, 1956) states that humans cannot compare more than seven objects without getting confused. The numerical scale proposed in AHP is based on 17 values which can make the questionnaire too difficult to comprehend. So, in this project a 5 point linguistic scale is used in the questionnaire so that the respondents can easily fill in the survey without any confusion. The odd number scale has been commonly used in literature to confirm distinction between the measurement points (Vargas, 2010).

The odd number scale has been repeatedly used in literature to cater the issue of uncertainty. A study conducted on machine tool selection uses the same scale of 1, 3, 5, 7, 9 (Durán & Aguilo, 2008). A study conducted on selection of computer aided maintenance system also uses the same scale (Durán, 2011). Another study conducted on selecting a suitable location for a plastic manufacturing company in Bangladesh uses the same odd number AHP scale to compare five districts and ten criteria (Rahman, Ali, Hossain, & Mondal, 2018). A case study on ranking and selecting the chief inspectors of bank has also used the odd number scale to make the comparisons (Dooki, Bolhasani, & Fallah, 2017). Another paper that has reviewed the use of AHP in construction management has also used the same scale (Darko, et al., 2018). A research conducted on sustainable energy planning in Pakistan has also used the five point linguistic scale to compare the criteria and alternatives (Solangi, Tan, Mirjat, & Ali, 2019).

Table 3: Linguistic scale

Linguistic scale	**Numerical value**
Equally preferred	1
Moderately preferred	3
Strongly preferred	5
Very strongly preferred	7
Extremely preferred	9

3.1 Sample selection and data collection

The first step in sample selection was to finalize the companies that are going to fill in the responses. As the paint industry was finalized for this project due to its growth potential and product mix so a screening process was conducted to finalize which companies are most suitable for this project. One of the leading paint manufacturer company AkzoNobel was approached for this purpose. One of the top managers in the procurement department was contacted and was asked about the major type of suppliers that the paint industry is dealing with. The suppliers were categorized into two groups, namely chemical and packaging suppliers. The procurement manager gave a list of total eight suppliers that are most common in the paint sector. The list of these chemical and packaging suppliers is given in Table 4. Next step was to do a detailed market research to identify the companies that are directly dealing with these eight suppliers. A total of six companies were finalized who were dealing with these suppliers and were in close contact with them. In this project the alternatives are the chemical and packaging suppliers of the selected paint companies of Pakistan.

Table 4: List of mutual suppliers

Supplier companies	**Category**
Power chemicals	Chemical suppliers
Grace chemicals	Chemical suppliers
Enar petroleum	Chemical suppliers
Nimir resins	Chemical suppliers
Rehan cans	Packaging suppliers
Hussain cans	Packaging suppliers
Pioneer cans	Packaging suppliers
Bullehshah packaging	Packaging suppliers

The six paint companies that were finalized for this project are Nippon, Berger, AkzoNobel, Kansai, Jotun and Diamond paints. It was important to select individuals that were best suited to address the project questions related to some specific suppliers therefore purposive sampling technique was used. As the questions used in the survey were purely focused on supplier selection and evaluation criteria so the employees of procurement department who were directly interacting

with the supplier companies had to be approached for this project. The survey was sent to the managers of procurement department of the six selected paint companies. A total of 23 survey forms were emailed to the managers of procurement department, out of which 13 surveys were submitted making the response rate of 56%. The AHP hierarchy table that has been designed for this project is given in Figure 1.

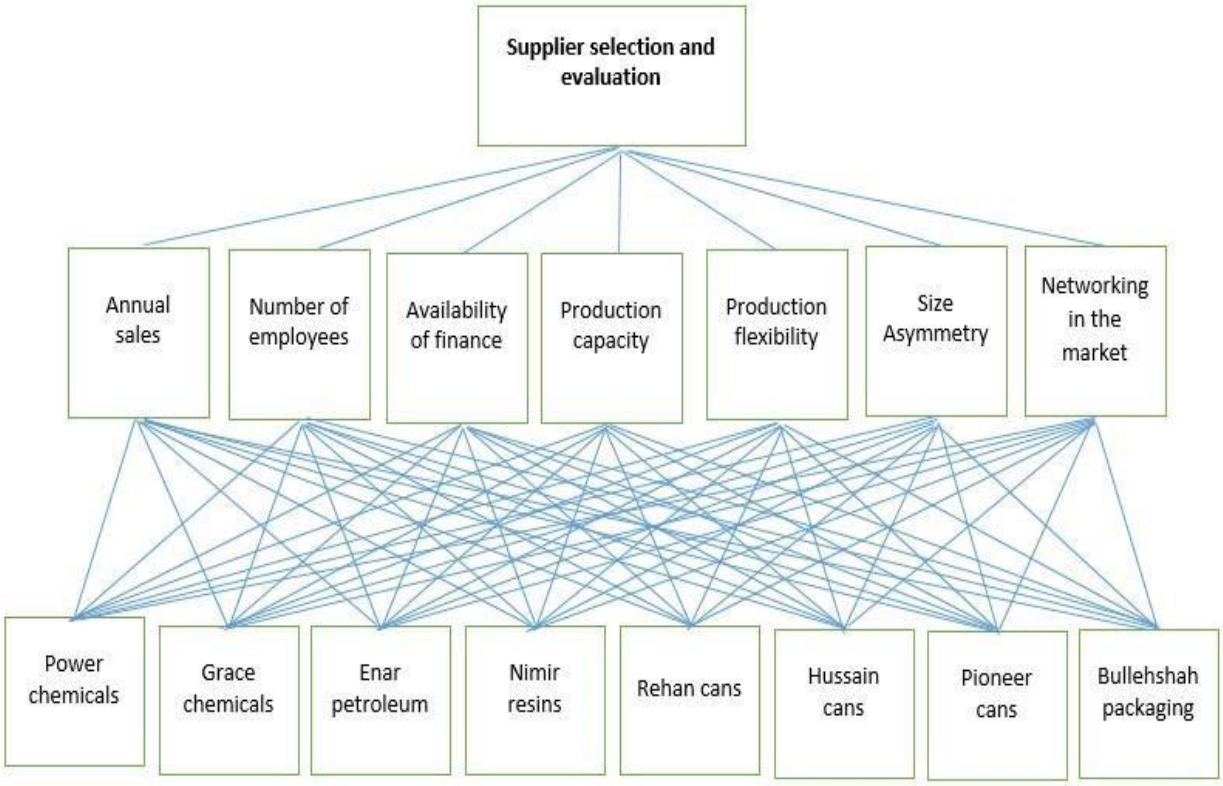

Figure 1. AHP hierarchy chart

CHAPTER 4: RESULTS AND ANALYSIS

After getting the questionnaire filled the next step is to generate linguistic pairwise comparison matrices for each level of the hierarchy. The linguistic label and each variable to be used in generating the matrix is given in Table 5.

Table 5

Linguistic Label	**Variable**	**Scale of 1 – 9**
Equally preferred	S9	1.00
Moderately preferred	S11	3.00
Strongly preferred	S13	5.00
Very strongly preferred	S15	7.00
Extremely preferred	S17	9.00
1/Equally preferred	S9	1.00
1/Moderately preferred	S7	0.33
1/Strongly preferred	S5	0.20
1/Very strongly preferred	S3	0.14
1/Extremely preferred	S1	0.11

The linguistic pairwise comparison matrix (LPCM) was generated in two steps, first for the criteria ranking and then for suppliers using each criterion independently. A 7/7 LPCM matrix was generated for each respondent and one respondent's results is given in Table 6.

Table 6: LPCM for criteria

	Annual sales	No. of employees	Size asymmetry	Availability of finance	Prod. capacity	Prod. flexibility	Networking
Annual sales	9	13	5	7	5	7	7
No. of employees	5	9	9	5	3	5	5
Size asymmetry	13	9	9	7	9	9	9
Availability of finance	11	13	11	9	5	5	9
Production capacity	13	15	9	13	9	13	9
Production flexibility	11	13	9	13	5	9	13
Networking	11	13	9	9	9	5	9

Similarly, a 4/4 LPCM matrix for packaging suppliers and chemical suppliers was generated for all seven firm size factors used in this study. A total of 14 matrices were generated, seven for chemical suppliers based on each firm size factor and seven for packaging suppliers.

Table 7: LPCM for supplier

	A1 (Comparison of each alternative against annual sales)			
	Power chemicals	Grace chemicals	Enar petroleum	Nimir resins
Power chemicals	9	5	11	3
Grace chemicals	13	9	11	3
Enar petroleum	7	7	9	3
Nimir resins	15	15	15	9

The next step is to convert LPCMs into numerical preference comparison matrices while using a numerical scale. The validity of the results depends on the scale used in this step. The study of literature shows that various numerical scales have been proposed other than the Saaty's scale. Some of the scales proposed in literature are the geometrical scale (Ji & Jiang, 2003), balanced scale (PÖYHÖNEN, HÄMÄLÄINEN, & SALO, 1998) and the Salo Hämäläinen scale (Salo & Hämäläinen, 1997). The choice of scale is an open problem and this scale problem is linked with the concept of computing with words (CWW). According to this concept of CWW same words can be interpreted differently by different individuals (Mendel & Wu, 2010). To deal with this problem of computing with words a model was proposed by (Li, Dong, Herrera, Viedma, & Martínez, 2017). This model suggests the use of personalized scale when linguistic decision making is to be interpreted. A research conducted by (Huizingh & Vrolijk, 1997) also compares verbal and numerical judgments in AHP and has used personalized scale to improve the validity of results.

The use of crisp number scale has been criticized repeatedly in literature as words have different meanings for individuals, so it is not logical to use the same scale to interpret all responses. A model proposed in literature suggests the use of personalized scale to quantify linguistic variables at individual level. The aim of using the personalized scale is to minimize the inconsistency of the NPCMs. The quality of NPCMs can be ensured through consistency checks

and it confirms if the respondents were consistent while doing the pairwise comparison. This consistency check initiates from transitivity property and four types of transitivity rules were explained by (Viedma, Herrera, Chiclana, & Luque, 2004). These four basic transitivity rules include intransitivity, additive transitivity, weak stochastic transitivity and strong stochastic transitivity. On the basis of these transitivity rules, the types of inconsistencies are explained by (Zhang, Chen, Dong, Xu, & Wang, 2018) as contradictions, weak contradictions, numerical scale discreteness and numerical scale finiteness. It has also been stated that results will be fully consistent only if the transitivity rule holds for all the criteria and alternatives. However, as AHP is based on subjective criteria so practically comparison matrices always show some level of inconsistency. The study of literature also shows that the consistency measure as proposed by Saaty has been criticized by practitioners. Examples are presented by researchers that shows that some pairwise matrices with contradictory judgements turned out to be consistent according to the Saaty's consistency measure and some reasonable matrices were rejected (Costa & Vansnick, 2008)

Similarly, when the consistency ratios were calculated for the results of this study some values exceeded the acceptable value of 0.1%, so some alternative scale had to be used instead of using Saaty's fixed numerical scale. A study conducted by (Zhou, Dong, Zhang, & Gao, 2018) proposes a consistency driven approach to use a personalized scale. This step of converting linguistic preferences to numerical preferences is extremely important to deal with the problem of consistency. After generating LPCM matrices for all respondents the next part of analysis involves the use of MATLAB software to generate a personalized scale. This software makes it easier to enter matrix values and manipulate them for results. The basic purpose for using MATLAB function was to generate a personalized scale and the two scales for the respondents (personalized scale and Saaty's scale) that were used in MATLAB are given in Table 8 to Table 17.

Table 8: Personalized scale & Saaty's scale (Respondent 1)

Personalize Scale	**Saaty's Scale (1 - 9)**
1	1
1.2	2
1.4	3
1.6	4
1.8	5
3.4	6
3.6	7
9.4	8
9.6	9

Table 9: Personalized scale & Saaty's scale (Respondent 2)

Personalize Scale	**Saaty's Scale (1 - 9)**
1	1
1.2	2
1.4	3
1.6	4
1.8	5
3.4	6
3.6	7
6.6	8
6.8	9

Table 10: Personalized scale & Saaty's scale (Respondent 3)

Personalize Scale	**Saaty's Scale (1 - 9)**
1	1
1.2	2
1.4	3
1.6	4
1.8	5
3.4	6
3.6	7
6.6	8
13	9

Table 11: Personalized scale & Saaty's scale (Respondent 4)

Personalize Scale	**Saaty's Scale (1 - 9)**
1	1
1.2	2
1.4	3
1.6	4
1.8	5
3.4	6
3.6	7
3.8	8
4	9

Table 12: Personalized scale & Saaty's scale (Respondent 5)

Personalize Scale	**Saaty's Scale (1 - 9)**
1	1
1.2	2
1.4	3
1.6	4
1.8	5
3.4	6
3.6	7
3.8	8
4	9

Table 13: Personalized scale & Saaty's scale (Respondent 6)

Personalize Scale	**Saaty's Scale (1 - 9)**
1	1
1.2	2
1.4	3
2	4
2.2	5
2.4	6
2.6	7
7.2	8
7.4	9

Table 14: Personalized scale & Saaty's scale (Respondent 7)

Personalize Scale	**Saaty's Scale (1 - 9)**
1	1
1.2	2
1.4	3
1.6	4
1.8	5
3.4	6
3.6	7
6.6	8
6.8	9

Table 15: Personalized scale & Saaty's scale (Respondent 8)

Personalize Scale	**Saaty's Scale (1 - 9)**
1	1
1.2	2
1.4	3
2	4
2.2	5
2.4	6
2.6	7
9	8
9.2	9

Table 16: Personalized scale & Saaty's scale (Respondent 9)

Personalize Scale	**Saaty's Scale (1 - 9)**
1	1
1.2	2
1.4	3
2	4
2.2	5
2.4	6
2.6	7
9	8
9.2	9

Table 17: Personalized scale & Saaty's scale (Respondent 10)

Personalize Scale	**Saaty's Scale (1 - 9)**
1	1
1.2	2
1.4	3
1.6	4
1.8	5
3.4	6
3.6	7
9.4	8
13	9

In this project the respondent's results are not only going to be discussed according to Saaty's scale of preference, but a personalized scale will also help in the analysis of results. The comparison of fixed numerical scale and personalized numerical scale shows that consistency level improves when a personalized scale is used. The personalized scale is an important aspect of AHP project, and it plays a key role in the final decision and results. Another research conducted by (Tang, Zhang, Peng, Yang, & Pedrycz, 2019) explains the use of personalized numerical scale for different decision makers while dealing with the concept of computing with words. The main aim of personalized scale is to manage the problem of different meanings of words for different individuals which creates inconsistency in results. So, to improve the validity of results and maintain the consistency level within range personalized scale is generated for all respondents. The consistency ratios with fixed numerical scale and personalized scale for all respondents are given in the following tables.

Table 18: Consistency ratio (Respondent 1)

	CR	
	P.S	Saaty's scale (1, 3, 5, 7, 9)
C	0.0298	0.2309
A1	0.0214	0.1757
A2	0.0560	0.0705
A3	0.0322	0.0253
A4	0.0353	0.2671
A5	0.0161	0.0359
A6	0.0135	0.1272
A7	0.0353	0.0471

Table 19: Consistency ratio (Respondent 2)

	CR	
	P.S	Saaty's scale (1, 3, 5, 7, 9)
C	0.0619	0.0905
A1	0.0095	0.0091
A2	0.0473	0.2858
A3	0.0319	0.0247
A4	0.0291	0.1259
A5	0.0291	0.1259
A6	0.0095	0.0109
A7	0.0296	0.0300

Table 20: Consistency ratios (Respondent 3)

	CR	
	P.S	Saaty's scale (1, 3, 5, 7, 9)
C	0.0298	0.0333
A1	0.0214	0.1830
A2	0.0322	0.2531
A3	0.1009	1.0089
A4	0.0322	0.0531
A5	0.0274	0.2108
A6	0.0322	0.0231
A7	0.0360	0.0781

21: Consistency ratios (Respondent 4)

	CR	
	P.S	Saaty's scale (1, 3, 5, 7, 9)
C	0.0231	0.0619
A1	0.0731	0.1516
A2	0.0628	0.0715
A3	0.0053	0.1109
A4	0.0225	0.0529
A5	0.0324	0.0528
A6	0.0056	0.0678
A7	0.0586	0.2319

Table 22: Consistency ratios (Respondent 5)

	CR	
	P.S	Saaty's scale (1, 3, 5, 7, 9)
C	0.0126	0.1016
A1	0.0697	0.2894
A2	0.0628	0.0678
A3	0.0053	0.0528
A4	0.0225	0.0529
A5	0.0324	0.1109
A6	0.0056	0.0715
A7	0.0586	0.1516

Table 23: Consistency ratios (Respondent 6)

	CR	
	P.S	Saaty's scale (1, 3, 5, 7, 9)
C	0.0228	0.1939
A1	0.0214	0.0280
A2	0.0274	0.2108
A3	0.0214	0.1820
A4	0.0322	0.0296
A5	0.0053	0.0558
A6	0.0105	0.1126
A7	0.0308	0.0258

Table 24: Consistency ratios (Respondent 7)

	CR	
	P.S	Saaty's scale (1, 3, 5, 7, 9)
C	0.0391	0.2907
A1	0.0171	0.0539
A2	0.0583	0.2531
A3	0.0059	0.0705
A4	0.0538	0.0247
A5	0.0201	0.1240
A6	0.0220	0.0970
A7	0.0105	0.0126

Table 25: Consistency ratios (Respondent 8)

	CR	
	P.S	Saaty's scale (1, 3, 5, 7, 9)
C	0.0391	0.2907
A1	0.0171	0.0339
A2	0.0583	0.2531
A3	0.0059	0.0705
A4	0.0583	0.0487
A5	0.0201	0.1240
A6	0.0220	0.0907
A7	0.0105	0.0126

Table 26: Consistency ratios (Respondent 9)

	CR	
	P.S	Saaty's scale (1, 3, 5, 7, 9)
C	0.0233	0.1636
A1	0.0220	0.0970
A2	0.0489	0.1519
A3	0.0483	0.0424
A4	0.0059	0.0695
A5	0.0934	0.5109
A6	0.1032	0.5789
A7	0.0291	0.0259

Table 27: Consistency ratios (Respondent 10)

	CR	
	P.S	Saaty's scale (1, 3, 5, 7, 9)
C	0.0288	0.0234
A1	0.0095	0.0091
A2	0.0201	0.1272
A3	0.0220	0.0938
A4	0.0220	0.0949
A5	0.1595	1.0707
A6	0.0225	0.0958
A7	0.0344	0.1830

Table 28: Consistency ratios (Respondent 11)

	CR	
	P.S	Saaty's scale (1, 3, 5, 7, 9)
C	0.1172	0.0604
A1	0.0367	0.0377
A2	0.0322	0.2531
A3	0.0164	0.1397
A4	0.0353	0.0261
A5	0.1158	1.1706
A6	0.0573	0.5827
A7	0.0587	0.0221

The consistency ratio shows that some of the values are not within the range when Saaty's scale is used and this problem should be addressed before discussing the ranking of criteria and alternatives.

The AHP framework proposed in this project based on personalized scale is given in Figure 2

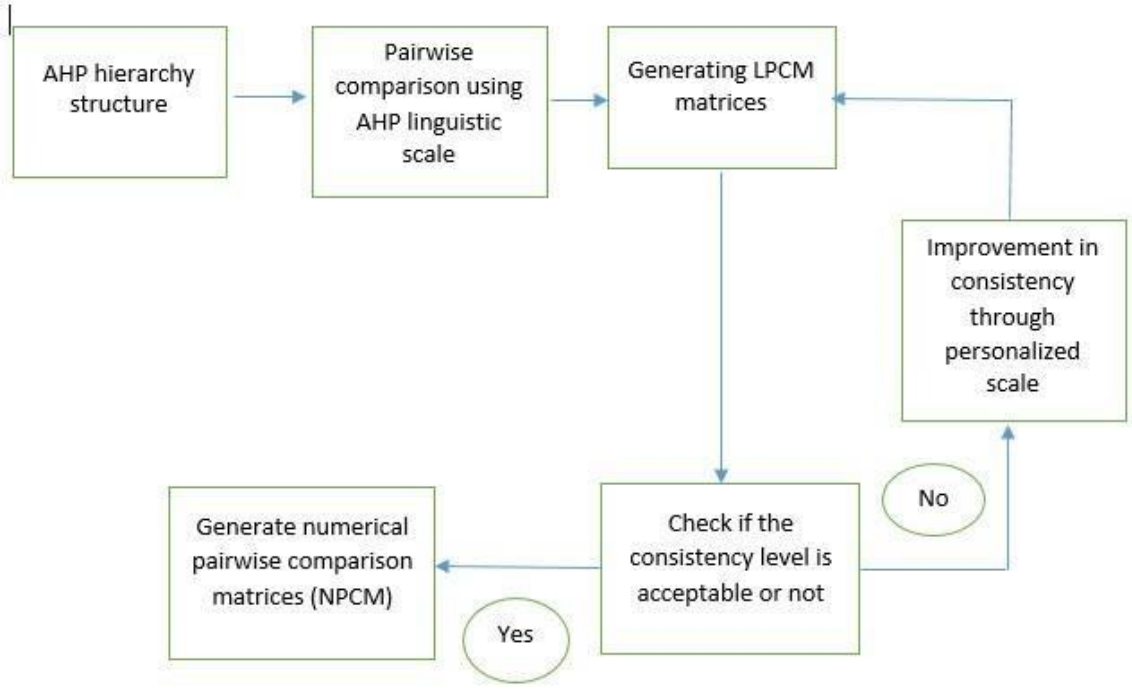

Figure 2: AHP framework and use of personalized scale

The LPCM data was used as input to generate a numerical pairwise comparison matrix (NPCM). Two types of matrices are generated to determine the ranking of firm size factors and the suppliers. The first one is based on personalized scale and is given in Table 29.

Table 29: NPCM (Personalized numerical scale for criteria)

C (criteria ranking)						
1.00	1.80	0.56	0.71	0.56	0.71	0.71
0.56	1.00	1.00	0.56	0.28	0.56	0.56
1.80	1.00	1.00	0.71	1.00	1.00	1.00
1.40	1.80	1.40	1.00	0.56	0.56	1.00
1.80	3.60	1.00	1.80	1.00	1.80	1.00
1.40	1.80	1.00	1.80	0.56	1.00	1.80
1.40	1.80	1.00	1.00	1.00	0.56	1.00

Again one 7/7 matrix for criteria ranking was generated and total 14 4/4 matrices for the 8 suppliers based on all seven firm size factors.

The second type of matrices were generated using the Saaty scale of 1 to 9.

Table 30: NPCM (Saaty's scale of 1-9 for criteria ranking)

C (criteria ranking)						
1.00	5.00	0.20	0.33	0.20	0.33	0.33
0.20	1.00	1.00	0.20	0.14	0.20	0.20
5.00	1.00	1.00	0.33	1.00	1.00	1.00
3.00	5.00	3.00	1.00	0.20	0.20	1.00
5.00	7.00	1.00	5.00	1.00	5.00	1.00
3.00	5.00	1.00	5.00	0.20	1.00	5.00
3.00	5.00	1.00	1.00	1.00	0.20	1.00

In this project the respondent's results are not only going to be discussed according to Saaty's scale of preference, but a personalized scale will also help in the analysis of results. While comparing both the results we can see that the ranking of alternatives and criteria remains the same but the values in the matrices are changed.

The next step is to generate the weight vector and for this step the numerical matrices are used to calculate Eigen vector. The MATLAB function used for this project helps in generating this Eigen vector that gives the output of weight vector for all seven criteria and weight vector of all the suppliers based on each criterion.

The weight vector for each criterion using the personalized scale is given in Table 31.

Table 31: Weight vector of firm size factors

Annual sales	No. of employees	Size Asymmetry	Availability of finance	Production Capacity	Production flexibility	Networking
0.0874	0.0742	0.1455	0.1240	0.2211	0.1751	0.1727

Now the next step is to look into the weight vector for suppliers based on each criterion as given in Table 32.

Table 32: Weight vectors for chemical suppliers

	Annual sales	No. of employees	Size asymmetry	Availability of finance	Production capacity	Production flexibility	Networking
	0.0874	0.0742	0.1455	0.1240	0.2211	0.1751	0.1727
Power chemical	0.2499	0.2745	0.2610	0.2193	0.2451	0.2301	0.3217
Grace chemical	0.2262	0.2046	0.1658	0.1522	0.2095	0.2126	0.1255
Enar Petroleum	0.1675	0.1525	0.2232	0.2788	0.2555	0.2112	0.2064
Nimir Resins	0.3563	0.3683	0.3500	0.3498	0.2899	0.3461	0.3464

The weight vector for each supplier based on the multiple criteria is then computed in excel by multiplying criteria preference vector by the preceding criteria matrix and adding the products. This step was again repeated for both scales to compare the results. Now if we compare the weight vectors for all suppliers it is easier to rank the suppliers based on level of preference for each respondent.

Table 33: Ranking of firm size factors (personalized scale)

	Annual sales	No. of employee	Size Asymmetry	Availability of finance	Prod Capacity	Prod flexibility	Networking in the market
Berger 1	0.1075	0.0825	0.1446	0.1376	**0.2139**	0.1711	0.1428
Dulux 1	0.1661	0.1351	0.0905	0.1771	0.1127	**0.1870**	0.1315
Dulux 2	0.1074	0.0854	0.1357	0.1522	0.1670	**0.1998**	0.1526
Berger 2	0.1323	0.0992	0.1074	0.1466	**0.1956**	0.1670	0.1519
Dulux 3	0.1454	0.1049	0.0894	0.1505	**0.1961**	0.1627	0.1509
Kansai 1	0.1375	0.1039	0.0974	0.1504	0.1820	**0.1896**	0.1393
Kansai 2	0.1442	0.0868	0.0998	0.1608	0.1693	**0.1974**	0.1437
Diamond	0.1422	0.0868	0.0998	0.1608	0.1693	**0.1974**	0.1437
Jotun 1	**0.1748**	0.1405	0.1160	0.1401	0.1280	0.1400	0.1606
Jotun 2	**0.1707**	0.1433	0.1145	0.1564	0.1342	0.1403	0.1408
Nippon	0.0874	0.0742	0.1455	0.1240	**0.2211**	0.1751	0.1727

If we look at the weight vector of each criteria than we notice a trend that the two criteria that are ranked highest are production flexibility and production capacity. There is only one company that has a different preference level and that is Jotun paints. The two respondents from Jotun paints have given most preference to annual sales criteria. The different response of managers of Jotun paints was investigated by doing some further analysis of results.

Next, we will compare the weight vectors of the four chemical suppliers that was computed while using the personalized scale and the ranking is shown in Table 34.

Table 34: Ranking of chemical suppliers (personalized scale)

	Power chemicals	**Grace chemicals**	**Enar Petroleum**	**Nimir Resins**
Berger 1	0.1649	0.2229	0.2256	**0.3867**
Dulux 1	0.2793	0.1891	0.1980	**0.3336**
Dulux 2	0.2528	0.1777	0.2367	**0.3328**
Berger 2	0.1238	0.1941	0.2163	**0.4651**
Dulux 3	0.1384	0.1906	0.1739	**0.4519**
Kansai 1	0.1821	0.2256	0.2262	**0.3662**
Kansai 2	0.1785	0.2123	0.2163	**0.3950**
Diamond 1	0.1781	0.2119	0.2159	**0.3932**
Jotun 1	0.2664	0.1889	0.2475	**0.2973**
Jotun 2	0.2464	0.1879	0.2591	**0.3069**
Nippon 1	0.2574	0.1832	0.2221	**0.3373**

Now if we look at the weight vectors for the four chemical suppliers, we notice that all 11 respondents have ranked the Nimir Resins at the top. While looking at the trends it is also obvious that the remaining ranking is not consistent among the 11 respondents. Some respondents have ranked Enar Petroleum on the second number whereas another respondent has ranked Power Chemicals as the second best, however majority companies have ranked Enar Petroleum as the second best.

Now if we look at the trends while following the Saaty's scale we get the following results for criteria ranking and chemical suppliers ranking as shown in Table 35 and 36.

Table 35: Ranking of factors (Saaty's scale)

	Annual sales	No. of employee	Size Asymmetry	Availability of finance	Prod Capacity	Prod flexibility	Networking in the market
Berger 1	0.0536	0.0353	0.1283	0.1215	**0.3174**	0.2226	0.1212
Dulux 1	0.1696	0.1147	0.0579	0.2063	**0.0864**	0.2567	0.1084
Dulux 2	0.0587	0.0276	0.1020	0.1686	0.1767	**0.3121**	0.1544
Berger 2	0.0991	0.0462	0.0555	0.1406	**0.3078**	0.2048	0.1459
Dulux 3	0.1337	0.0579	0.0321	0.1419	**0.3155**	0.1743	0.1446
Kansai 1	0.1047	0.0527	0.0406	0.1378	0.2463	**0.3008**	0.1172
Kansai 2	0.1120	0.0460	0.0814	0.1482	0.1959	**0.2592**	0.1574
Diamond	0.1120	0.0460	0.0814	0.1482	0.1959	**0.2592**	0.1574
Jotun 1	**0.2315**	0.1273	0.0709	0.1270	0.1284	0.1325	0.1825
Jotun 2	**0.2097**	0.1474	0.0597	0.1867	0.1248	0.1334	0.1383
Nippon 1	0.0313	0.0174	0.1791	0.1107	**0.2769**	0.1963	0.1882

Table 36: Ranking of chemical suppliers (Saaty's scale)

	Power chemicals	**Grace chemicals**	**Enar Petroleum**	**Nimir Resins**
Berger 1	0.0704	0.1678	0.1697	**0.5920**
Dulux 1	0.2837	0.1287	0.1501	**0.4339**
Dulux 2	0.2065	0.0695	0.2406	**0.4835**
Berger 2	0.0583	0.1475	0.2069	**0.5837**
Dulux 3	0.0947	0.1388	0.2005	**0.5659**
Kansai 1	0.0839	0.1639	0.1709	**0.5810**
Kansai 2	0.0935	0.1623	0.1724	**0.5738**
Diamond 1	0.0933	0.1620	0.1722	**0.5725**
Jotun 1	0.2325	0.1367	0.2892	**0.3416**
Jotun 2	0.2391	0.1238	0.2737	**0.3636**
Nippon 1	0.2252	0.1075	0.1785	**0.4893**

The ranking is the same for both personalized scale and Saaty's scale however the values are different in both cases.

4.2 Packaging suppliers

The second category of suppliers common in all six paint companies are the ones who provide the packaging material. The second part of this project is to analyze the preference of these suppliers. The pairwise comparison based on seven criteria is used to rank the importance of these four packaging suppliers.

Table 37: Ranking of Packaging suppliers (Personalized scale)

	Rehan cans	Hussain cans	Pioneer cans	Bullehshah packaging
Berger 1	**0.4018**	0.1852	0.1723	0.2407
Dulux 1	**0.3416**	0.2209	0.1691	0.2682
Dulux 2	**0.3100**	0.2109	0.2137	0.2655
Berger 2	**0.3910**	0.1479	0.2084	0.2527
Dulux 3	**0.2990**	0.2320	0.1802	0.2887
Kansai 1	**0.3874**	0.1908	0.1747	0.2472
Kansai 2	**0.3724**	0.2047	0.1777	0.2471
Diamond 1	0.1501	0.2155	0.2556	**0.3787**
Jotun 1	0.2709	0.2134	0.1718	**0.3440**
Jotun 2	0.2755	0.2156	0.1894	**0.3175**
Nippon 1	0.1594	0.2263	0.2514	**0.3630**

Out of the six respondent companies, 3 companies have ranked Rehan cans as the most preferred while the other 3 companies (Jotun, Nippon and Diamond paints) have preferred Bullehshah Packaging. The first 3 companies (Dulux, Berger, Kansai paints) who have preferred Rehan cans have given second preference to Bullehshah Packaging. On the other hand, Jotun paints have given second preference to Rehan cans. However, Nippon and Diamond paints have given second preference to Pioneer cans. These two companies have given least preference to Rehan cans.

The results of Packaging suppliers show that the respondent companies have very different preferences for this category of suppliers. The ranking of packaging suppliers according to Saaty's scale is shown in Table 38.

Table 38: Ranking of packaging suppliers (Saaty's scale)

	Rehan cans	Hussain cans	Pioneer cans	Bullehshah packaging
Berger 1	**2.5634**	0.4623	0.3672	0.8386
Dulux 1	**1.6671**	0.5489	0.2709	0.8148
Dulux 2	**1.3415**	0.3916	0.4088	0.7563
Berger 2	**2.1475**	0.2605	0.5630	0.8424
Dulux 3	**1.0367**	0.5410	0.2109	0.7646
Kansai 1	**2.5291**	0.4513	0.3795	0.8392
Kansai 2	**2.3096**	0.5519	0.3507	0.7975
Diamond 1	0.0195	0.0587	0.0778	**0.2111**
Jotun 1	0.6654	0.3234	0.2298	**0.7929**
Jotun 2	0.6783	0.3260	0.2824	**0.7597**
Nippon 1	0.0247	0.0761	0.0841	**0.2293**

Again, the comparison of Table 37 and 38 shows that the values are different, but the ranking is the same with both the scales.

4.3 Qualitative study

After the analysis of results from quantitative data interview guide was established and few of the respondents were contacted again to get their input on the results. All the interviews started with a summary of the current supplier selection criteria used in the respondent's firm. The interviewees described the formal and informal techniques that are being used in their companies. The multinational companies like Dulux, Jotun, Kansai paints have a very formalized process in which the local company collects all the information related to supplier and the regional team then makes the final decision. The multinational companies have their own set of criteria that has to be fulfilled in order to do business with them. A total of four interviews were conducted from four different companies including AkzoNobel, Kansai paints, Berger paints and Jotun paints. The procurement head at AkzoNobel reported that their company conducts proper interviews with the suppliers and specialized teams visit the supplier plants. The set criteria for supplier selection is evaluated through these visits and interviews and a set of documents including all the legal and technical details is submitted to the regional team to make the final decision. In addition to direct contact with the supplier they also conduct market research and get the feedback of the supplier to make a more informed decision before getting into contract with a particular supplier. As the main aim is not only supplier selection but vendor development is always under consideration at every step of the process so capacity and flexibility of the supplier are mainly considered to check if a particular supplier can be a primary one in near future. Similarly, Jotun paints and Kansai paints also get approval from their regional teams for selecting a particular supplier.

When asked about the parameters being considered in supplier selection, production capacity was pointed out by all the respondents. It is one of the main criteria that is under consideration for supplier selection and vendor development as well. The only respondent who emphasized the importance of financial standing of a particular supplier along with their production capacity was the purchase manager at Jotun paints. Different companies have different ways to assess the capacity of the supplier as it holds utmost importance to make any company the primary supplier. AkzoNobel conducts interviews with suppliers and arranges technical team visits at the supplier plants to assess their capacity. Jotun paints focuses a lot on the financial documents to assess the capacity of the supplier while Berger and Kansai rely on market research to assess production capacity of suppliers.

When asked if the production capacity is a criterion of firm size the respondents agreed that bigger firms do have larger capacity as well. The quantitative study also highlights the production capacity and flexibility to be the top ranked factors of firm size that are considered in supplier selection. The study of literature also emphasizes the importance of this factor and its direct link with firm size. A research paper highlighting export possibility and firm size has discussed how larger firms have more resources to invest in production as compared to smaller firms (Mittelstaedt, Harben, & Ward, 2003). Another paper describes the firm size as the amount and variety of production capacity (Niresh & Thirunavukkarasu, Firm Size and Profitability: A Study of Listed Manufacturing Firms in Sri Lanka, 2014) The production capacity factor gives the idea of financial position of a supplier as quoted by the procurement head at AkzoNobel as he said that availability of finance cannot be checked directly but it can be assessed through plant visits and the analysis of capacity planning. As their technical team visits the supplier's plant so they can better assess the capacity planning of a particular supplier. The purchase manager at Berger also thinks that availability of a certain raw material is the most important factor that has to be fulfilled for supplier selection and only bigger firms have the capacity to fulfill the demands on timely basis as they have invested in their capacity. The purchase manager at Kansai paints also added to this framework by stating the fact that working with market leaders has always been beneficial for them as they hardly ever run short of the required raw materials.

The next top ranked criteria to be studied was of flexibility and inverse relationship is found between flexibility and firm size. Project results indicate that firms often don't stay flexible when they grow. The output fluctuation in any industry is inversely proportional to its size (Fiegenbaum & Karnani, 1991). Small firms usually do not have the resources to achieve economies of scale and hence cannot compete with bigger firms, so the best strategy suited to them is to gain competitive edge in terms of flexibility. As small firms are less structured and bureaucratic so it is convenient for them to produce customized products by showing flexibility in their production plans (Ebben & Johnson, 2005)**.** Larger firms are usually more inclined towards mass production to achieve economies of scale and are therefore controlling the unit cost and offering competitive prices. For this purpose they have invested heavily in their capacity building but on the other hand small firms gain the competitive edge by focusing on manufacturing flexibility (Carlsson, 1989)**.** The procurement head of AkzoNobel also supports the argument that companies want to achieve economies of scale through standardization of products as they grow in size and this reduces their

flexibility. The suppliers can only offer competitive prices if they have the capacity to achieve economies of scale. However, when interviewees were asked if their primary suppliers who are mostly bigger in size are cooperating with them in terms of flexibility, they replied that they hardly ever face any issue regarding flexibility. The purchase manager at Kansai linked flexibility with capacity and pointed out that as the bigger firms have the resources and capacity to fulfill the demand, so they do show flexibility as well. When purchase and planning manager at Berger was asked about the flexibility of a supplier, he responded that our aim is to have bigger firms as our main suppliers and these suppliers always come up with a solution in case of uncertain demand. The respondent believes that production capacity and flexibility are interlinked, and a bigger firm will have higher capacity and will be more flexible as well. However, when asked if bigger firms have standardized operations, they all agreed that they are offering competitive prices as well due to their investment in capacity. The procurement head at AkzoNobel said that in case of bigger supplier firms we have to approach them and convince them to be our primary supplier and negotiate on the terms of contract. Our quantitative study shows that majority of the respondents have highlighted the flexibility factor to be an important one and agree that their primary suppliers are showing flexibility, but the literature shows inverse relationship between size and flexibility. Here the years of relationship with the primary suppliers plays a key role in fulfilling the demand of paint manufacturers. As the bigger firms like Nimir Resins, Rehan Cans and Bullehshah packaging have been working with the manufacturing firms since a long time so this can be the reason that they prioritize the demand of these manufacturers. The paint manufacturers that are being studied in this project are market leaders as well so this could also be the reason that suppliers keep them at the top priority.

When asked about the importance of actual sales figure of suppliers the procurement head pointed out that this is not their primary concern. They do have some financial area to look into when completing the documents for supplier selection process but their main concern is always the management of the company and their capacity because it is highly important that a particular supplier should be able to meet the demand. The availability of finance of a particular supplier cannot be exactly checked according to the procurement head of AkzoNobel but the plant visits and production capacity gives them the idea if a particular supplier will have the finances to fulfill the demand. Only Jotun paints highlighted the importance of financial standing in the market, but the other three interviewees did not consider this factor to be an important one. When purchase

planner at Berger paints was asked if the company considers the availability of finance and actual sales figure of a supplier, the respondent said that we do not evaluate these factors directly but the market reputation gives the idea if a certain supplier has the resources to meet the demand. The manager at Kansai did not deny the importance of financial check in supplier selection and pointed out their supplier selection process does include some financial checks of supplier. This gives them a better understanding of the operations of a supplier and their capacity planning as well.

The procurement head at AkzoNobel also pointed out that bigger supplier always has a strong network in the market, so this is also a deciding factor in supplier selection. The procurement team always gets the feedback from the market before deciding to work with a particular supplier. The purchase planner at Berger paints also pointed out that size, capacity and flexibility all can be evaluated through market research and feedback as bigger firms have a strong network in the market and good reputation as well. Secondly the bigger and stronger network in the market shows that a particular supplier is big enough to cater the market needs and has shown satisfactory performance. Market research is the common term used by all interviewees that shows that network in the market holds significance in supplier selection. The respondents were also asked about the number of employees criteria and it was highlighted that it is directly connected with capacity of supplier firm. This factor is not considered on its own, but it plays an important role in relation to capacity planning.

In the end of each interview the respondents were asked that why Nimir Resins, Rehan Cans and Bullehshah packaging are the top ranked suppliers of the paint industry. All four respondents directly and indirectly mentioned the size factor as the primary one making these suppliers the market leaders. The procurement head at AkzoNobel said that capacity and the management team of these suppliers make them our first choice for the supply of chemical and packaging materials. The respondent at Berger also preferred Nimir resins and Rehan cans as both the companies are major vendors in the industry covering most of the demand. The manager at Kansai paints pointed out that Nimir Resins has also acquired another big chemical supplier in the market and is now in a better position to fulfill the demand of the industry. In case of packaging supplier again Rehan cans has been ranked at top because it is considered market leader and always fulfill the demand as they have higher production capacity. The other top ranked supplier in the market is Bullehshah packaging and according to the purchase and planning manager at Jotun it is better than Rehan cans in terms of production capacity and fulfilling the demand. All these

interviews help us to understand the importance of firm size in supplier selection. Firm size has always been highlighted in literature for years, but the main contribution of this study is to look at firm size from different perspective and that is the reason why these seven factors were studied through quantitative and qualitative research. The interviews with the respondents further validated the significance of these factors and their link with firm size. The interviews showed that firm size is a primary factor in supplier selection and buyers always want to associate with market leaders to avoid risk factor in the supply chain.

4.3 Years of experience and AHP results

Another aspect that is taken into consideration in this study is the years of experience of respondents in the respective companies being included. The main reason for taking this aspect into account was to explore if this factor plays a role in respondent's preferences. As it was observed that one company's managers responses were different from the remaining five companies so we couldn't ignore the factor of experience of respondents. The experience in years of the respondents is shown in the form of a graph in figure 3:

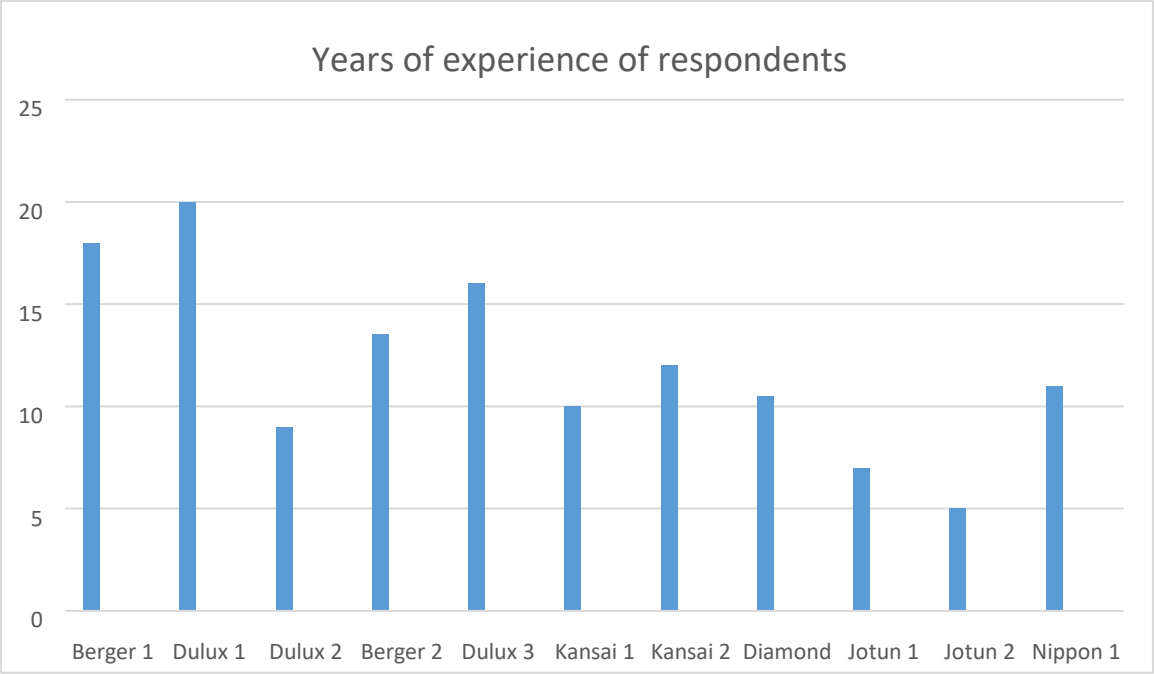

Figure 3: Respondents' years of experience in the firms

If we look at the trend that the two respondents who had different preference level in terms of criteria have less experience in their respective company as compared to the other respondents. The two respondents from Jotun paints have 5 and 7 years of experience in the company while the other 9 respondents mostly have more than 10 years of experience in their companies. The two respondents from Jotun paints have ranked annual sales criteria at the top while the remaining companies preferred production capacity and production flexibility to be the most important.

Now if we look into a few charts generated from google forms to examine the general trend towards annual sales criteria than we can clearly see that this particular criterion is least preferred when compared with any other criteria. The Figure 4 that shows the comparison of annual sales and production capacity clearly shows that majority of the respondents prefer production capacity over annual sales of suppliers. Similarly, availability of finance is also preferred more than annual sales as shown in Figure 5.

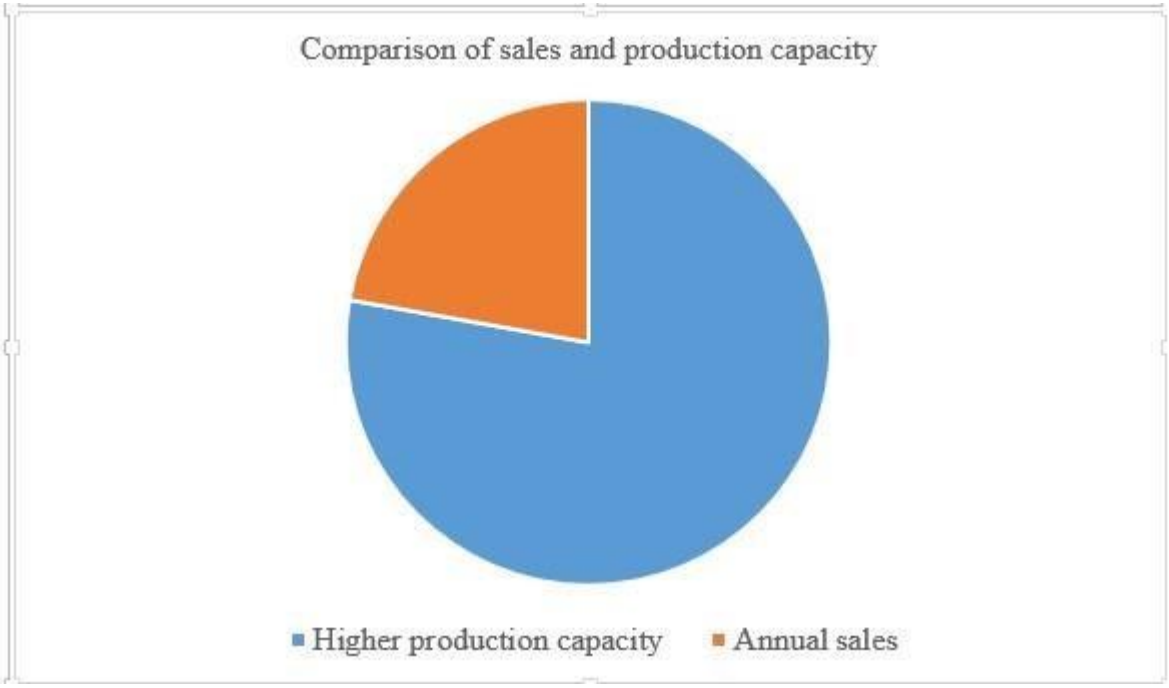

Figure 4: Comparison of Sales and Production Capacity

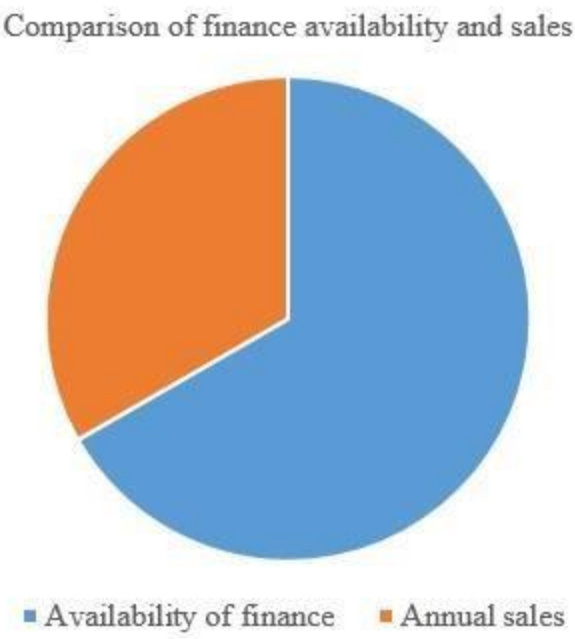

Figure 5: Comparison of Sales and Availability of Finance

However, if we look at Figure 6 that compares annual sales with size asymmetry than we can clearly notice a shift in preferences. Annual sales are more preferred over the size asymmetry factor.

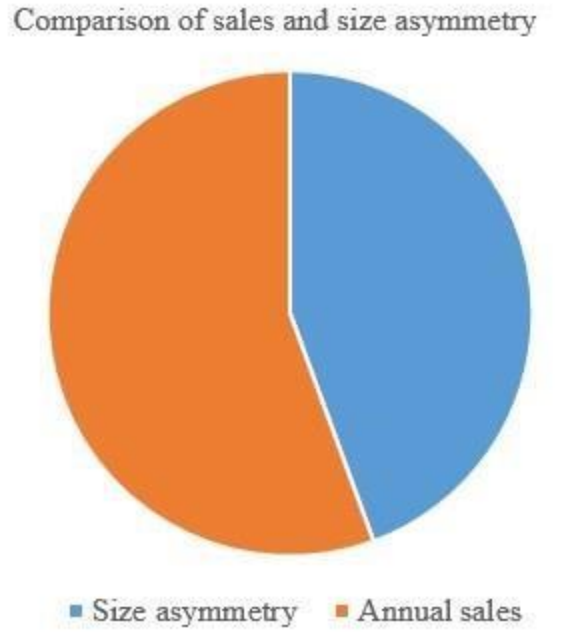

Figure 6: Comparison of Sales and Size Asymmetry

Another comparison where sales are more preferred is when compared with the number of employees (Figure 7). When these two factors are compared the preference towards annual sales is drastic and it can easily be interpreted that respondents do not give much importance to the number of employees factor in supplier selection.

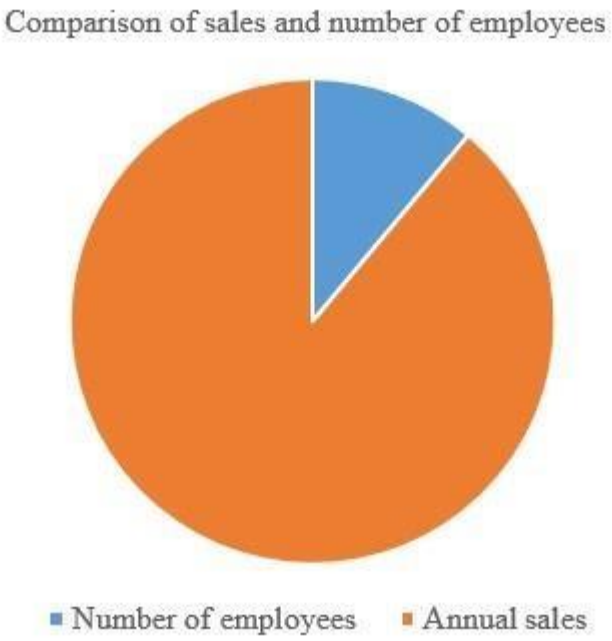

Figure 7: Comparison of Sales and Number of Employees

Figure 8 and 9 show that annual sales are less preferred when compared with production flexibility and networking in the market factor. These charts clearly show that annual sales is overall a less preferred firm size factor and although it has been used repeatedly in literature and by practitioners but this pairwise comparison shows that it is clearly a misconception that annual sales are considered majorly when selecting suppliers.

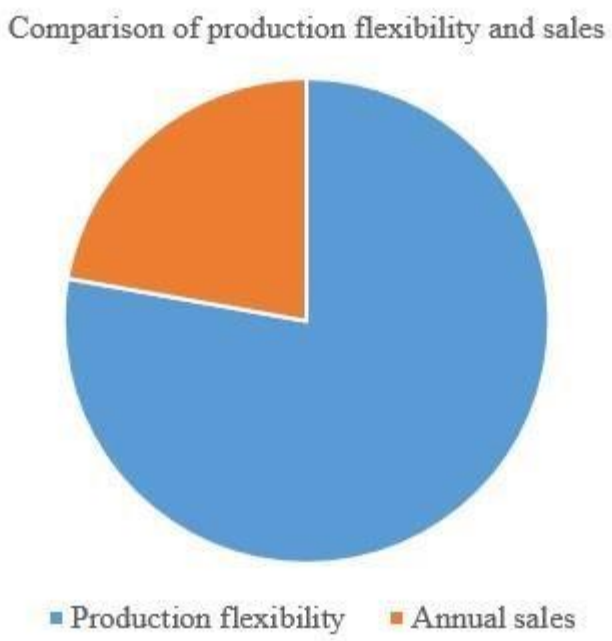

Figure 8: Comparison of Sales and Production Flexibility

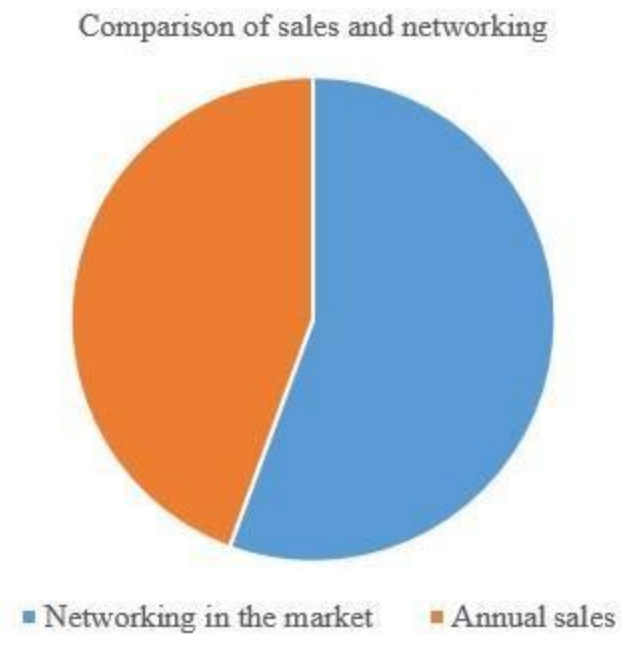

Figure 9: Comparison of Sales and Networking

4.4 Duration of relationship with suppliers

Another aspect that is studied in this project is if the years of relationship impact the respondent's ranking of suppliers. To look into this matter some additional data was collected from the paint companies. The procurement department of the six paint manufacturers were approached after the ranking of suppliers and they were asked for how long have they been working with each chemical and packaging supplier. The reason for collecting this additional information was to analyze if the ranking was only based on the firm size factors prioritized by them or the years of relationship impacts their decision. The information collected from Dulux paints shows that they have been working with Nimir Resins for the longest duration and if packaging suppliers are considered than they have been working with Pioneer cans for the longest time. If we investigate the ranking of suppliers by the three respondents of Dulux paints, then all three respondents have ranked Nimir resins at the top (Table 39). Table 40 shows the years of relationship of Dulux paints with these chemical suppliers. Dulux has been working with Nimir Resins for the longest duration and it has also ranked this supplier at the top and two out of three respondents have ranked Power chemicals at the second number and this supplier has been working with them for around 10 years. It can be interpreted that the number of years of relationship does impact the ranking of suppliers in addition to the firm size factors for Dulux paints.

Table 39: Ranking of chemical suppliers by Dulux paints

	Ranking of chemical suppliers			
	1	2	3	4
Dulux respondent 1	Nimir Resins	Power Chemicals	Enar Petroleum	Grace Chemicals
Dulux respondent 2	Nimir Resins	Power Chemicals	Enar Petroleum	Grace Chemicals
Dulux respondent 3	Nimir Resins	Grace Chemicals	Enar Petroleum	Power Chemicals

Table 40: Years of relationship of Dulux paints with chemical suppliers

Suppliers	Nimir Resins	Power Chemicals	Enar Petroleum	Grace Chemicals
Years of relationship	15 years	10 years	8 years	8 years

Now the next step is to look at the ranking of packaging suppliers and the years of relationship with these suppliers for Dulux paints. The ranking of these suppliers by all three respondents shows that the years of relationship does not impact the prioritization decision. Dulux paints have the longest relationship with Pioneer cans, but this company has been ranked at the 4th number by two of the respondents. However, if we look into the remaining ranking of packaging suppliers there is some relation between ranking and the years of relationship with the suppliers. The supplier that has been ranked at the top has 18 years of relationship with Dulux paints but again for the next two suppliers the trend doesn't follow.

Table 41: Ranking of packaging suppliers by Dulux paints

	Ranking of packaging suppliers			
	1	2	3	4
Dulux respondent 1	Rehan cans	Bullehshah Packaging	Hussain cans	Pioneer cans
Dulux respondent 2	Rehan cans	Bullehshah Packaging	Pioneer cans	Hussain cans
Dulux respondent 3	Rehan cans	Bullehshah Packaging	Hussain cans	Pioneer cans

Table 42: Years of relationship of Dulux paints with packaging suppliers

Suppliers	Pioneer cans	Rehan cans	Hussain cans	Bullehshah packaging
Years of relationship	20 years	18 years	13 years	9 years

Next, we will look at the trends for the two respondents of Berger paints. Table 43 shows the ranking of chemical suppliers by the two respondents and Table 44 shows the years of relationship with these suppliers for Berger paints.

Table 43: Ranking of chemical suppliers by Berger paints

	Ranking of chemical suppliers			
	1	2	3	4
Berger respondent 1	Nimir resins	Enar Petroleum	Grace chemicals	Power Chemicals
Berger respondent 2	Nimir resins	Enar Petroleum	Grace chemicals	Power Chemicals

Table 44: Years of relationship of Berger paints with chemical suppliers

Suppliers	Nimir Resins	Enar Petroleum	Power Chemicals	Grace Chemicals
Years of relationship	20 years	15 years	10 years	7 years

Again if we look at the trends summarized in the two tables 43 and 44 we can see that the top ranked supplier is the one with the longest duration of relationship and even for the supplier ranked at the second number the trend is the same. However, for the next two suppliers ranking the years of relationship does not show any link. Next, we will look at the ranking of packaging suppliers and the years of relationship with these suppliers. The comparison of the two tables 45 and 46 shows that the ranking of first two suppliers shows the link with the number of years but again the trend does not follow for the next two suppliers. Hussain cans has very little business with Berger paints but still one of the two respondents is ranking it at the 3rd number.

Table 45: Ranking of packaging suppliers by Berger paints

	Ranking of packaging suppliers			
	1	2	3	4
Berger respondent 1	Rehan cans	Bullehshah packaging	Hussain cans	Pioneer cans
Berger respondent 2	Rehan cans	Bullehshah packaging	Pioneer cans	Hussain cans

Table 46: Years of relationship of Berger paints with packaging suppliers

Suppliers	Rehan cans	Bullehshah packaging	Pioneer cans	Hussain cans
Years of relationship	15 years	10 years	10 years	5 years (very little business)

The next company that provided us with the data for years of relationship with suppliers is Kansai paints. The ranking of the chemical suppliers for this company is given in Table 47 and Table 48 shows the years of relationship. For this company the top two ranked companies have the longest duration of relationship however for the next two rankings both the respondents have preferred Grace chemicals over Power chemicals but the relationship trend shows that Kansai paints have been working with Grace chemicals for 6 years whereas they have been working with Power chemicals for around 10 years.

Table 47: Ranking of chemical suppliers by Kansai paints

	Ranking of chemical suppliers			
	1	2	3	4
Kansai respondent 1	Nimir resins	Enar petroleum	Grace chemicals	Power chemicals
Kansai respondent 2	Nimir resins	Enar petroleum	Grace chemicals	Power chemicals

Table 48: Years of relationship of Kansai paints with chemical suppliers

Suppliers	Nimir Resins	Enar Petroleum	Power Chemicals	Grace Chemicals
Years of relationship	13 years	9 years	10 years	6 years

After looking at the trends for chemical suppliers we next examine the trends for packaging suppliers in Table 49 and 50. Again the link between years of relationship holds true for the top two companies with the longest duration of relationship but for the next two companies no link can be seen.

Table 49: Ranking of packaging suppliers by Kansai paints

	Ranking of packaging suppliers			
	1	2	3	4
Kansai respondent 1	Rehan cans	Bullehshah packaging	Hussain cans	Pioneer cans
Kansai respondent 2	Rehan cans	Bullehshah packaging	Hussain cans	Pioneer cans

Table 50: Years of relationship of Kansai with packaging suppliers

Suppliers	Rehan cans	Bullehshah packaging	Pioneer cans	Hussain cans
Years of relationship	12 years	10 years	7 years	9 years

When the ranking of chemical suppliers by Diamond paints is compared with the years of relationship, they have with the suppliers than the link can be seen for the top two ranked suppliers. However, there is a difference when the 3rd and 4th ranked supplier are considered as they have 10 years of relationship with Power chemicals and 7 years of relationship with Grace chemicals. The respondent has ranked Power chemicals at the fourth number while Grace chemicals at the third rank. The comparison of the trends is shown in Table 51 and 52.

Table 51: Ranking of chemical suppliers by Diamond paints

	Ranking of chemical suppliers			
	1	2	3	4
Diamond respondent	Nimir resins	Enar petroleum	Grace chemicals	Power chemicals

Table 52: Years of relationship of Diamond paints with chemical suppliers

Suppliers	Nimir Resins	Enar Petroleum	Power Chemicals	Grace Chemicals
Years of relationship	19 years	16 years	10 years	7 years

There is no link for years of relationship of packaging suppliers and their ranking done by the respondent of Diamond paints. Diamond paints has been working with Pioneer cans for the longest duration of 21 years, but they have ranked this supplier at the second number. Next, they have the longest relationship with Rehan cans for 18 years whereas this supplier has been ranked fourth. The supplier that has 12 years of relationship with them is top ranked while Hussain cans who has been ranked at the third number has 9 years of relationship with them. All these ranking trends for packaging suppliers of Diamond paints that it is clearly based on firm size factors and not on the years of relationship.

Table 53: Ranking of packaging suppliers by Diamond paints

	Ranking of packaging suppliers			
	1	2	3	4
Diamond respondent	Bullehshah packaging	Pioneer cans	Hussain cans	Rehan cans

Table 54: Years of relationship of Diamond with packaging suppliers

Suppliers	Rehan cans	Bullehshah packaging	Pioneer cans	Hussain cans
Years of relationship	18 years	12 years	21 years	9 years

The ranking for Nippon paint shows that the entire ranking of chemical suppliers is in accordance to the years of relationship with these companies. So, it can be interpreted that for this paint company there is a link between ranking of suppliers and the years of the relationship with them.

Table 55: Ranking of chemical suppliers by Nippon paints

	Ranking of chemical suppliers			
	1	2	3	4
Nippon respondent	Nimir resins	Power chemicals	Enar petroleum	Grace chemicals

Table 56: Years of relationship of Nippon paints with chemical suppliers

Suppliers	Nimir Resins	Enar Petroleum	Power Chemicals	Grace Chemicals
Years of relationship	12 years	10 years	10 years	7 years

However, if we look at the trends for packaging suppliers in Table 38 and 39 the complete link cannot be seen between years of relationship and supplier's ranking. Bullehshah packaging and Hussain cans have been working with Nippon paints for equal number of years (9 years) but the respondent has ranked one of these on the top rank and the other one on 3rd number. At the same time Rehan cans that has the longest duration of relationship is ranked at the 4th number.

Table 57: Ranking of packaging suppliers by Nippon paints

	Ranking of packaging suppliers			
	1	2	3	4
Nippon respondent	Bullehshah packaging	Pioneer cans	Hussain cans	Rehan cans

Table 58: Years of relationship of Nippon with packaging suppliers

Suppliers	Rehan cans	Bullehshah packaging	Pioneer cans	Hussain cans
Years of relationship	11 years	9 years	7 years	9 years

The last company in our analysis is Jotun paints that shows a slight link of ranking with the years of relationship. They have the longest relationship with Nimir resins and have also ranked this supplier at the top. The second and third ranking is different for the respondents however it does have a link with the years of relationship. Grace chemicals has only 8 years of relationship with Jotun paints and they have been ranked at the fourth number. So, the trend shows a link in years of relationship and the ranking of suppliers as shown in Table 59 and 60.

Table 59: Ranking of chemical suppliers by Jotun paints

	Ranking of chemical suppliers			
	1	2	3	4
Jotun respondent 1	Nimir resins	Power chemicals	Enar petroleum	Grace chemicals
Jotun respondent 2	Nimir resins	Enar petroleum	Power chemicals	Grace chemicals

Table 60: Years of relationship of Jotun paints with chemical suppliers

Suppliers	Nimir Resins	Enar Petroleum	Power Chemicals	Grace Chemicals
Years of relationship	18 years	15 years	9 years	8 years

Rehan cans has the longest relationship with Jotun paints and it has been ranked at the second number by the two respondents. Bullehshah packaging has 10 years of relationship with them and has been ranked at the top. Again, for the next two suppliers the trend doesn't follow with Hussain cans having 10 years of relationship with Jotun and ranked at 3rd number while Pioneer cans having 18 years of relationship but ranked at 4th number.

Table 61: Ranking of packaging suppliers by Jotun paints

	Ranking of packaging suppliers			
	1	2	3	4
Jotun respondent 1	Bullehshah packaging	Rehan cans	Hussain cans	Pioneer cans
Jotun respondent 2	Bullehshah packaging	Rehan cans	Hussain cans	Pioneer cans

Table 62: Years of relationship of Jotun with packaging suppliers

Suppliers	Rehan cans	Bullehshah packaging	Pioneer cans	Hussain cans
Years of relationship	15 years	10 years	18 years	10 years

The reason for adding this to the analysis part of the project was to make sure if the respondents were actually taking into consideration the firm size criteria into account or they were just ranking the suppliers based on their strong ties built with them over the years. The overall trend for all six respondent companies shows that the years of relationship does impact the ranking of suppliers but there has been different rankings as well which clearly shows that firm size factors other than the years of relationship is playing a major role in the ranking process.

CHAPTER 5: CONCLUSION

5.1 Discussion

This project was focused on supplier selection and evaluation criteria as the importance of this function in the supply chain management cannot be ignored. This area has been studied and practiced since a long time from many different aspects, however the criteria for supplier selection and evaluation varies from one company to another. Many different sets of criteria have been used by researcher and practitioners and many different tools and methods have been identified for using these criteria to select the best suppliers for the company. In this study the main aim was to find out the underlying subjective determinants of firm size that are not documented in the company's policy of supplier selection, but the procurement managers and their teams are taking these into consideration. Whenever firm size is discussed in literature or by managers working in a practical setting it is mostly taken into consideration in quantitative terms like number of employees and annual sales. In this study we have explored the firm size determinants while considering some subjective prospects as well. Through the study of literature and brainstorming sessions a gap was identified, and seven factors were shortlisted that were most relevant to firm size. The two main determinants of sales and number of employees were also added because we wanted to be sure if the companies were only considering these two objective terms or they are taking into consideration some subjective criteria.

As the AHP method assists in group decision making when subjective criteria is involved so this method was chosen to design the questionnaire. The main aim was to identify the ranking of criteria that procurement managers are unconsciously considering while selecting the suppliers. AHP method was used for its relevance to the project being conducted and for its simplicity and less cumbersome mathematical modeling involved. This tool does not only help in the ranking of criteria being selected but also helps in ranking of alternatives, which in our case is the list of chemical and packaging suppliers. The AHP hierarchy model helps practitioners to divide the complex task into simpler steps and makes it easy to comprehend the results being generated. Multiple respondents can be involved through AHP tool application and their subjective judgments can easily be considered to reach a consensus. This simplified model of group decision making can be practiced for a single company and for the overall industry as well. In the case of this project we have used this tool to analyze the firm size factors for the paint industry and we have also ranked the alternatives to help the industry in better decision making in the future.

In addition to the criteria identification and AHP method being used for ranking of these criteria and alternatives we have also conducted a qualitative study where some of the respondents were contacted again and brief semi structured interviews were planned. The aim of the qualitative study was to get the feedback on the results generated and discuss if the factors used in this project hold any credibility in actual supplier selection process in these companies. The purpose of using mixed method study was to understand if there is any contradiction between quantitative and qualitative findings. The respondent's point of view was important to ensure that ground realities are supporting the findings of this study. As the main aim was to understand the impact of firm size in supplier selection so it was important to take into consideration the experience of the respondents to ensure that they do agree with the listed criteria of firm size.

As supplier selection involves both quantitative and qualitative factors so respondents' detailed feedback was required to better understand the factors used in this project . The main purpose of this qualitative study was to evaluate the top ranked factors and practically assess if they are linked with firm size and if they hold any significance in supplier selection. AHP method used in this project is a very widely used Multi criteria decision making method but its purpose is not served by only ranking the criteria and choosing the best alternative. The theoretical and practical implications should be further studied to validate the project conducted. The quantitative study has helped to rank the criteria, but the real-world application of this criteria could only be understood by qualitative study.

Some additional aspects have also been considered in our project. The years of experience of respondents which has proved to be a critical factor was studied in detail to analyze the results being generated. The years of experience shows that with experience the ranking of criteria changes for the respondents. The respondents who have longer duration of experience are ranking the criteria differently as compared to the respondents who have less experience in the business. So it can be interpreted that with the growing experience the practitioners gain more insight into the relative importance of these firm size factors. The respondents who had minimum years of experience have only ranked the objective factor of annual sales at the top and have not given much importance to the subjective criteria. In addition to the years of experience the years of relationship with the suppliers has also been considered in our project. The trends were observed for each respondent company and it was noted that years of relationship does impact the ranking but only

to an extent. This helps us to conclude that the ranking of suppliers by respondents was mainly done while considering the firm size factors.

5.2 Academic contribution

Supplier selection, development and evaluation has been studied for decades now but this project highlights some key areas of firm size of suppliers that have not been explored earlier. The project contributes to the current literature on the paint industry of Pakistan as limited work has been done in this area despite the growing trend towards construction and renovation. Numerous criteria and sub criteria for supplier selection and evaluation have been discussed but according to the gap identified in this project the firm size factors still need to be explored. Supplier selection criteria is mostly discussed overall in terms of quality, cost, delivery, etc. but the focus of this project was to design a framework mainly based on firm size of suppliers. It has been observed that the size of suppliers and buyers play a major role in their relationship dynamics, so the main focus of this project was to identify these underlying factors of firm size. Previously firm size has only been taken into account in terms of quantitative terms of sales and number of employees but this criteria is very simple and straightforward and does not take into account a number of underlying subjective factors that majorly impacts decision making by procurement managers. Other than sales and number of employees the five other factors that have been used in this project are subjective in nature and cannot be quantified. The results generated through this study clearly shows that firm size factors were been ignored previously. The two firm size factors of production capacity and flexibility that has been most preferred by practitioners shows that annual sales and number of employees have very less importance when firm size is being considered. These objective terms are very simple and uncomplicated and are directly relevant when firm size factor is being considered however deeper analysis of firm size shows that other critical factors are way more important. This project adds to the existing body of literature a number of firm size factors that have not been used previously in any field or areas of project.

5.3 Practical implications to practitioners

The results of this project will expand the scope of supplier selection and evaluation techniques for the procurement departments of various industries. Although the ranking may differ from one industry to another however the criteria that are highlighted through this project will help managers in better supplier selection. The analytic hierarchy process used in this project will help procurement managers in the paint sector to have insights into the firm size of suppliers while

selecting the most suitable one for their firm. The managers can use the framework to easily rank the criterion and eventually prioritize their suppliers based on the given criteria. The hierarchy developed through AHP will help practitioners to categorize their supplier selection problem into simpler steps. The model is not restricted to the paint industry but can be used in other manufacturing sectors as well.

The aim of this project was to consider the most critical deciding firm size factors that can affect the sourcing decision. The AHP framework given in this project is quite simple to follow for practitioners and is less time taking to adopt. The model proposed in the project can easily overcome the vagueness of thinking style and can help in group decision making. The criteria identified can help in overcoming the subjective preferences of the decision makers in the procurement department of not only the paint industry, but these factors can also be used in other industries when firm size is under consideration. In terms of methodological contribution this project has developed an instrument that can be used by buyer firms to categorize their suppliers based on critical firm size factors. The criteria that have been identified in this project are not restricted to be used in AHP model but can be used in other methods of supplier selection and evaluation. Our results have also added one more aspect that is often ignored by managers and that is the years of experience of managers in the company. As our result shows that trends of ranking of firm size factors changes with the years of experience so practitioners can also take this aspect into account in future while selecting and evaluating their suppliers.

5.4 Limitations and future project

One of the limitations of this project is the use of limited respondents from each company. Although we contacted the top management in the procurement department of each company and usually the procurement department of these paint manufacturer companies had limited employees but still the results could vary a little if more respondents were added in the study. The lower level managers were not involved however for some other industry the scope of the study can be expanded by adding more hierarchy levels in the procurement department. The results may vary if the lower level managers had to rank the criteria and suppliers, so future project can be extended in this regard. The framework proposed in this project could be used in other industries as well to see if the respondents in other sectors have the same ranking of the firm size factors. Some other industry might not consider all these factors while selecting their suppliers and might reject one or more factors while finding them irrelevant in their industry. Another further aspect is that the firm

size factors proposed in this project can be used to select and evaluate supplier while using some other tool other than AHP. The results may be different if this aspect of the study is explored.

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