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**SUPPLIER PRE-SELECTION FRAMEWORK : A CRITERIA TO EVALUATE  
SUPPLIERS IN EARLY STAGE**

A Thesis in

Industrial Engineering

by

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## ABSTRACT

Organizations are being forced to evaluate and improve their purchasing practices as supply chain management (SCM) becomes more important. COVID-19 has disrupted global supply systems, resulting in production and distribution halts and closures. The pandemic triggered an unprecedented wave of consumption shock around the globe, upending long-held consumer norms. After the lengthy and exhausting supplier selection process failed, original equipment manufacturers (OEMs) had to rethink their tactics for bringing new goods to market. The process by which OEMs locate, analyze, and contract with suppliers is known as supplier selection. The supplier selection process deploys an enormous amount of a firm's financial resources and plays crucial role for the success of any product. There are many different analytical approaches to supplier selection criteria and procedures in the literature. By merging multiple types of selection approaches, some researchers have created hybrid models. However, these strategies may only be employed in practice if the information provided by competing suppliers is thorough and accurate.

The purpose of this study is to propose a new supplier selection methodology for original equipment manufacturers (OEMs) that will result in effective supplier nomination for bidding processes by utilizing data gained from supplier pre-selection (SPS) processes. For this methodology, we propose the supplier pre-selection (SPS) framework that includes 62 evaluation criterion in 7 major areas; supplier management strategy, design and development strategy, innovation capability, sub supplier management, production strategy, quality system and logistics, and we explain how the SPS framework is applied to a real supply chain. The methodology is developed to identify and pre-qualify new suppliers with the objective of extending the portfolio of suppliers for existing products or new product introductions to the agreed circle of bidders. SPS is the first performance and competence evaluation of new suppliers, it is a standardized procedure

which is complete with regard to content for the selection strategy of new suppliers and avoids any additional outlay for nominated suppliers who do not comply with the requirements. The SPS framework assigns a qualitative or a quantitative grade to all the 62-evaluation criteria to derive a holistic supplier rating and robust comparison between competing suppliers. The SPS framework was implemented at German auto manufacturer (GAM) by the author; at the end of the study a GAM purchasing manager and author compares existing model with the SPS framework to validate efficacy.

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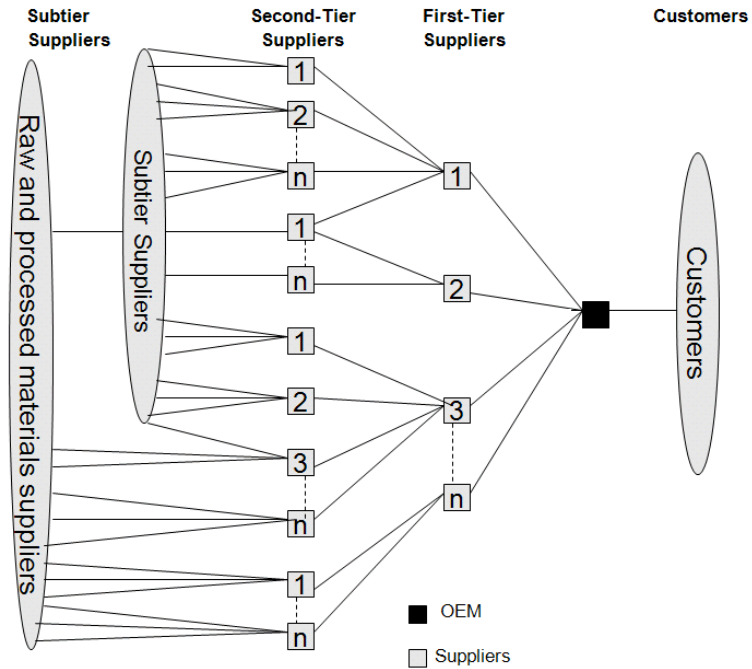
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## **Chapter 1**

### **Introduction, Objective and Motivation**

A supply chain consists of a connected set of activities concerned with planning, coordinating and controlling materials, parts and finished good from supplier to customer [1]. The objective of any supply chain is to maximize the overall value generated. The value a supply chain generates is the difference between what the final product is worth to the customer and the effort the supply chain expends in filling the customer's request [1]. The majority of OEMs are structured as networks of production and distribution facilities that buy raw materials, develop them into intermediate and final goods, and then deliver those items to customers. A typical structure of the supply chain of an OEM is illustrated in Figure 1.

In the majority of the cases value is directly proportional to the supply chain profitability, the difference between the revenue generated and the cost across the supply chain. In the past decades, the concept of supply chain management and strategic sourcing was one of the fastest growing area of management [2].



**Figure 1 Typical structure of the supply chain of an OEM [3]**

The short-term objective of SCM is primarily to increase productivity and reduce the entire inventory and the total cycle time, while the long-term objective is to increase customer satisfaction, market share, and profits for all organizations in the supply chain: suppliers, manufacturers, distribution centers (DCs), and customers [1].

### **Motivation**

The devastating effects of the COVID-19 pandemic have wreaked havoc on global supply chains. During the height of the COVID-19 shutdown, I had the opportunity to work for a renowned German auto manufacturer I got a firsthand look at how complicated supply chains work and how poor supplier selection decisions affect the OEM's operational and financial efficiency.

There are inherent risks in supplier selection process, but during the Covid-19 pandemic these risks peaked as the transparency and trust decreased as the world moved towards virtual bidding and nomination process. Supplier delivery, quality performance problems and lack of experienced labor caused profoundly negative impact on OEM's. For example, after 95 years as supplier of the Ford Motor Company, Firestone severed its relationship with Ford in May of 2001 following Ford's announcement that it would launch a \$3 Billion recall to replace an additional 10 to 13 million defective Firestone tires beyond the original tire recalls started in the summer of 2000. Ford's quality ratings as reported by J.D. Power and Associates sank to last place among the world's seven largest automakers during 2001 [4]. In addition to the quality problems, the product launch of the redesigned 2002 Ford Explorer was delayed due to quality concerns, costing Ford by some estimates over \$1 Billion in revenue due to the delays in the delivery of new products [4].

In many industries, cost of purchasing raw material and component parts from suppliers constitutes a major percentage of total expense. For manufacturing firms, raw material cost can account for 40%-60% of the production cost. According to the report by [5], cost of purchasing raw materials and services can occupy up to 80% of the total product cost. Furthermore, there is an unrelenting rise in the cost of many raw materials in recent years and disruption of logistics due to uneven demand around the world has cut the corporate profits. Therefore, sourcing decisions

including identification, evaluation and management of the right suppliers become critical for OEM's to maintain the product quality and customer as well as controlling cost.

How do you identify a new supplier, especially in the current environment with COVID-19 dominating many aspects of our lives and business? Under these circumstances, detailed and correct information about suppliers before nomination becomes very critical to take decision of supplier selection for new products.

## **Problem Statement**

In this thesis, we address the issue of supplier selection in current times, when there are many suppliers and the purchasing cycle is reduced due to the increased demand for new technological goods in the automobile industry. To filter the most suitable providers from a given group of suppliers for a new project, we advocate including a supplier pre-selection (SPS) assessment criterion into the existing supplier selection process. The supplier selection problem is fundamentally a multi-criterion problem; all of the criteria are reviewed, and the justification for each is assessed using academic research and industry specialists. The SPS assessment is qualitative as well as quantitative.

## **Thesis Outline**

The thesis is organized as follows: Chapter 2 consists of the literature review of the supply chain concept, strategic purchasing and supplier selection criteria. Chapter 3 introduces the supplier pre-selection framework and each area is discussed in detailed. Chapter 4 compares the existing model and SPS framework on timeline, nomination and supplier selection, small case studies are mentioned for each . Chapter 5 consists of conclusions and directions for future research.

## Chapter 2

### Literature Review

Supply chain can notably be different from one business to another one. The difference between the old model of supply chain and today's model is that companies have moved away from slow-moving vertical integration where the flows of products, materials and money moved only in one direction [6]. Today's market necessitates quick responses and a great deal of flexibility in movement across the network and among all participants. It might be a highly sophisticated, multi-layered, worldwide network with a wide range of business partners.

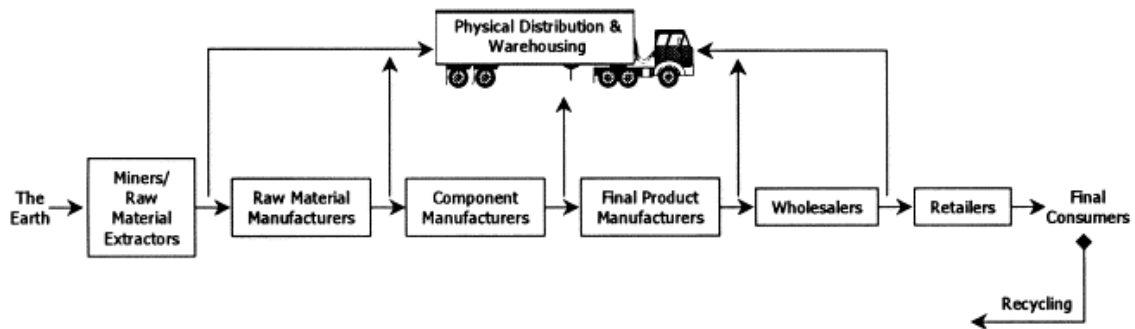
There is complex and perplexing jargon abound in supply chain management literature, such as: integrated purchasing strategy, integrated logistics, supplier integration, buyer-supplier partnerships, supply base management, strategic supplier alliances, supply chain synchronization and supply chain management, to address elements or stages of supply chain management philosophy( [7]; [8]; [9]). While each terminology addresses elements of the phenomenon, typically focusing on immediate suppliers of an organization, supply chain management is the most widely used (but abused) term to describe this philosophy. Unfortunately, there is no explicit description of supply chain management or its activities in the literature [8]. For example, [10] describes supply chain management as managing business activities and relationships with;

1. internally within an organization,
2. with immediate suppliers,
3. with first and second-tier suppliers and customers along the supply chain, and
4. with the entire supply chain.

( [11]) and [8] describe supply chain management as the chain linking each element of the manufacturing and supply process from raw materials through to the end user, encompassing

several organizational boundaries. Supply chain management, by this broad definition, spans the complete value chain and includes materials and supply management from the extraction of raw materials to the end of their useful life.

Figure 1.2 shows the activities and firms involve in such a value chain as portrayed by [8]. It originates with the extraction of raw materials or minerals from the ground and continues through manufacturers, distributors, retailers, and end users. When applicable, supply chain management also includes product or material recycling or re-use. All organizations in the value chain appear to be treated as a single unified 'virtual business' entity by supply chain management. Planning, product design and development, sourcing, production, fabrication, assembly, transportation, warehousing, distribution, and post-delivery customer care are all part of this process.



**Figure 2 Activities and entities in a supply chain. [12]**

While this definition of supply chain management covers the management of supply processes throughout the value chain in theory, a practical approach to supply chain management is to strategically build partnerships with key suppliers/entities in the value chain in order to leverage expertise and knowledge to generate value for customers and partners. To gain the benefits of supply chain management, the value chain is technically too complicated to accomplish full integration of all corporate units within it. As a result, a second, more limited definition of supply



chain management emerges: the integration of the various functional areas/departments within an organization to enhance the flow of goods from immediate strategic suppliers/entities through manufacturing and distribution chain to the end user [13].

In true sense the concept of supply chain was summarized by [14] when she stated that the philosophy of supply chain management extends the concept of partnerships into a multiple firm effort to manage the total flow of goods inventory from the supplier to the ultimate consumer. Instead of fragmented groupings, the chain is seen as a whole, a single unit that performs its own purpose. A number of academics have supported the significance of "partnership" within the supply chain. For instance, [15] emphasize the necessity of partnering with suppliers to strengthen supply chains. And [16] the value of partnerships in supply chain management cannot be overstated. And [17] strongly implies that partnerships are necessary for a lean supply process.

However, as the supply chain management idea grew in popularity in both the business world and academia, particular implications for purchasing began to emerge. [18] provided a conceptual model of the purchasing process in the supply chain. They argued that strategic purchasing is the most important link in the supply chain's management hierarchy. The point being made is that purchasing should indeed play a significant role in supply chain management.

## **Strategic Purchasing**

The term "strategic purchasing" was coined based on actual evidence by [19] by means of a literature review and empirical research, they found three factors to be indicators of strategic purchasing:

1. the purchasing function has a formally written long-range plan,
2. purchasing's long-range plan is reviewed and adjusted to match changes in the company's strategic plans on a regular basis,
3. purchasing's long-range plan includes the kinds of materials or services to be purchased.

The purpose of strategic purchasing, according to this definition, is to guide all purchasing efforts toward opportunities that are consistent with the firm's capacities to fulfill its long-term goals. This strategic purchasing viewpoint is in line with the general strategy literature. One of the most widely used definitions of strategy is [20] states that strategy is the plan that integrates an organization's major goals, policies, and action sequences into a cohesive whole. In the 1980s, the concept of strategic purchasing began to take shape. Historically, however, top management has viewed purchasing as a support function in the business [21]. Both scholars and management were paying significantly greater attention to strategic purchasing by the 1990s. The purchasing procedure was tied to company strategy planning, according to articles authored [22].

This significant link between purchasing strategy and organizational strategy is demonstrated in the following example. Heparin is an important ingredient in dialysis products and drugs that thin the blood and avoid blood clots during surgery. Heparin has lately been linked to four deaths in the United States and 350 adverse reactions in patients who received heparin from Baxter International. Surprisingly, China produces more than half of the world's heparin. The necessity to control sourcing responsibility has been underlined by recent deaths. Pulp taken from

pig intestines, which is then heated in enormous vats, is one of the major elements in the heparin manufacturing process. This essential component is commonly acquired from small, poorly regulated Chinese companies. For example, one Chinese firm, Yuan Intestine and Casing Factory, also manufactures sausage casings. Baxter buys its heparin from Scientific Protein. Scientific Protein's president claims that tracing sources in China is more difficult than in the United States. The example demonstrates the significance of supplier selection and its impact throughout the entire supply chain, from raw materials to completed goods. This case demonstrates how gaps in purchasing strategy can harm a company's reputation [23].

A strategic decision is concerned with supply chain design and has a long-term impact on the performance of a company. These situations typically encompass a long-term horizon and a high level of uncertainty. Therefore, when components represent the largest cost of the main product or provide product differentiation, then the supplier selection becomes a strategic decision. According to [24], studies show that when sourcing strategic components, it is less important to consider geographical boundaries than strategic issues. Some examples of strategic issues are supplier's culture, capabilities, reputation, position in the sector, and management skills. [25] pointed out that "Soft non-quantifiable selection criteria, such as supplier's strategic commitment to a buyer, have a greater impact on performance than hard quantifiable criteria".

Literature on strategic purchasing consists of mainly qualitative tools. For instance, [26] suggested that purchasing strategy is influenced by two strategic choices. The first concerns the supplier markets to enter and second is the level at which the organization decides to buy a product. [27] presented a conceptual framework to examine the effects of purchasing strategy, which encourages competition between suppliers. [28] developed a framework for understanding long-term seller-buyer relationship. He concluded that traditional relationships are no longer sufficient and more collaborative approaches were needed. He suggested that supplier base needs to be

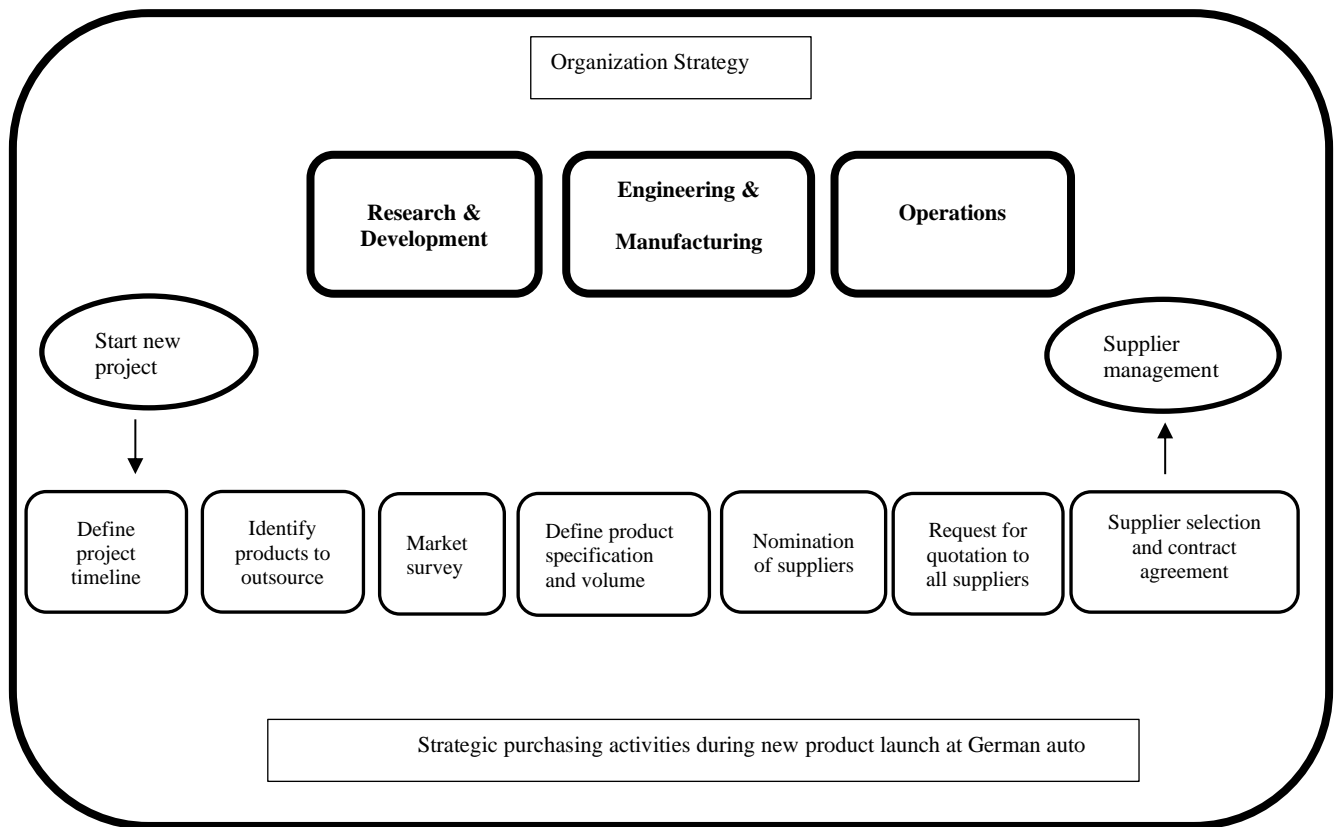
reduced and supplier input should be taken early in the design process. [29] examined the issue of long-term supplier selection through a combination of case studies and literature review. She also developed four factors that should be considered in strategic supplier selection. [30] developed a matrix model which weighs supplier selection based on pre-determined benchmarks. The benchmarks reduced the subjectivity of supplier rating on each factor. [31] presented a set of comprehensive and configurable metrics for supplier selection which take into account product type, supplier type and the level of integration.

In today's global market it is impossible to successfully produce high quality products without good suppliers. Formation of strategic supplier relationships requires time, resource and information sharing. Strategic purchasing, if carried out properly, can be very effective for developing new technologies and products, reducing supply risk and remaining competitive. For the products and services critical for the projects the top management has to be involved in making supplier selection decisions. The purchasing group conducts crucial tasks to guarantee that the company gets the most out of its money. Supplier identification and selection, purchasing, negotiation, and contracting, supply market research, supplier measurement and improvement, and the development of purchasing systems are some of the important tasks that must be performed. Purchasing referred by a purchasing manager at German automotive company as doing "the five rights": getting the right quality, in the right quantity, at the right time, for the right price, from the right source.

To supporting these 5 requirements purchasing teams has to do the following:

1. Buy products and services at the right price
2. Buy them from the right source
3. Buy them at the right specification that meets customer's needs.
4. Buy them in the right quantity
5. Deliver at the right time
6. Deliver to the right internal/external customer

Procurement activity can be divided into many steps; Figure 1.2 gives an overview of the outsourcing process;



**Figure 3 Activities of purchasing department at German auto manufacturer**

## **Supplier Selection**

The supplier selection is one of the most important decision-making issues in supply chain management field. The selecting process is critical for enhancing the company's competitiveness and requires the assessment of different alternative suppliers based on different criteria [32]. According to [33] one of the most crucial components in SCM is supplier selection; it is a multiple criteria decision making (MCDM) problem which involves both qualitative and quantitative criteria. A suitable supplier selection would reduce purchasing costs, improve profits, decrease product lead time, grow the customer satisfaction, and strengthen the competitiveness [34]. That is why it has become an essential focus for every purchasing organization, but there is no any standard for supplier selection, and it should be applied based on the situation. Whereas a wrong choice can lead the supply chain to suffer losses, and this would directly affect the performance of the company [34]. In fact, it is always difficult to choose the right supplier for purchasing managers, especially today, that the needs of supplier selection criteria are changing.

According to [35], the goal of a good supplier selection is to find the appropriate supplier who can provide the buyer with the right quality products or services at the right price, in the right quantities at the right time. It is difficult to follow the same strategy, while facing different financial status and reputation among its customers even by producing product of same specifications and quality. That is why many firms prefer to pay more money, put more effort and time to ameliorate the purchasing process, valuate in advance suppliers and all possible risks. In addition, in different firms the actual supplier selection can run in a different way [36]. While for some product it can be a simple record of actions where every step of the formal process may not be required, for another

product it can change into a highly complex framework where every step is regulated by professionals [37].

According to [38], when the quotations are received from the potential suppliers, a preliminary technical and commercial evaluation should be done by the purchasing department in order to weight the technical, logistics, quality, financial, and legal aspects. In addition, the offered price can be compared between the suppliers but the more important is to look at the total cost of ownership instead of at the prices itself.

The buyer starts the supplier evaluation process by identifying the “dimensions” it wishes to use when evaluating suppliers. [39] surveyed seventy-six papers on supplier selection in the purchasing literature and found that price, quality, and delivery were the most commonly listed supplier evaluation dimensions. [39] provides an extensive list of such dimensions, categorized by prevalence in the purchasing literature. Frequently appearing dimensions include:

- Production capacity and flexibility
- Technical capabilities and support
- Information and communication systems
- Financial status
- Innovation and R&D

Dimensions that appear with moderate frequency in the literature include quality systems, management and organization, personnel training and development, performance history, geological location, reputation and references, packaging and handling ability, amount of past business, warranties and claim policies, procedural compliance, attitude and

strategic fit, labor relations record, and desire for business [40] Of course, buyers often use new dimensions in order to respond to actual's business issues and challenges. Dimensions that have come out recently include environmental and social responsibility, safety awareness, domestic political stability, cultural congruence with the buyer organization, and terrorism risk [40].

On the other hand, [41] introduced six steps for supplier evaluation and selection process which are:

1. Recognizing the need for supplier selection: the process can be initiated based on the anticipation of a future purchase requirement. Here, the engineering staff might have some preliminary specifications on the type of the needed materials, processes, or services. However, the specifications have no specific details, but these specifications are enough to initiate the process for finding a potential source of supply.
2. Identifying the key sourcing requirements: understanding the importance of the requirements that is essential for the purchaser, and these requirements might vary from an item to item.
3. Determining the sourcing strategy: that includes for instance, domestic versus foreign suppliers, single versus multiple supply sources, short term versus long term purchase contracts.
4. Identifying the potential supply sources: this step is dependent on different sources of information.



5. Reducing the suppliers' number in selection pool: purchasing staff often use an in-depth evaluation of all possible suppliers in order to narrow the number to a small list which will be used for an in-depth formal evaluation.
6. Determining the method of supplier evaluation and selection: the method will be applied on the remained supplier after the first cut in the former step. The evaluation and selection can be conducted using many methods including evaluating the suppliers' information, using a list of preferred suppliers, or carrying out a site visit.

An identification of supplier selection criteria together with the right supplier selection methods are the driving factors determining a firm's growth and competitiveness, thus criteria are truly important in the supplier selection. For many years, the traditional approach to supplier selection has been to select suppliers simply based on price. However, as companies have learned that the sole emphasis on price as a single criterion for supplier selection is not well-organized, they have turned into to a more comprehensive multi-criteria approach [42]. Recently, these criteria have become increasingly complex as environmental, social, political, and customer satisfaction concerns have been added to previously defined factors such as quality, delivery, cost, and service. The realization that a well-selected set of suppliers can make a strategic difference to a firm's ability to provide continuous improvement in customer satisfaction drives the search for new and better ways to evaluate and select suppliers. The use of multiple suppliers provides more considerable flexibility due to the diversification of the organization's total requirements and fosters competitiveness among alternative suppliers [42]. Despite the strategic importance of the supplier selection, many firms still limit themselves with

evaluating the price performance as the single determiner when choosing a supplier. The evaluation of this only criterion is not the most suitable approach, since many other factors must be considered for the selection process to be successful. Nowadays, it is important to structure the problem and to explicitly assess pertinent criteria before reaching a decision. Several methods have been developed to solve multi-criteria problems, and many of them is the idea that most decision-making can be improved by breaking down the general evaluation of alternatives into evaluations on a number of relevant criteria. Supplier criteria are divided into quantitative and qualitative attributes. The selection of suitable criteria also depends on the purchasing situation.

**Table 1 Supplier selection literature synthesis**

| <b>Criteria</b>                         | <b>Authors</b>  | <b>Definition</b>  |
|---|-----------------|--|
| Environmental and social responsibility | [43]            | The supplier's responsibility to sustainably use natural resources, minimize damage, and ensure that these resources are available for future generations.   |
| Product development                     | [6], [39], [44] | The supplier's ability to change an existing product or its presentation, or to formulate a totally new product that meets a newly identified consumer need or market niche.   |
| Performance history                     | [39], [45]      | The performance history of the supplier in the financial, economic, social, organizational, and societal area.   |
| Warranties and claim policies           | [39], [46]      | The claim policy is a formal request for coverage or compensation for a covered loss or policy event, as well as the stated written guarantee that promises to repair or replace the product if necessary within a specified period. |

|  |                  |   |
|--|------------------|---|
| Communication system                   | [39], [47]       | The supplier's communication system, which includes information on order progress data.   |
| Service                                | [48], [49], [34] | Customization (size, shape, color, design, OEM, label service), minimum order quantity, communication (react time, information, language), industry expertise, adaptability, and change response are all examples of a supplier's capacity to supply intangible products. |
| Mutual trust and ease of communication | [50], [51], [44] | The amount of confidence in the supplier's ability to deliver high-quality work. And it refers to the obligations that the buyer and the supplier have to each other. The easy communication is a simple information exchange between the company and the provider.       |
| Reliability                            | [39], [44], [52] | References (customer feedback), financial stability (capital, annual turnover), past and current business partners, firm organization and staff, diversity of ownership, and cultural awareness all contribute to the supplier's trustworthiness and dependability.       |
| Process improvement                    | [53]             | The supplier's ability to optimize and meet new quotas or quality requirements by identifying, analyzing, and improving existing business processes inside its company.   |
| Supplier's profile                     | [48], [50]       | The supplier's status, prior performance, finances, certificates, and references for superiority and reputability.  |
| Professionalism                        | [39], [54]       | The supplier's competence or skill expected of a professional.  |
| Product development                    | [39], [44]       | The supplier's ability to change an existing product or its presentation, or to formulate a totally new product that meets a newly identified consumer need or market niche.  |

|                                     |   |  |
|-------------------------------------|---|--|
| Quality                             | [39], [53],<br>[44], [55],<br>[46], [54],<br>[48], [56] | The supplier's ability to consistently meet quality specifications, such as quality features (material, dimensions, design, and durability), variety, production quality (production lines, manufacturing procedures, and machinery), quality system, and continual improvement. |
| Delivery                            | [39], [53],<br>[44], [54],<br>[52], [50], [55]          | The ability of the supplier to meet specified delivery schedules which include lead-time, on-time performance, fill rate, returns management, location, transportation, and incoterms.   |
| Price                               | [39], [53],<br>[44], [52],<br>[55], [22]                | The price criteria include unit price, pricing terms, exchange rates, taxes, and discount.   |
| Labor relations                     | [39], [53]  | The supplier's relationship between management and its workforce.  |
| Reputation and position in industry | [39], [53],<br>[22]                                     | A ranking and reputation of a brand, product, or company, in terms of its sales volume relative to the sales volume of its competitors in the same industry.   |

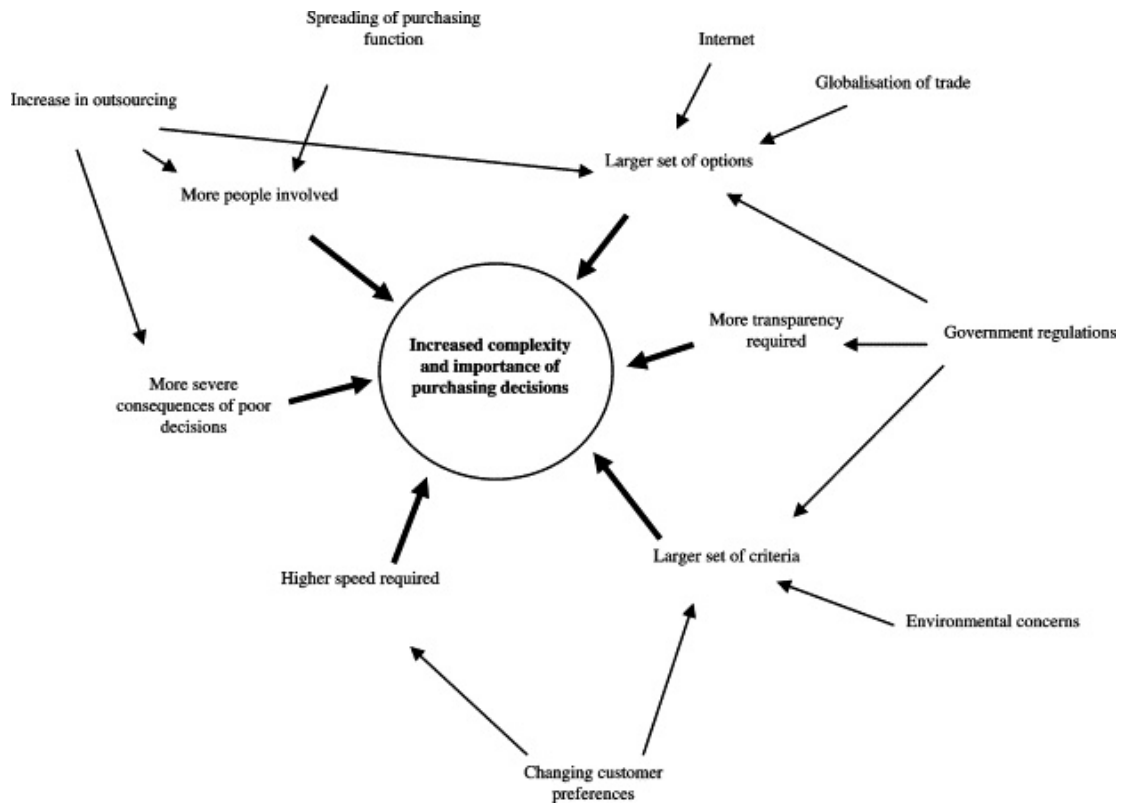
According to the literature, there are a lot of supplier selection criteria which are gathered and listed in Table above. Furthermore, the definition of each criteria is provided.

## **Chapter 3**

### **Supplier Pre-Selection Framework**

Integration, a term often heard in the popular press, is in many cases not well defined. In this text, we define integration as “the process of incorporating or bringing together different groups, functions, or organizations, either formally or informally, physically or by information technology, to work jointly and often concurrently on a common business-related assignment or purpose.” Purchasing was integrated from the two perspectives into a common body of knowledge that encompasses all the value-adding activities on the value chain, researchers realized the importance of incorporating supply chain management in overall business planning process [10]. However, it is not widely practiced. Business process reengineering literature [57] supports the notion of closely integrating the operations across functional areas between manufacturers, suppliers and customer. In an empirical survey, [58] also discover that despite the increased emphasis of integrating purchasing into overall corporate strategy, the primary function of purchasing has remained a clerical role of negotiating price/items.

Supplier selection studies have used a wide variety of supplier evaluation criteria, due to the diversity of the purchasing context as observed in the Fig 3.1. Thus, we propose an integrated supplier pre-selection framework to identify the critical supplier pre-selection criteria which are important for OEM’s across industries and across purchasing contexts to filter out and identify potential suppliers before the nomination phase to deliver better and resilient suppliers to the project. The framework also lists the importance of these criteria to the OEM’s purchasing teams and how it results in better decision making for the strategic projects.



**Figure 4 Complex criteria for supplier selection [59]**

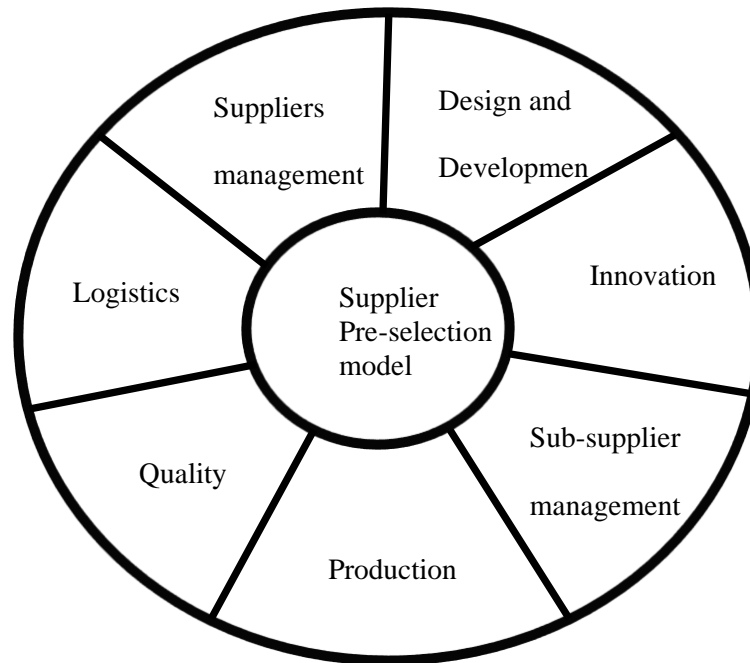
Let's look at a situation described by the German OEM's purchasing manager for the HPDC (high pressure die-casting) products, these are safety critical products with precision ranging few micrometers. His job is to ensure an unbroken flow of parts and materials from around the globe, finding HPDC industries in China as the OEM see major growth in the market and awarding contracts to select few. Recently, he was in Nanjing, CN, agitated, and meeting with Chinese supplier that wasn't delivering the quality products promised in contract to the German OEM's factories in Asia. This HPDC product had multiple precisely parallel holes which hold the body of the automobile, any dimensional and metallurgical nonconformances to these holes are identified

on the assembly line during the shift, which leads to line stoppage and millions of dollars lost. Manager adds “Nothing is worse for a buyer’s reputation than throwing business to a low-ball supplier that then has trouble delivering”. He exactly remembers this project was awarded to the supplier looking at the experience they had dealing with this supplier in Germany on a different product, noting that not just supplier’s management is important for the successful project, but overall suppliers’ capability in delivering similar products. In the automobile business alone the percentage of the total cost of products made up of out-sourced components has doubled to 60% in the past decade. “If you’re not good at buying in today’s world, it’s a big competitive disadvantage.” So, the German OEM’s purchasing manager decided to call an outside consulting firm, which sent him a list of 97 HPDC factories from Brazil to Bulgaria that could potentially make the HPDC products as required. This led to development of supplier pre-selection framework. Pre-selection of suppliers is defined as the process of reducing the large set of suppliers to a smaller manageable set of suppliers. The primary benefits of pre-selection of suppliers is:

1. The possibility of rejecting good suppliers at an early stage is reduced.
2. Resource commitment of the OEM’s purchasing team towards purchasing process is optimized.
3. With the application of pre-selected criteria makes the supplier selection process is narrow and detailed.

The framework we present for the supplier pre-selection accommodates the requirements of all the departments involved during the lifetime of the project from production, development to logistics. The goal of the integrated purchasing strategy is to create manufacturing processes and logistics functions seamlessly across the supply chain as an effective competitive weapon that cannot be easily duplicated by competitors [7]. Higher level of integration with suppliers in the supply chain is expected to result in more effective competitive advantage [60]; [61]; [62]. The articles we

discuss here under the heading of pre-selection have originally appeared as supplier selection articles. We acknowledge that they could be used in the final selection phase, but their sorting nature makes them more suitable for pre-selection phase.



**Figure 5 Supplier pre-selection framework**



## **Suppliers Management**

Success comes from good leadership - there's no argument there, but leaders are mainly in the driver's seat, defining vision and strategy to steer the company towards success. However, no leader or company is going to get very far without a reliable engine to power it. What's the engine? A well-structured hierarchy of people - organization. When your people are engaged, the very best flows from them and the company's work will be done more effectively, efficiently, and with more success. Organizations cannot function without some degree of regularized, formal information flows, policies, procedures, and meetings through which the essential tasks of the business are carried out. Organizations are also built upon the skills, experience, and needs of the people who compose them.

Effective leadership starts with the chief executive's and his top team's vision, capitalizing on market or service opportunities, continues through a strategy that will give the organization competitive or other advantage, and leads to business or service success. It goes on to embrace all the beliefs and values held, the decisions taken, and the plans made by anyone anywhere in the organization, and the focusing of them into effective, value-adding action.

As previously mentioned HPDC supplier in Nanjing, China; A detailed investigation of the causes of dimensional and metallurgical nonconformances revealed that many of the problems were of the supplier's own making, due to its failure to communicate requirements between its teams based in

Germany and China. The German OEM discovered that the quality performance of its supplier improved when

1. Suppliers leadership and organization from the local plant got involved
2. Contract was agreed with the local plant considering the technology and systems available.

This above case shows there was clearly no central communication strategy at the supplier which kept the local plants in the loop during contract agreements. Thus, to evaluate supplier's management for any project, the critical areas are identified below;

- M1. The company has a clear vision and strategy.
- M2. The company possesses a broad knowledge about the market (quality, quantity, market share, position, number and competences of competitors).
- M3. The company has a diverse customer portfolio which makes supplier independent from major customers.
- M4. The company has experience with similar products (as a supplier of an OEM with high volume).
- M5. The company has a structured, balanced and effective organization structure (hierarchy, proportion of direct /indirect employees, clear decision-making processes).
- M6. A professional project management is implemented in the organization.
- M7. Accompanying processes (e.g. controlling, planning) as well as responsibility, number, competence and education of the employees meet the project requirements.
- M8. A process to estimate the feasibility of a new contract volume is established (consideration of current OEE, technical feasibility, required investment (staff, machinery)).
- M9. The information flow is not affected by language barriers, accessibility problems.
- M10. The company have required certification to produce goods(e.g. ISO 14001, ISO16949)
- M11. The company or any of its key persons (directors, executives, owners) is or was not subject to compliance relevant judgments, pending litigation, or public investigations (violations related to corruption, bribery, or antitrust issues).
- M12. The company is in good financial condition with healthy cash flow.

### **Design and Development**

The automotive industry's rapid rate of technological change has reduced product life cycles in the recent decade, and market globalization has resulted in a renewed executive focus on new product development procedures. Suppliers are becoming a more essential resource for OEMs in a competitive economy. "Firms that involve suppliers early, compared to companies that do not involve suppliers, obtain an average 20% decrease in materials cost, 20% improvement in material quality, and 20% reduction in product development time," according to a German auto manufacturer's management. Development teams that include suppliers as members" Across all worldwide OEM's, purchased materials account for over 50 percent of the cost of goods sold. In addition, suppliers have a large and direct impact on the cost, quality, technology, and time-to-market of new products. Effective integration of suppliers into the product value/supply chain will be a key factor for manufacturers in achieving the improvements necessary to remain competitive.

For instance, in developing its compact sedans (the Chrysler Cirrus and Dodge Stratus), Chrysler Corporation outsourced 95 percent of the parts required for production. Chrysler used a team approach and chose the suppliers before the parts were even designed, which meant virtually eliminating traditional supplier bidding. The results of this effort included significant reductions in cost, quality improvements, and innovative new designs. While such results typically go undisputed, there is mounting evidence that not all such efforts are successful. [63].

Thus, to achieve this integration we have identified major criteria to evaluate suppliers in pre-selection:

- D1. The company has a professional development department with an adequate, competent and trained staff.
- D2. The company has appropriate tools and techniques for design analysis and applies them as needed. (D-FMEA, Finite Element Method, CFD simulation, lessons learned from previous projects).
- D3. The company ensures that the specified customer quality and reliability goals are achieved in the development phase. (simulations, hardware testing).
- D4. The laboratory equipment of the development department (durability, climatic test) is on the latest technical level and corresponds to the requirements of the product spectrum and the development competence.
- D5. The company has robust data management system.
- D6. The company has single part traceability for hardware in development phase.
- D7. There are (effective and efficient) methods and tools established at the company that allow and ensure a systematic identification, analysis, evaluation, administration and processing of all relevant requirements on system and software level.

## **Innovation**

Globally, rising environmental concerns are gaining traction, making it easier to employ green innovation for long-term supply chain management (SSCM). The automobile industry is going through a time of unprecedented change. Vehicles and auto manufacturing facilities do not appear the same as they did a decade ago, thanks to modern computer systems, manufacturing techniques, and novel designs. We already covered why suppliers should be involved in the concept and design phases of new product development. We'll go through why suppliers need to evolve and innovate in this section. Suppliers need to change their business strategies to focus on innovation, rather than production while refining their product offerings to the best that they do. As the German auto manufacturer manager adds “ Tier 1 suppliers realized a few years ago that to stay profitable, they need (to innovate), If you provide value, you are no longer a commodity. You become something the automaker needs.”

The adoption of new production methods by Western car manufacturers and the openness of global markets, together with an increasing sophistication of specific automotive components and systems have resulted in new relationships being formed between a reducing number of car manufacturers and a reducing number of suppliers capable of performing under changing industry conditions.

The importance of product innovation for successful firm performance has been well established in many industrial sectors [64] and the automotive sector is no exception. Automotive suppliers are a critical source of innovation for major vehicle manufacturers [65]. As innovation cycles in the automotive sector shortened, the specialization of suppliers on specific product categories strengthened the performance of car production networks as cars became increasingly

complex products. They pose challenges to the sourcing and procurement departments of automotive companies in seeking to keep up with innovation trends in the industry, in understanding their impact on future product sourcing categories, and on future product sourcing strategies.

**Table 2 Three ways suppliers are innovating [66]**

| Method  | Example   |
|---|---|
| Buy or partner with new companies             | Delphi's Aptiv spinoff and Samsung's purchase of HARMAN both aim to enhance the suppliers' ability to innovate. |
| Focus the product offering                    | Visteon sold off product lines to focus on being a top cockpit electronics supplier.                            |
| Work closely with clients to tackle new needs | GM recognized its supplier, Comau, for developing technology to improve future vehicle launch quality.          |

Future procurement and sourcing strategies need to be considered some time in advance to allow sufficient time to identify potential suppliers, to judge and evaluate their capabilities, and to engage in appropriate negotiations and agree contractual arrangements with selected suppliers. Thus, discussion above was used to decide the criteria for supplier pre-selection framework. Sourcing and procurement departments use a range of data sources, knowledge and information to support sourcing strategies and decisions.

- I1. The company has existing relationships / cooperation's with research establishments (e.g. Universities) and/or engineering service providers.
- I2. Patents for products and/or production processes were awarded to the company and are currently used by the company.
- I3. The company operates an innovation scouting
- I4. The company offers innovative and/or technical leading solutions within his sector.
- I5. Innovative production- and management methods are used by the company.
- I6. Innovation know-how is proactively contributed for concept optimizations.
- I7. Risk-free series release of innovations is ensured by a validation process.

### **Sub Supplier Management**

Today's competitive global market have complex and closely interlocked logistics chains. Instead of producing all their components in-house, manufacturers procure the individual modules from specialist suppliers. These suppliers will in turn assemble components supplied by specialized component suppliers. The suppliers of individual parts are found on the third or fourth tier. These boundaries are not always so clearly defined. Thus, management of these suppliers is an important aspect of resilient supply chain. As, OEM's are moving beyond traditional adversarial relationships to cooperative, mutually beneficial relationships, which view suppliers and sub-suppliers as virtual extensions of their OEM. Many businesses have found that they can strengthen worldwide competitiveness by operationalizing the supplier-manufacturer partnership philosophy that blurs companies' boundaries and creates an environment that fosters cooperation and innovation. One example of successful supplier-manufacturer partnerships is Procter & Gamble, which reduced the cost of goods by 4% and other supply chain costs by an estimated 25% through effective management of suppliers [67].

Supply chain literature has extensively discussed managerial practices for managing direct suppliers (i.e. tier-1 suppliers) [68], [69]. In general, these managerial practices can be classified into assessment and collaboration practices [70], [71]. Assessment practices such as supplier audits or monitoring seek to identify deviations in requirements. During supplier selection phases assessment practices aid choice of "capable" suppliers [72]. Even though sub-suppliers play a critical role in supply chain, relatively limited research has focused on sub-supplier management, but is emerging [73], [74] [66]. Existent literature acknowledges that similar practices of "traditional supplier management" can be applied to sub-suppliers. For example, Hewlett-Packard



initiated specific sub-supplier management programs including assessment and collaboration practices [75].

Considering the unique challenges of approaching sub-suppliers it needs to be one of major criteria's in supplier selection thus below mentioned is the criteria to evaluate at the suppliers in pre-selection process:

- S1. Tier-x suppliers are inspected, selected and released according to precisely defined processes (e.g. quality audits, initial sample tests).
- S2. A supplier rating system is installed within the company which comprehensively monitors the performance of the sub suppliers (e.g. evaluation of supplier ratings, monitoring of the delivering quality, handling of complaints)
- S3. Proactive communication concerning Tier-x topics takes place towards the customers (e.g. changes, problems, contract situation)
- S4. The company takes complete responsibility for costs (detailing and minimization of costs), product properties (change management) and part supply (supplying concept, stocks, cycle time) of the value chain.
- S5. The company guarantees strict observance of local social guidelines within the sub supplier structure (exclusion of child labor, observance of environmental protection requirements).
- S6. The company has a robust advanced product quality planning system with sub-supplier network.

## **Production**

A supply chain is made up of a number of manufacturing units that turn raw materials into completed goods. Within a supply chain, a pipeline refers to the flow of data, materials, components, and assemblies associated with a certain product. It is typical for manufacturing plants to put considerable effort to optimize the performance of a horizontal slice of a supply chain (such as coordination among parts that share a common resource). The need to optimize the performance of the vertical slice (the supply chain connecting raw material to finished product) by controlling the transmission of schedule instability and the resulting inventory fluctuation is often overlooked. A schedule is stable if actual production requirements for a given period do not change from the forecast production requirements. Stable production schedules are important when managing supply chains as they help control inventory fluctuation and inventory accumulation. Failure to control schedule instability results in high average inventory levels in the system.

It is typical for OEM's and suppliers to put considerable effort into coordination among them; that is, to coordinate the production schedules of parts that are inter dependent on each other. After careful consideration of all the major factors affecting OEM's following criteria was laid out to evaluate suppliers in pre-selection phase:

- P1. The company ensures planning and implementation of capacities and adequacy of all equipment to meet the production requirements (process FMEA with a link to product FMEA).
- P2. The company has a technology competence/ machinery according to the demand and products on a long-term basis (equipment, maintenance condition).

- P3. Alternative operations and or effective emergency strategies to prevent production interruptions are implemented.
- P4. Maintenance: Regular / preventive maintenance is established (maintenance plan), availability of spare parts is guaranteed to prevent a production interruption, training of the maintenance staff is ensured.
- P5. Integrated trainings for employees are guaranteed (training matrix, training plan, training during the implementation of new / modified processes, incorporation plan).
- P6. Building / environment conditions are within or better than international industry standards: - Light, area, emissions, electrostatic discharge (ESD), suitability of production layout for future product(s).
- P7. Cleanness and building maintenance (e.g. structure, doors, windows, roof, paint) are ensured.
- P8. Fundamental aspects concerning job safety are fulfilled and maintained consistently (injury protection, noise, eye protection).
- P9. An extensive tool management is implemented within the company (e.g. determination, design, production, tool life, wear evaluation, repair arrangements, compensation detection, documentation).
- P10. The company has completed, updated workstation visuals and placed them on the right position (e.g. calibration record, maintenance records, operator instructions, border samples, failure catalog, failure analysis, skills matrix)
- P11. The company has implemented a production control system, mistake avoidance (Poka-Yoke) and prevention of potential manipulations. (In-line checking, failure catalog, all rejects recorded, red/yellow failure boxes)

- P12. The company has implemented coherent process plans and schedules (batch plan, cycle times, running times, shortage, balancing, buffer plan, shift flexibility, processing, contingency).
- P13. Regular 5S inspections using a 5S checklist are executed by the manager / supervisor. Results are visualized and measures are derived.
- P14. Fire protection: The supplier has a fire protection insurance; extinguishing systems are available in production and logistic areas.

## Quality

In today's highly competitive global company climate, meeting rising customer demands as well as improving product quality has become a strategic focus. OEM's must produce the correct products at the accurate time and deliver them promptly to customers to sustain their competitive advantage in the marketplace [76], [77]. OEM's increasingly purchase components from suppliers or hire contract manufacturers to produce necessary parts, and they assemble these parts to deliver finished products to customers. In the automotive industry, the cost of components and parts purchased from outside vendors have increased up to 50% of their revenues [5]. The high technology firms spend more than 80% of total product costs on purchasing materials and services [78]. Obviously, the quality of parts obtained from suppliers determines the quality of the finished products produced by manufacturers as well as the customers' satisfaction and loyalty. Therefore, the evaluation of supplier performance and selection of suppliers are becoming major challenges faced by the manufacturing and purchasing managers .

Assessing a group of suppliers and selecting one or more of them are a complex task because various criteria must be considered in the decision-making process such as quality, cost, goodwill, service, delivery time, and environmental impact [48]. According to research conducted by [79], quality and delivery are two of the most demanded items by component suppliers. Twenty-five years after Dickson's research, [5] still considered quality to be of "extreme importance" and delivery to be of "considerable importance". According to Weber's research on the Just-In-Time (JIT) model, the importance of quality and delivery remains the same. [80] surveyed 210 members of the National Association of Purchasing Management (NAPM), who were randomly selected from the listings of electronic firms in the two-digit SIC code 38, and they indicated that quality is the most important criterion in the selection and evaluation of suppliers for both the small and large electronic firms that were surveyed. Furthermore [81] investigated the strategies and practices in

the supply chain management using the sample of 128 Swedish manufacturing firms and concluded that many aspects are important when companies choose supply chain partners, but quality is the most important criterion. In other words, based on the above works, quality can be seen as a fundamental factor for supplier evaluation among various criteria.

- Q1. There is a documented and integrated quality management system(QMS) (written in local and international language, comprises all divisions, levels and employees of the company).
- Q2. All elements of the QMS are examined regularly in internal audits in accordance with audit plan.
- Q3. A professional procedure for identification, release, calibration, monitoring and maintenance of check and test equipment's is defined and established.
- Q4. The company has comprehensively specified processes to control defective parts.
- Q5. A location for the evaluation of damaged field parts exists / is indicated.
- Q6. A process for initiation, monitoring, implementation of corrective actions in the agreed time is established (customer 8D, internal 8D, supplier 8D, Kaizen, 6 Sigma, cost benefit).
- Q7. A functioning document management system including updates for all relevant documents is established and makes them available to customers proactively (documentation is always complete, identifiable and traceable).
- Q8. The information flow concerning change management is ensured (drawing change, specification change, notification of change, control of change implementation).
- Q9. The Q-indicators from the past 6-months meet the customer requirements.

## **Logistics**

Global logistics is a complex inter-organizational process. For example, a single global shipment of toys requires an average of 27 parties to complete. Thus, to build global logistics competence poses a major challenge for manufacturing-based companies. [82] reports that both dotcoms and Old Economy companies are now paying more attention to collaborative logistics. Using the latest information and communication technologies to interconnect manufacturers, retailers, and transporters, these companies can easily exchange information with others. However, the use of information technologies is not all that is necessary to enhance global logistics competence. It is even more important to effectively manage the relationships with all supply chain partners.

- L1. The location of the company is well connected from a logistic point of view (Transport feasibility, transport duration to OEM, infrastructure of the location, i.e. transport connection, production halls, warehousing).
- L2. An MRP system (production system) for production, capacity and shipping planning is available and is used.
- L3. The delivery call-offs are continuously (EDI-System) and promptly forwarded to the respective sub-suppliers.
- L4. Supply of production materials is reliably guaranteed (Kanban, marks for the identification of parts/shelves, security to prevent confusion, FIFO at the production line, instructions for withdrawals)
- L5. A structured problem-solving and improvement process is established (value stream mapping, Ishikawa). Derived measures are sustainably implemented.

- L6. The production and shipping process ensure avoiding wrong deliveries (identification, bar-coding, monitoring, retractability).
- L7. An independent logistics organization within the company/plant is established.



## **Chapter 4**

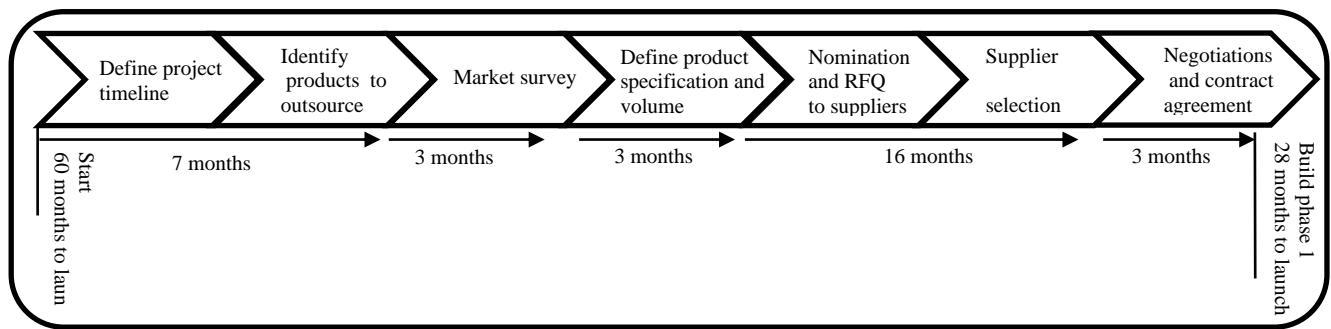
### **Implementation**

The goal of this part is to incorporate the aforementioned SPS framework to an actual strategic purchasing process of German auto manufacturer (GAM) and evaluate supplier selection at its suppliers. Further GAM purchasing manager also shares some particular notes on request for quotations, supplier selection evaluations, contracts, and timelines for SPS model. Because of current business trends, future purchasing processes will need to be more differentiated and elaborate. As a result, businesses must assess how these new purchase scenarios will affect their purchasing processes in order to determine what new resources, routines, and expertise they will require in or around their purchasing processes.

Let's look at the current state of the auto industry to better understand the need for and efficacy of the SPS model. The COVID-19 crisis had forced about 95 percent of all German automotive-related companies to put their workforces on short-term work during the shutdown, a scheme in which employees are temporarily laid off and receive a substantial portion of their pay through the government. The COVID-19 incident had far-reaching and unprecedented global consequences. In fact, many auto-suppliers were closed for 3 months or longer. During these times OEM's were not just facing supply constraint situation due supply chain disruption but also unprecedented demand for new generation products which would require huge collaboration and knowledge sharing with the suppliers to develop these products and bring to market in astronomically less time compared to normal time required to launch products.

In traditional purchasing the relationships are typically conducted at arm's length. GAM buyers have, however, stepwise-introduced concepts such as: supply base reduction, partnership,

contracting, and vendor certification, from other disciplines e.g. from purchasing, quality control and manufacturing. In general, a purchasing process contains steps such as: define specification; Identify suppliers; nomination and contract agreement; ordering; supplier management. A number of supply chain authors have defined similar processes for selecting suppliers. (e.g. [78]) or [14]).



**Figure 6 Traditional purchasing process**

Based on the discussion above, practical experience at the German auto manufacturer and traditional purchasing process is a framework, focusing on the early steps until contracting in a purchasing process. The objective with the framework is first to describe the characteristics of the different phases for purchasing and what is required to carry them out in a situation at the suppliers during the launch of new products at the GAM. Secondly, the SPS framework will be incorporated in the traditional process and the improvements to the existing framework will be discussed. The GAM purchasing manager also mentions an example to support the model. Finally, this section identifies the phases where there is a need for further development in order to facilitate an efficient purchasing process and barriers to implementation of the model.

### **Define Project Timeline**

[83] states, “New Product Introduction (NPI) is information and knowledge intensive work”. Developing successful new products is possible through the integration of the abilities of both upstream (design engineers) and downstream manufacturing expertise and an OEM’s development capabilities are derived from their ability to create, distribute and utilize knowledge throughout the process until tier-n suppliers. [84] consider knowledge that is shared to be “one of the unique, valuable and critical resources that is central to having a competitive advantage”.

“NPI typically consists of a set of historically uninterrupted and inter-related activities” [85]. In order to successfully compete in today’s competitive business environment a company is required to provide quality new products on time and at the right cost. Speed to market has become a paradigm of world-class manufacturing. According to [86] most large companies have developed a new product introduction and development process to launch products successfully and swiftly. NPI is a broad field of endeavors dealing with the design, creation, and marketing of new products, in this study we focus on the developing systematic methods for guiding all the supply chain processes involved in getting a new product to market.

New product launch timeline is the most critical for the success of OEM’s, thus in this phase the research & development, engineering and manufacturing, and operations departments collaborate to define a timeline for safe launch. Usually these timelines are 54 to 72 months in advance for the automotive OEM’s as they have hundreds of parts to be outsourced to right suppliers at right cost. The detailed plan is sketched out with each phase from outsourcing decision to contract agreements is agreed with the purchasing departments for all commodities.

### **Identify Products to Outsource**

In the field of operations and supply chain management, outsourcing is a critical decision. Manufacturing outsourcing is a way for businesses to shift from a fixed cost base to a more flexible cost base for production. As discussed in the paper by [87] following the Dell model, producers of complex manufactured goods have tried to abandon vertically integrated production, increasing the scale and scope of their outsourcing. On the one hand outsourcing helps focusing on the core business, on the other hand it allows to leverage external technological expertise [88]. A common theme in GAM purchasing team observed is cost reduction is the rationale most often given for outsourcing, the second most important reason is to access skills not found in-house. As a consequence, outsourcing requires firms to develop more in depth relationships with suppliers including strategic partnerships [89] ; [90] the early involvement of suppliers in product development [91], more open and inclusionary innovation processes [88] and an increased customization. These traits are particularly evident in the auto industry [83]

A strategic commodity's goals are to establish a competitive advantage, support and use the supplier's core competences, develop best-in-class suppliers, support the company's entire strategy, and improve value-added services beyond a standard purchase agreement. Involving a supplier as early as possible in the product development process lays the groundwork for more information sharing and improvement.

Outsourcing to suppliers allows the transfer of risks including technological and demand variability – suppliers are able to achieve economies of scale to carry out tasks with lower costs and access newer technologies. Managing the shift in risks and the transfer of influence to suppliers has led to a more strategic perspective and focus on alliances and partnerships [92] ; [80] These studies could contribute to explain why OEMs rely on suppliers to develop and manufacture critical products. As

the German auto manufacturer purchasing manager quotes “ the decision to outsource products is strategic decision considering the many different aspects of technical expertise available, uniqueness of the product, investment required, and market trend”

## **Market Survey**

The process of collecting information for sources particular to the item being purchased in order to assist competitive procedures and supplier selection is known as supplier research. Market analysis is the process of obtaining relevant data from economic indicators and emerging trends within a specific industry, as well as the competitive environment of the product or service being sought. As a result, an image or model of the marketplace can be created, allowing individual supplier qualifications and performance to be evaluated not only in terms of the organization's requirements, but also in terms of what is commercially accessible for purchase. Supplier research and market analysis, taken together, provide the basis to understand the available products and services, qualified potential suppliers, and market for product and services.

To develop a bigger supplier base, especially if the strategy is to find “best price”, your market analysis will involve researching all elements of the market. These elements include:

- market characteristics that are important to your project
- market structure, size and the key suppliers
- competition among suppliers and how that affects price, quality and delivery
- barriers to entry and exit
- the product life cycle

### **Define Product Specification and Volume**

As items are consumed at the same time they are manufactured, there must be unambiguous agreement between suppliers and OEMs on product specifications and volume in order for OEMs to continue creating high-quality completed products and delivering them to customers on time. This internal information is critical not only for evaluating suppliers, but also for giving them a fair chance to generate offers. Typically, new automobile projects begin as exhibition(model) items, which necessitate a high level of standardization and simplification for mass production, which is especially significant for purchasing strategies because it leverages economies of scale.

Once the supplier pre-selection for the specific product is finished, a small supplier group emerges with the necessary experience and understanding to manufacture similar products. Both OEM and supplier design and engineering teams collaborate to develop product standards that are aligned with the project and expertise (technology and machines) available to mass-produce the items. "The purchasing commodities leverage the small number of suppliers after pre-selection to iterate and reiterate the design with the suppliers to an optimal design for the skills and technology available, sometimes we recommend suppliers to invest in newer technologies to improve design and quality of products," says the purchasing manager of a German auto manufacturer.

## **Supplier Pre-selection**

### **Timeline**

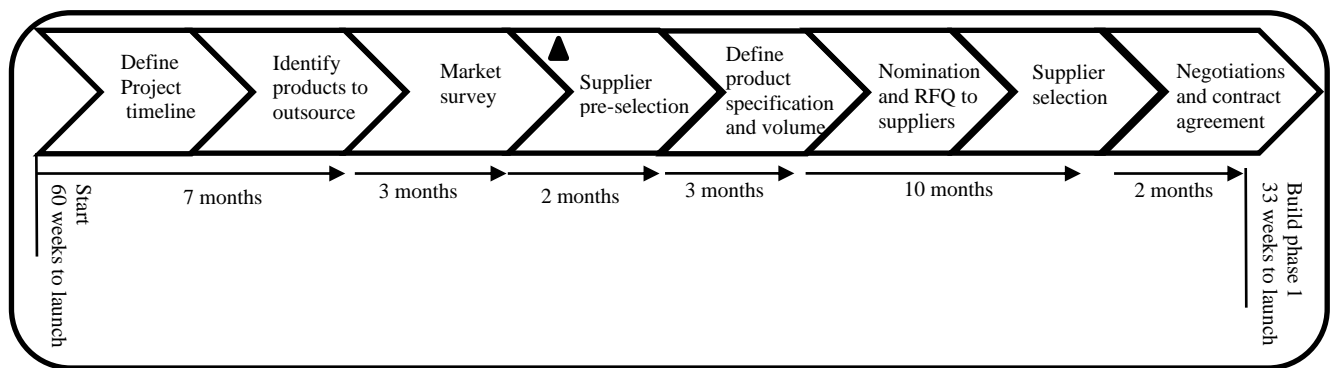
Because of the wide variety of products available, determining a conventional product launch timeframe can be difficult. "How long is a piece of string?" is a similar question. "As long as it takes," says the answer. Even though each product is unique, there are several stages that all products will go through. Understanding those steps can assist them in estimating the time it will take to get their product to market. The product safe launch timeframe at GAM is usually 60 to 72 months in advance. We discussed the standard timeframe before, and now we'll include the supplier pre-selection stage in the strategic purchasing cycle. "The HPDC supplier list contained roughly 96 vendors in the first list," recalls the GAM buying manager. "By no means was it possible for the purchasing team to vet 96 suppliers when the demand for new technology items is immediate."



The supplier pre-selection stage resulted in:

1. Reduction of number of suppliers to a small high potential supplier.
2. The smaller list resulted in less time required for nomination and supplier selection.

There was an improvement of 5 weeks in the launch cycle as the final supplier was selected 33 weeks prior to the launch. This time was a than later be used for production and process qualifications for safe launch.



**Figure 7 Purchasing process after SPS framework**

### **Nomination and Request for Quotation to Suppliers**

This is the first draft of the potential suppliers for the commodity, the improvements observed due to supplier pre-preselection were:

- Visibility in the process – as the information was available about each supplier in detailed from quality to logistics. Thus, the internal teams collaborated to make final supplier selection. Earlier as there was very little to no information on these topics, the internal teams had to work after project is awarded with the supplier to validate or improve processes.

As the GAM purchasing manager adds “ the HPDC list of suppliers was down to 13 from 96, these were all high potential suppliers and GAM purchasing analyst visited each manufacturing site in-person to get better understanding of the supplier’s organization culture and initiate a relationship between them as these GAM analyst will be single points of contact for any issues during the project life”

Once the buyer has identified potential suppliers, the next step in supplier selection is to formally request that the suppliers provide information about their goods or services. While there is no agreed-upon terminology, generally the buyer makes one of three types of information requests to suppliers. The request types, each appropriate for a different situation, are described below.

Request for information (RFI) is issued when the buyer seeks to gain market intelligence regarding what alternatives and possibilities are available to meet the buyer's needs. Typically, the buyer will inquire about the items and services that suppliers may be able to give, as well as what sets them apart from other vendors in the industry. The buyer does not say whether or not he intends to award a contract when he issues an RFI. However, because responding to an RFI takes time, suppliers will usually only react if they expect the buyer to issue a request for proposal (RFP) or a request for quote (RFQ), both of which are covered further below.

Request for proposal (RFP) is issued when the buyer has a sense of the marketplace and has a statement of work containing a set of “performance” requirements that the buyer needs fulfilled. The RFP may, for example, define a formed part with specific strength, flexibility, and fire-resistance requirements, but not the material composition. Suppliers reply to the RFP by describing how they will meet the buyer's performance objectives and the price they are ready to pay to do so. The buyer may change its needs and/or negotiate exact conditions with suppliers after understanding the supplier's offered pricing. As a result, the procedure is usually iterative. An RFP is intended for nonstandard or extremely complex items that require supplier involvement and knowledge on the best method to achieve the requirements outlined in the RFP.

Request for quote (RFQ) is issued when the buyer can develop a statement of work that states the exact specifications of the goods or service needed. This is the situation, for example, if the customer requires a part produced of a specific plastic and moulded to a given thickness, density, and shape. RFQs are frequently used as part of highly organized competitive tendering processes. After receiving bids, most companies do not need to engage in thorough negotiations with suppliers since the lowest price or some other objective criterion is used to evaluate proposals. RFQs are excellent for procurement of items that are standard and well-known in the marketplace due to their up-front specification criteria. Commodity components in the electronics industry, for example, would comprise cables, connectors, and circuit boards.

Improvements on the RFx due to supplier pre-selection:

- Quotation have detailed plan as the time invested by the OEM and information shared is thorough with small circle of suppliers.
- Suppliers and OEM generate in trust in each other as lessons learned from previous projects are shared
- Suppliers and OEM have healthy conversations on tooling and equipment investment
- Multiple suppliers can collaborate on difficult project to deliver better service and generate value. E.g Two suppliers, collaborated to create a new greenfield location close to OEM to reduce risk and produce good quality parts.
- OEM and suppliers can collaborate to do a strategic agreement to setup new facilities.

## **Supplier Selection**

### **Negotiation and Contract Agreement**

When making contract award decisions, the buyer examines each supplier's qualifications as well as the contract terms they propose, as we shall explain in the section headed "Negotiation and Contract Award" (e.g., price). The qualifications of a supplier are typically considered exogenous; for example, a supplier's reputation is based on past performance and is not changeable in the short term. The customer and supplier, on the other hand, can "negotiate" contract conditions. In a negotiation, the buyer tries to persuade suppliers to agree to beneficial terms, and the suppliers try to persuade the buyer to agree to favorable terms. There are many different types of negotiating processes that can be used. Negotiations are frequently perceived as zero-sum games, in which the buyer gains what the supply loses. The take-it-or-leave-it offer method, in which a powerful customer basically dictates the conditions to the providers, is an extreme example of this. For example, the customer may demand a specific price and refuse to evaluate the supply unless the price is met.

The buyer and one or more suppliers sign a contract at the end of the supplier selection process. A contract with a supplier lays out what the supplier must do and how the buyer will compensate them. Contract terms, at their most basic level, refer to either monetary transfers (payment conditions) or how the contract will be carried out (nonpayment terms). Contracts can provide a variety of payment and nonpayment options. A few of the more popular ones are included here to give the reader an idea of the types of contract terms that the buyer might consider during negotiations and when deciding on a contract award. The choice of the particular contract structure (long-term or short-term, fixed-cost or cost-plus, etc.) is beyond the scope of this article.

### **Case study**

German auto manufacturer (GAM) is a leading global corporate manufacturer of luxury vehicles and motorcycles with headquarters in Munich, Germany, as addressed in this thesis. Furthermore, is a multinational firm with operations in Germany, Brazil, China, India, Mexico, the Netherlands, South Africa, the United Kingdom, and the United States. This company is guided by German original principles of quality, innovation, integrity and commitment today, as it has been since its inception. The quest of continuous development and profitable expansion is one of the key initiatives to produce shareholder value. For procuring a specific component, GAM employs both single and multiple sourcing strategies. Although the goal is to reduce the number of suppliers, the majority of them are multiple sourcing. Because of control and tracking concerns, some indirect products and commodities are sourced exclusively. In GAM, purchase contracts with suppliers have a specified length and normally last for the duration of the project (often 7 years) in exchange for a percent cost reduction each year and other negotiable items.

The purchasing department at GAM for powertrain commodity includes 12 members who source about 125 parts from various tier 1&2 suppliers based in the United States, Mexico, Germany, China, and Canada. The function of the powertrain is to couple the engine that produces the power to the driving wheels that use this mechanical or electric power to rotate the axle. This connection involves physically linking the two components, which may be at opposite ends of the vehicle and so requiring a long propeller shaft or drive shaft.

The automotive industry has largely comprised of the same two powertrain types that had characterized the industry for over a century: gasoline and diesel. Today, there is a broad powertrain

mix as the industry pushes towards more environmentally friendly and efficient transportation. As the powertrain portfolio diversifies and includes an increasing number of hybrid and electric varieties, the powertrain component landscape is becoming more complex and dynamic. Due to these developments that are both driven by few small number of OEM's and government are affecting OEMs, suppliers, and new entrants alike, which are taking place at a pace that not many would have foreseen a few years ago, a comprehensive view is changing the powertrain component market. Below shown in powertrain commodity:

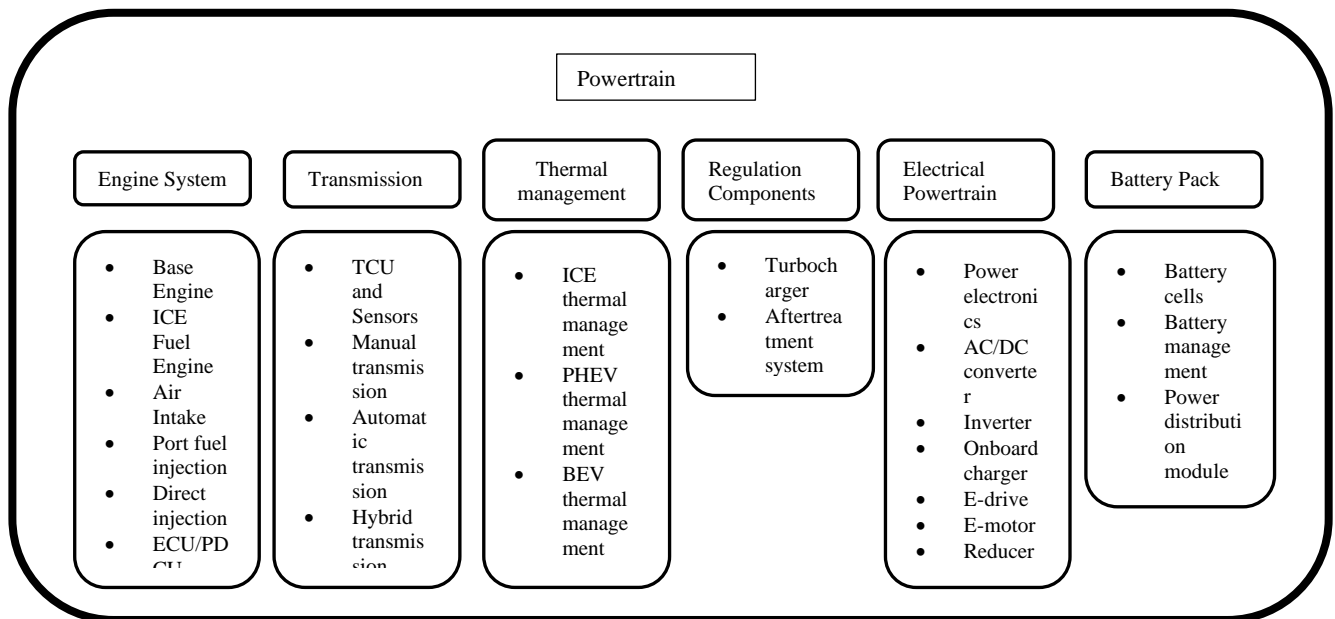


Figure 8 Powertrain commodity chart

GAM has the policy of following a seven phases and steps process for strategic purchasing. The strategic purchasing process is described in more detail in Figure 6. The following case study shows how a supplier pre-selection framework was put in place at a German automaker. GAM was in the process of procuring components for future battery electric and plug-in hybrid electric vehicles, which were around 72 months away from going on the market. The GAM's purchasing specialist for electric powertrain components is in charge of ensuring a continuous flow of parts

and materials from throughout the world, as well as identifying suppliers for new projects. During the 62 months leading up to the vehicle's introduction, all of the outsourced components are determined, and considerable market research is conducted. The market research yielded a list of 45 potential suppliers in China, Germany, and the United States, but this specific electric powertrain component customized for the GAM application is unique and requires industry-leading technology to manufacture, necessitating a massive generalization of specifications for mass production. The internal research and development team requests GAM's purchasing specialist for information on suppliers' production capabilities and technology. Because this is a new product with all of the suppliers being new, GAM's buying specialist decides to conduct a supplier pre-selection audit on all 45 vendors to gather information on each. The SPS audit was conducted over the next three months, including virtual meeting platforms for suppliers based outside the United States and in-person audits for suppliers in the United States. SPS evaluated the suppliers based on 62 mutually exclusive, cumulatively exhaustive criteria in seven primary areas. The data acquired from the SPS audit was used to rate all of the suppliers in each category, and clear four outperformers were discovered in each region, including the United States, China, and Germany, which are all key markets. These 12 vendors were the most viable options for producing the crucial electric powertrain component in large quantities and with high quality. In the next phase the supplier's engineering was closely involved with the GAM research and development team during the following phase of product definition and volume decision. The development team established the specification based on resources available at suppliers, local law and regulations, and technological competence, and general information about the product was provided with suppliers under non-disclosure agreements. As the number of iterations increased, the product design became more streamlined, and better tailored designs were accessible to suit the expertise of each supplier. By the end of this phase, the purchasing specialist had all of the information necessary about the investment required from each supplier to support the project. Suppliers re-



evaluated their proposals after learning more about the project and needs, and a few decided to abandon the project. Getting into these multi-year project contracts is typically a multi-million-dollar investment for suppliers, so they must make strategic decisions.

At the completion of this phase, GAM is 56 months from launch. The next phase is nomination and request for information, and only 7 suppliers were nominated for RFQ based on investment and project criteria. Multiple internal teams grade suppliers on logistics, financial health, quality, and a variety of other essential project variables, and the most viable suppliers are subsequently nominated for RFQ. Quotes from a supplier expert "We saw more thorough RFQ's due to suppliers' early involvement," as the number of suppliers in this phase decreased from 45 to 7, resulting in significant time savings for the project, which could subsequently be used for multiple build phase validation leading to a safe product launch. When SPS audits were not undertaken, GAM supplier specialists would typically get 40 to 45 supplier RFQs to assess, resulting in a 6 to 8 months delay in projects for the same component. This is the thesis study's main finding. Implementing the SPS framework saves time and allows for improved decision-making.

## **Chapter 5**

### **Conclusion and Future Research**

For optimal OEM supplier selection, this thesis provides a supplier pre-selection framework. It incorporates current purchasing processes and literature from German car manufacturers; an audit is conducted prior to the market survey to evaluate vendors in order to achieve a holistic grade that aids in supplier selection. An intensive literature review on purchasing strategy and supplier selection led to the creation of a supplier pre-selection audit. It was discovered that there was no one, unified approach for pre-selecting suppliers prior to the nomination step. All of the elements that were identified in the research to have a substantial impact on the purchasing strategy were chosen, and the entire cumulative framework was modeled using them. The SPS framework is divided into seven distinct categories, each containing 62 mutually exclusive and collectively exhaustive criteria.

External forces such as competition, the threat of new electric vehicle entrants, and customer pressure encouraged GAM purchasing specialists to shorten the time it takes to select a supplier. During the supplier selection phase, GAM purchasing professionals and a small number of suppliers developed stronger connections, and the supplier-buyer interface transformed as GAM shared product information and real demand from consumers for newer technology goods. Suppliers were now are viewed as assets that provide several value-added benefits such as quality, engineering support, new product ideas, and service support. This perspective considered the supplier as being not only a source for low-cost material that can be easily manipulated for price reductions, but also a way to complement and enhance the GAM core competencies. The GAM's

purchasing cycle time was reduced from 33 to 28 months as a result of all of the above relationship alterations caused by the supplier pre-selection framework.

### **Future Research**

The SPS framework was implemented at a specific German auto manufacturer. The same SPS framework can be extended and applied to other industries where the purchasing cycle times are different. With different characteristics of demand and product life cycle, various other supply chain strategies can be modeled and studied. Supplier pre-selection is a multiple criteria optimization problem with conflicting criteria, such as quality, delivery, service, product safety and others. Several multiple criteria sourcing models exist in the literature. But further area of study can be the fact that the relative importance of the supplier attributes depends on the product life cycle phase.

Additionally, the SPS framework can be used to integrate with supplier selection framework to reduce redundancy in the audits. The framework covers seven important areas, while this can be explored in detail to add any other areas missed in the study.

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## Appendix

### Supplier Pre-selection Audit Sheet

| Management |  |                       |            |                                 |               |                          |
|------------|--|-----------------------|------------|---------------------------------|---------------|--------------------------|
| No.        | Question   | Completely Agree<br>5 | Agree<br>4 | Neither agree nor disagree<br>3 | Disagree<br>2 | Completely Disagree<br>1 |
| M1.        | The company has a clear vision and strategy.   |                       |            |                                 |               |                          |
| M2.        | The company possesses a broad knowledge about the market (quality, quantity, market share, position, number and competences of competitors).   |                       |            |                                 |               |                          |
| M3.        | The company has a diverse customer portfolio which makes supplier independent from major customers.  |                       |            |                                 |               |                          |
| M4.        | The company has experience with similar products (as a supplier of an OEM with high volume).   |                       |            |                                 |               |                          |
| M5.        | The company has a structured, balanced and effective organization structure (hierarchy, proportion of direct /indirect employees, clear decision-making processes).  |                       |            |                                 |               |                          |
| M6.        | A professional project management is implemented in the organization.  |                       |            |                                 |               |                          |
| M7.        | Accompanying processes (e.g. controlling, planning) as well as responsibility, number, competence and education of the employees meet the project requirements.  |                       |            |                                 |               |                          |
| M8.        | A process to estimate the feasibility of a new contract volume is established (consideration of current OEE, technical feasibility, required investment (staff, machinery)).   |                       |            |                                 |               |                          |
| M9.        | The information flow is not affected by language barriers, accessibility problems.   |                       |            |                                 |               |                          |
| M10.       | The company have required certification to produce goods(e.g. ISO 14001, ISO16949)   |                       |            |                                 |               |                          |
| M11.       | The company or any of its key persons (directors, executives, owners) is or was not subject to compliance relevant judgments, pending litigation, or public investigations (violations related to corruption, bribery, or antitrust issues). |                       |            |                                 |               |                          |
| M12.       | The company is in good financial condition with healthy cash flow.   |                       |            |                                 |               |                          |

| Innovation |   |                       |            |                                 |               |                          |
|------------|---|-----------------------|------------|---------------------------------|---------------|--------------------------|
| No.        | Question  | Completely Agree<br>5 | Agree<br>4 | Neither agree nor disagree<br>3 | Disagree<br>2 | Completely Disagree<br>1 |
| I1.        | The company has existing relationships / cooperation's with research establishments (e.g. Universities) and/or engineering service providers. |                       |            |                                 |               |                          |
| I2.        | Patents for products and/or production processes were awarded to the company and are currently used by the company.                           |                       |            |                                 |               |                          |
| I3.        | The company operates an innovation scouting   |                       |            |                                 |               |                          |
| I4.        | The company offers innovative and/or technical leading solutions within his sector.   |                       |            |                                 |               |                          |
| I5.        | Innovative production- and management methods are used by the company.  |                       |            |                                 |               |                          |
| I6.        | Innovation know-how is proactively contributed for concept optimizations.   |                       |            |                                 |               |                          |
| I7.        | Risk-free series release of innovations is ensured by a validation process.   |                       |            |                                 |               |                          |

Design and Development

| No. | Question   | Completely Agree<br>5 | Agree<br>4 | Neither agree nor disagree<br>3 | Disagree<br>2 | Completely Disagree<br>1 |
|-----|--|-----------------------|------------|---------------------------------|---------------|--------------------------|
| D1. | The company has a professional development department with an adequate, competent and trained staff.   |                       |            |                                 |               |                          |
| D2. | The company has appropriate tools and techniques for design analysis and applies them as needed. (D-FMEA, Finite Element Method, CFD simulation, lessons learned from previous projects).  |                       |            |                                 |               |                          |
| D3. | The company ensures that the specified customer quality and reliability goals are achieved in the development phase. (simulations, hardware testing).  |                       |            |                                 |               |                          |
| D4. | The laboratory equipment of the development department (durability, climatic test) is on the latest technical level and corresponds to the requirements of the product spectrum and the development competence.                                    |                       |            |                                 |               |                          |
| D5. | The company has robust data management system.   |                       |            |                                 |               |                          |
| D6. | The company has single part traceability for hardware in development phase.  |                       |            |                                 |               |                          |
| D7. | There are (effective and efficient) methods and tools established at the company that allow and ensure a systematic identification, analysis, evaluation, administration and processing of all relevant requirements on system and software level. |                       |            |                                 |               |                          |

| Sub Supplier Management |  |                       |            |                                 |               |                          |
|-------------------------|--|-----------------------|------------|---------------------------------|---------------|--------------------------|
| No.                     | Question   | Completely Agree<br>5 | Agree<br>4 | Neither agree nor disagree<br>3 | Disagree<br>2 | Completely Disagree<br>1 |
| S1.                     | Tier-x suppliers are inspected, selected and released according to precisely defined processes (e.g. quality audits, initial sample tests).  |                       |            |                                 |               |                          |
| S2.                     | A supplier rating system is installed within the company which comprehensively monitors the performance of the sub suppliers (e.g. evaluation of supplier ratings, monitoring of the delivering quality, handling of complaints) |                       |            |                                 |               |                          |
| S3.                     | Proactive communication concerning Tier-x topics takes place towards the customers (e.g. changes, problems, contract situation)  |                       |            |                                 |               |                          |
| S4.                     | The company takes complete responsibility for costs (detailing and minimization of costs), product properties (change management) and part supply (supplying concept, stocks, cycle time) of the value chain.                    |                       |            |                                 |               |                          |
| S5.                     | The company guarantees strict observance of local social guidelines within the sub supplier structure (exclusion of child labor, observance of environmental protection requirements).   |                       |            |                                 |               |                          |
| S6.                     | The company has a robust advanced product quality planning system with sub-supplier network.   |                       |            |                                 |               |                          |

| Production |  |                       |            |                                 |               |                          |
|------------|--|-----------------------|------------|---------------------------------|---------------|--------------------------|
| No.        | Question   | Completely Agree<br>5 | Agree<br>4 | Neither agree nor disagree<br>3 | Disagree<br>2 | Completely Disagree<br>1 |
| P1.        | The company ensures planning and implementation of capacities and adequacy of all equipment to meet the production requirements (process FMEA with a link to product FMEA).                                    |                       |            |                                 |               |                          |
| P2.        | The company has a technology competence/ machinery according to the demand and products on a long-term basis (equipment, maintenance condition).   |                       |            |                                 |               |                          |
| P3.        | Maintenance: Regular / preventive maintenance is established (maintenance plan), availability of spare parts is guaranteed to prevent a production interruption, training of the maintenance staff is ensured. |                       |            |                                 |               |                          |



|      |  |  |  |  |  |  |
|------|--|--|--|--|--|--|
| P4.  | The company has experience with similar products (as a supplier of an OEM with high volume).   |  |  |  |  |  |
| P5.  | Integrated trainings for employees are guaranteed (training matrix, training plan, training during the implementation of new / modified processes, incorporation plan).  |  |  |  |  |  |
| P6.  | Building / environment conditions are within or better than international industry standards: - Light, area, emissions, electrostatic discharge (ESD), suitability of production layout for future product(s).                       |  |  |  |  |  |
| P7.  | Cleanliness and building maintenance 5S (e.g. structure, doors, windows, roof, paint) are ensured.   |  |  |  |  |  |
| P8.  | Fundamental aspects concerning job safety are fulfilled and maintained consistently (injury protection, noise, eye protection).  |  |  |  |  |  |
| P9.  | An extensive tool management is implemented within the company (e.g. determination, design, production, tool life, wear evaluation, repair arrangements, compensation detection, documentation).                                     |  |  |  |  |  |
| P10. | The company has completed, updated workstation visuals and placed them on the right position (e.g. calibration record, maintenance records, operator instructions, border samples, failure catalog, failure analysis, skills matrix) |  |  |  |  |  |
| P11. | The company has implemented a production control system, mistake avoidance (Poka-Yoke) and prevention of potential manipulations. (In-line checking, failure catalog, all rejects recorded, red/yellow failure boxes).               |  |  |  |  |  |
| P12. | The company has implemented coherent process plans and schedules (batch plan, cycle times, running times, shortage, balancing, buffer plan, shift flexibility, processing, contingency).   |  |  |  |  |  |
| P13. | Regular 5S inspections using a 5S checklist are executed by the manager / supervisor. Results are visualized and measures are derived.   |  |  |  |  |  |
| P14. | Fire protection: The supplier has a fire protection insurance; extinguishing systems are available in production and logistic areas.   |  |  |  |  |  |

| Quality |   |                       |            |                                 |               |                          |
|---------|---|-----------------------|------------|---------------------------------|---------------|--------------------------|
| No.     | Question  | Completely Agree<br>5 | Agree<br>4 | Neither agree nor disagree<br>3 | Disagree<br>2 | Completely Disagree<br>1 |
| Q1.     | There is a documented and integrated quality management system(QMS) (written in local and international language, comprises all divisions, levels and employees of the company).                                      |                       |            |                                 |               |                          |
| Q2.     | All elements of the QMS are examined regularly in internal audits in accordance with audit plan.  |                       |            |                                 |               |                          |
| Q3.     | A professional procedure for identification, release, calibration, monitoring and maintenance of check and test equipment's is defined and established.   |                       |            |                                 |               |                          |
| Q4.     | The company has comprehensively specified processes to control defective parts.   |                       |            |                                 |               |                          |
| Q5.     | A location for the evaluation of damaged field parts exists / is indicated.   |                       |            |                                 |               |                          |
| Q6.     | A process for initiation, monitoring, implementation of corrective actions in the agreed time is established (customer 8D, internal 8D, supplier 8D, Kaizen, 6 Sigma, cost benefit).                                  |                       |            |                                 |               |                          |
| Q7.     | A functioning document management system including updates for all relevant documents is established and makes them available to customers proactively (documentation is always complete, identifiable and traceable) |                       |            |                                 |               |                          |
| Q8.     | The information flow concerning change management is ensured (drawing change, specification change, notification of change, control of change implementation).  |                       |            |                                 |               |                          |
| Q9.     | The Q-indicators from the past 6-months meet the customer requirements.   |                       |            |                                 |               |                          |

| Logistics |   |                       |            |                                 |               |                          |
|-----------|---|-----------------------|------------|---------------------------------|---------------|--------------------------|
| No.       | Question  | Completely Agree<br>5 | Agree<br>4 | Neither agree nor disagree<br>3 | Disagree<br>2 | Completely Disagree<br>1 |
| L1.       | The location of the company is well connected from a logistic point of view (Transport feasibility, transport duration to OEM, infrastructure of the location, i.e. transport connection, production halls, warehousing). |                       |            |                                 |               |                          |
| L2.       | An MRP system (production system) for production, capacity and shipping planning is available and is used.  |                       |            |                                 |               |                          |
| L3.       | The delivery call-offs are continuously (EDI-System) and promptly forwarded to the respective sub-suppliers.  |                       |            |                                 |               |                          |
| L4.       | Supply of production materials is reliably guaranteed (Kanban, marks for the identification of parts/shelves, security to prevent confusion, FIFO at the production line, instructions for withdrawals).                  |                       |            |                                 |               |                          |
| L5.       | A structured problem-solving and improvement process is established (value stream mapping, Ishikawa). Derived measures are sustainably implemented.   |                       |            |                                 |               |                          |
| L6.       | The production and shipping process ensure avoiding wrong deliveries (identification, bar-coding, monitoring, retractability).  |                       |            |                                 |               |                          |
| L7.       | An independent logistics organization within the company/plant is established.  |                       |            |                                 |               |                          |