



**CHALMERS**  
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# Robust Supplier Management

Mapping and Improving the supplier management and purchasing process of Tier-1 automotive supplier.

Master's Thesis in Quality and Operations Management

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**DEPARTMENT OF TECHNOLOGY MANAGEMENT AND ECONOMICS**  
*Division of Service Management & Logistics*

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# Abstract

The increased competitiveness in the market pushes companies to improve their business processes to achieve efficiency and effectiveness. This thesis work is carried out on a Tier-1 supplier of automotive components aimed at improving the supplier management of the company in the purchasing process.

The theoretical framework engraved a variety of topics which supported the authors during the data collection, analysis and improvement parts of this thesis work. The thesis work employed qualitative research strategy with the inductive research approach followed by the case study research design. The data collection tools used for this thesis work includes Process and Enterprise Maturity Model (PEMM) questionnaire to assess the organizations and purchasing function's maturity, organizational documents consisting of business processes activities and interviews with the stakeholders from the purchasing function.

The empirical data from the organizational documents have been categorized into supplier management, project purchasing and supplier management in serial production processes and they have been transformed into process flow charts based on the "Spiral of knowledge". The interview findings were categorized into direct and indirect purchasing based on the organizational process documents. The gaps in the "As-is" process of the supplier management, project purchasing and supplier management in serial production in direct and indirect purchasing have been determined based on the interview data. The escalation model for quality deviations is a subprocess of supplier management in serial production identified as a critical opportunity for improvement in the company based on the "Gap analysis". The PEMM questionnaire captured the current maturity level of the purchasing function and the company.

The results of this thesis work includes both minor and major improvements in the supplier management and purchasing processes. The minor improvements consist of responsibility changes and the major improvements consist of redesign of the escalation model for quality deviations. The supplier management, project purchasing and supplier management in serial production processes have been improved based on the theoretical framework and IATF 16949 standard. The "To-be" supplier management in the serial production process was designed based on the data integrated from the three sub processes. The knowledge management areas of the direct and indirect purchasing were addressed and improved. Further, the thesis concluded that the change agents and liaison personnel will play a key role in implementing the improvement processes. By incorporating the improvements, the maturity of the company and purchasing function would improve in the future.

Keywords: Direct purchasing, Indirect purchasing, IATF 16949, AIAG, PEMM, process flow charts, Supplier management, Risk assessment



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Desikan Badri Narayanan, Gothenburg, June 2021

Vighnesh Tharayil, Gothenburg, June 2021





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# List of Abbreviations

- RFQ - Request for Quotation
- PEMM - Process and Enterprise Maturity Model
- AIAG - Automotive Industry Action Group
- IATF - International Automotive Task Force
- ASQ - American Society for Quality
- RQ - Research Question
- TQM - Total Quality Management
- ISO - International Organization for Standardization
- EMS - Environmental Management System
- OEM - Original Equipment Manufacturer
- PPAP - Production Part Approval Process
- APQP - Advanced Product Quality Planning
- BPM - Business Process Management
- ERP - Enterprise Resource Planning
- IT - Information Technology
- LO - Logistics Operations
- EU - European Union
- NDA - Non Disclosure Agreement

IM - Injection Moulding

CSL - Control Shipping Level

CDM - Customer Directed Materials

SQE - Supplier Quality Engineer

SRA - Supplier Risk Assessment

PAR - Project Authorization Request

AHP - Analytical Hierarchy Process

DEA - Data Envelopment Analysis

TOPSIS - Technique for Order Preference and Similarity to Ideal Solution

# 1

## Introduction

*This chapter gives the reader a brief description and overall background of the problem and the case company. The authors have tried to include both a theoretical and practical perspective to the problem background. Three significant research questions were framed which the reader will be introduced to, in order to help deliver the purpose of the thesis and to guide the reader through the entirety of the thesis.*

### 1.1 About the company

The case Company in this thesis work is a leading global manufacturer of a wide variety of products and a Tier-1 supplier to OEM's mainly associated with the automotive industry. Some of their products include bumpers/fascias, grilles, exterior trim and subsystem components. Their product capability also includes single-source solutions for tooling, injection molding, chroming, paint applications and assembly. The company is headquartered in Windsor, Canada, and Gothenburg, Sweden. They have manufacturing and engineering plants in Canada, USA, Mexico, Sweden, Belgium, Norway, China, Germany and Japan.

### 1.2 Background and problem description

Most companies today spend more than half of their sales turnover on purchased parts and services, thus efficient and constructive relationships with suppliers are key to the company's short-term financial position and long-term competitive power (Van Weele, 2001). The current paradigm of the market has shifted from what used to be the seller's market to that of a buyer's market. Hence, purchasing managers and professionals do not only contribute significantly to the bottom line of the company but also to its top line (Van Weele, 2001). This shift has marked the importance of purchasing management which according to Van Weele (2001) refers to "*Activities necessary to manage supplier relationships in such a way that their activities are aligned with the company's overall business strategies and interests. Purchasing management is now focused on structuring and continuously improving purchasing processes within the organization and between the organization and its suppliers*". This is further corroborated in the research by Cooper and Ellram (1993) which studied the roles purchasing and logistics departments have both outside and inside the firms with respect to interactions up the channel with suppliers and interfaces with the functions who have purchasing requirements within the firm. Cooper and Ellram (1993) concluded that more effective inter-firm

and intra-firm communications are needed, which falls in line with the research by (Van Weele, 2001).

Quality management practices employed by companies especially in measuring total quality management in purchasing consisted of factors like purchasing function, supplier interaction and purchasing organization among others (Sanchez-Rodriguez & Martinez-Lorente, 2004). Factors like management commitment, coordination among cross-functional units, employee management, supplier management and quality indicators contribute greatly to the quality of materials, on-time delivery and overall performance improvement (Sanchez-Rodriguez & Martinez-Lorente, 2004). In order to achieve this organizational effectiveness, implementing TQM, ISO standards, efficient process management is needed which is positively associated with improvement of performance (Benner & Tushman, 2003). One of the standards mentioned above is the IATF 16949 which is the standard developed by the International Automotive Task Force (IATF) under the ISO is the quality management system that is employed as the main standard for automotive suppliers (Gruszka & Misztal, 2017).

In today's fast-paced competitive markets, which most companies are faced with, it is not only important to have breakthrough products but also to have impeccable product quality. A committed purchasing manager knows that the ultimate product quality will be limited greatly by the quality of the incoming material and therefore places high emphasis on Supplier Management (Sanchez-Rodriguez & Martinez-Lorente, 2004). This need for competitiveness and a high standard of quality means having to forge and maintain congenial relationships with suppliers. This growing dependence of firms on their suppliers has highlighted the need for effective supplier management (Prajogo, Chowdhury, Yeung, & Cheng, 2012).

This is further supported by Chen and Paulraj (2004) who proposes that firms with a strategic orientation emphasizing cooperation among supply chain partners are more likely to achieve great returns on investment and economic success when compared to firms that practice the traditional, zero-sum based notion of competition. Furthermore, Chen and Paulraj (2004) shows that alliances in which partners exchange timely, accurate and relevant information and share critical and sensitive information are more successful than collaborations that do not exhibit those behaviors.

Based on the advantages stated above, it is no surprise that companies are trying to improve their processes as much as they can to maintain a competitive edge and not to lose out to their competitors. The company in focus for this thesis currently has undefined and non-standardized purchasing processes and responsibilities which leads to confusion in accountability and unidentified critical process parameters. To this extent, the company in focus has decided to concentrate on further developing their supplier management and purchasing practices mainly centralized in the EU region.



This has motivated the authors to develop and map a very elaborate and improved supplier management and purchasing system for the company which will not only improve the internal working structure of the company but also improves the relations with their supplier which leads to the overall quality of the products and economic benefits. The process can be further developed to include a comprehensive map of the processes and subprocesses at each stage along with the responsibilities assigned. According to Van Weele (2001) improving purchasing processes and policies contribute to business success in several ways. Some of them being, improved sales margins, better quality and logistics arrangement with suppliers, and contribution by suppliers to the company's innovation process. This also allows us to experience and navigate an implementation of improved processes over an already tried and tested process which would also require change management knowledge.

### 1.3 Purpose and research questions

The purpose of this thesis work is to improve the supplier management of the company by developing and suggesting improvements in supplier quality along with detailed process flow charts with sub-processes for the respective purchasing process as per IATF standard and corporate requirements.

To support this thesis work and to reach its purpose, three Research Questions (RQ) have been formulated:

Process management has become a central element in quality management and implementing quality principles, process management also serves as a tool to map and improve organizational processes (Benner & Tushman, 2003). Therefore the first RQ was formulated as:

- **RQ1: How to improve the existing purchasing process to support a robust supplier management in purchasing function?**

In this thesis work, the term "Robust" refers to clear stakeholder responsibility mapping with the correct sequence of activities in the purchasing function.

Gruszka and Misztal (2017) emphasizes a multidisciplinary approach covering risk identification and risk analysis with respect to the new IATF 16949 standard that the authors wish to incorporate into the processes. Therefore, the second RQ was formulated as:

- **RQ2: How to incorporate the risk-based thinking approach as per the IATF standard in the existing business process?**

According to Kotter et al. (1995), the change process goes through a series of phases which usually requires a considerable length of time. The improved process will take a considerable amount of time to be implemented and for results to be analyzed. There will be resistance to the new suggestion by resistors, who are quick to spot

any opportunity to stop change (Kotter et al., 1995). Therefore the third RQ was formulated as:

- **RQ3: How can the updated processes be implemented to secure lasting improvements?**

## 1.4 Delimitations

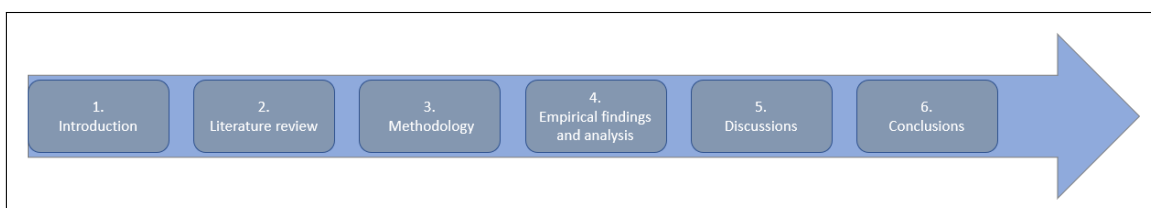
In this thesis there are some delimitations made:

Firstly, the thesis work has a main focus on purchasing processes in the EU region with Gothenburg being the purchasing headquarters. The North American purchasing functions were decided as out of scope and left out of the study as it wasn't considered viable within the given time frame. Second, the focus for developing logistic solutions and a sustainable supply chain is not in the scope of the thesis. Third, the environmental focus of the business process is not considered in the scope of this thesis. However, the results from the thesis could be relevant to consider. Fourth, Implementing and following up the result from an implementation of the proposed change in the purchasing process was not in the scope for this thesis.

Finally, the Coronavirus pandemic has led to a great disruption in the normal work routines. This has led to some interviews being canceled due to unforeseen circumstances.

## 1.5 Thesis Outline

A brief but detailed description of the study is given below, and a visual representation of the outline of the thesis is shown in Figure 1.1



**Figure 1.1:** Thesis Outline

**Chapter 1 - Introduction :** The first chapter gives a brief description of the problem, the purpose of the thesis, research questions, and the delimitations.

**Chapter 2 - Literature Review :** This chapter presents the relevant literature that was used in the thesis work with respect to quality management, process management, business process improvements, supplier management, supplier quality, risk management, knowledge management, change management, and quality standards.

**Chapter 3 - Methodology :** This chapter explains the research strategy that was selected for the thesis work, and the methods of data collection and data analysis. This chapter also includes reflections on the research methodology such as research quality and ethical consideration.

**Chapter 4 - Empirical data & Analysis :** This chapter presents the major findings and data that were collected from the Process and Enterprise Maturity Model (PEMM) questionnaire and the semi-structured interviews and a brief description of the existing purchasing processes. This chapter also presents the reader with the GAP analysis of the current state of the purchasing & supplier quality processes and analysis of the major findings.

**Chapter 5 - Discussions :** This chapter brings forth the theoretical findings along with the GAP analysis and the suggested improvements with respect to the processes.

**Chapter 6 - Conclusion :** This chapter summarizes the main findings of the thesis work and tries to answer the research questions that were put forth to the reader. Recommendations and future research also presented here.

# 2

## Literature Review

*This chapter introduces the reader to the different theoretical concepts that were identified and studied in correspondence to the main purpose of this thesis work.*

### 2.1 Quality Management

Quality has evolved from inspection of the products and reaction to conformance to standards to preventing the defects from happening in the first place (Lengnick-Hall, 1996). Strategic quality management has been seen as a means to shift customer-supplier relations by turning quality into a competitive weapon instead of a problem to be addressed (Lengnick-Hall, 1996). Competition and dynamic business environments have made achieving quality an essential part of organizational success as concluded by (Lengnick-Hall, 1996). Considering customers as the primary recipients and beneficiaries of products and services is the dominant perspective in most quality-management programs (Lengnick-Hall, 1996). This importance of a customer focus and high-quality product, or service, lead to enhanced competitive quality of a system (Lengnick-Hall, 1996). Ahire and Golhar (1996) proposed that Total quality management (TQM) practices in either large or small enterprises are a good strategy to execute. Ahire and Golhar (1996) further argued that TQM firms reported better effectiveness and product quality with respect to firms that have not implemented TQM. Ahire and Golhar (1996) concluded their arguments that TQM within the auto parts industry which the company that is the focal point of this study is situated in, both large and small firms reported high yields in quality.

A comprehensive review of the quality management principles and literature by Ahire and Golhar (1996) shed light on a few criterias for TQM implementations such as Commitment of top management, supplier quality management, and benchmarking. Sanchez-Rodriguez and Martnez-Lorente (2004) argued that top management plays a significant role in the form of a catalyst for quality management implementation by creating value goals and a system to improve organizational performance and satisfy customer needs. Similarly, Ahire and Golhar (1996) posited that lack of management support can lead to inadequate resource allocation for quality management efforts. This inadequacy can lead to less frequent uses of improvement techniques such as benchmarking and statistical process controls which were also mentioned by Ahire and Golhar (1996) as few criteria for TQM. Parallels can be drawn from Saraph, Benson, and Schroeder (1989) who also proposed that the success of an organization depends on its top management support to quality improvement efforts.

These include quality, empowering of employees and developing the human resource, employing quality based thinking and regular analysis for factors affecting quality.

### 2.1.1 Process Management

Process management became popular as a central element in quality management and continues to be at the forefront of quality initiatives for continuous improvements (Benner & Tushman, 2003). Benner and Tushman (2003) argued that process management is based on viewing the organization as an interlinked system of processes and involves significant effort to map and improve the existing organizational processes. Furthermore, Benner and Tushman (2003) posited that process management tends to be aimed at developing and improving processes that lead to customer satisfaction as the end result. However, it should be noted that customers are not limited to the external customers who are the recipients of the services or the products but also internal customers at linkage points between the processes (Benner & Tushman, 2003). This is because outputs from upstream processes become inputs for the subsequent processes which is supported by Zairi (1997) who defines processes as an approach for converting inputs into outputs. Process management normally entails 3 main practices: **mapping the processes, improving the processes, and sustaining those improved processes** (Benner & Tushman, 2003). These practices will be visited in the coming sections in detail.

Implementing process management in an organization comes with benefits such as increased productivity and streamlined processes which eliminate non-value-adding tasks and activities (Benner & Tushman, 2003). Process management also aims at improvements in processes and outputs for the organization's customers (Benner & Tushman, 2003). By measuring and collecting customer satisfaction data they are able to focus on better understanding and satisfying the customers (Benner & Tushman, 2003). It was also found that organizations having routines and procedures, as a result of implementing process management are likely to do better in stable environments, such as auto industries (Benner & Tushman, 2003). Process management further leads to efficient communication channels which guide to developing rules and procedures to streamline individual and group behavior to be more aligned to the organization missions (Benner & Tushman, 2003).

However, implementing process management as a means to improve efficiency is not without its limitations. Benner and Tushman (2003) argued that there is a tendency for increased resistance to change from process management activities. Therefore process management is positively associated with effectiveness in stable environments but can be met with resistance during turbulent environments (Benner & Tushman, 2003).

## 2.2 Supplier Management

Most companies believed that their ways of managing and influencing suppliers made no difference in their overall performance as a company. The industry

was strife with lack of trust with suppliers and playing the suppliers against one another in order to achieve drastic cost deductions (Trent & Monczka, 1999). The perceived supplier importance all changed in the presence of intense worldwide competition and constant cost reductions. Other significant trends were a more focused approach to core competencies and outsourcing of non-core requirements and international pressure to innovate and improve continuously (Trent & Monczka, 1999). Similar parallels can be found in Van Weele (2001) which stated that “*A fair and open attitude towards suppliers can help the company position itself as an attractive business partner. Buyers must make sure that the company actually meets its contractual obligations towards suppliers.*” In order to strengthen this relationship with the suppliers Prajogo et al. (2012) stated that buyers need to continuously monitor their respective supplier performance and provide feedback for improvement. This is because without this careful monitoring of performance the buyers will not be able to determine if their key suppliers can meet the current demands and future business (Prajogo et al., 2012).

Purchasing managers (PM’s) and officials play a major role in supplier management. Their understanding of uncoordinated behaviors on suppliers can be used to improve their interactions with both suppliers and operations personnel and ensure successful purchasing initiatives (Ellegaard & Koch, 2012). It was found that in order to maintain positive relations with suppliers it is required to counsel and support them throughout the initiative (Ellegaard & Koch, 2012). It is also beneficial to have continuous interaction to see how the initiatives are progressing and to take necessary corrective actions (Ellegaard & Koch, 2012).

Most supplier management efforts main focus is to identify poorly performing suppliers and to develop them to acceptable standards, but rarely focused on suppliers that are performing adequately (Fletcher, 1992). The author argued that while the “push” method of developing suppliers is effective, combining it with a “pull” method of recognizing outstanding suppliers can multiply the returns of a supplier management system.

### **2.2.1 Supplier Quality**

Significant differences in customer satisfaction levels were found in companies employing quality-oriented purchasing practices as opposed to those companies that did not (Sanchez-Rodriguez & Martnez-Lorente, 2004). In order to achieve satisfactory levels of quality in their services and products, companies would need to mobilize their internal (employees) resources and external (suppliers) resources in a continuous process (Sanchez-Rodriguez & Martnez-Lorente, 2004). Sanchez-Rodriguez and Martnez-Lorente (2004) argued that the buyer-supplier relationships have effects on supplier quality and characteristics of the relationships such as visits to supplier plants, supplier rewards and recognition, communication, and information sharing with the suppliers among other things are important. Hence, the overall quality performance information and monitoring on material rejection rates, non-conforming deliveries, and others need to be implemented to

assure the continuous improvement of quality and supplier capabilities (Sanchez-Rodriguez & Martnez-Lorente, 2004). Suppliers also need to be informed of their performance so the areas of weakness can be identified and can later be improved (Sanchez-Rodriguez & Martnez-Lorente, 2004). Furthermore, Ahire and Golhar (1996) acknowledged this argument by stating that supplier involvement is critical for incorporating quality into the products and for the buyers to ensure a reliable source of high-quality raw materials. Saraph et al. (1989) proposed that supplier quality control and purchasing policy emphasizing quality over cost could increase the standard of quality.

Furthermore, Saraph et al. (1989) suggested having long-term relationships with the supplier and vendors based on their ability to supply quality parts rather than lower prices to ensure quality in supplier involvement.

### **2.2.2 Supplier evaluation and Audits**

One way to make sure that the supplier adheres to the quality standard requested by the buyer is through supplier evaluation and audits (Trent & Monczka, 1999). Companies, particularly in the automotive and the large electronic manufacturing sectors have been conducting evaluations based on either process (Quality management, supplier organizations system) or performance-based evaluations (supplier quality or delivery performance) (Purdy, Astad, & Safayeni, 1994). With the advent of Just-In-Time manufacturing and Lean production, the sensitivity to variability had drastically increased (Purdy et al., 1994). Hence, buyers need to secure a minimum variability from the supplier side. Supplier evaluation may be a means to decrease said variability in for example quality and delivery. Suppliers found to have undesirable variability are recommended to be eliminated from the buyer's pool of suppliers (Purdy et al., 1994). This was corroborated by Trent and Monczka (1999) who in their research found that 80% of purchasing managers formally assess supplier process capability, control techniques, and commitment of the supplier to continuous quality improvement. These visits are usually preferred to be done by team site visits. Zeydan, Çolpan, and Çobanoğlu (2011) posited that the overall objective of a supplier evaluation process for a company should be to reduce risks and be able to maximize value. Zeydan et al. (2011) argued that an effective supplier survey should be reliable, flexible, objective, and mathematically sound.

The purpose of an evaluation or an audit is to force organizations to take a peek at their operations and look more closely at the intricacies of their process and functions. Purdy et al. (1994) found that suppliers, when having to prepare for an audit, looked more closely into their operation and altered their internal operations, and thereby improved their effectiveness by themselves. Furthermore, having an emphasis on documenting processes is considered important since it gives an at-a-glance view of their organizational structure which can help buyers and customers to determine the quality standard of the supplier (Purdy et al., 1994).

### 2.2.3 Drawbacks of Supplier evaluation

Evaluation of suppliers has its merits and its demerits. One such demerit is that suppliers can learn how to “look good” on paper and get a good score during the evaluation without actually improving themselves (Purdy et al., 1994). Hence it is imperative to consider different perspectives and criteria rather than having only the required systems and procedures in place (Purdy et al., 1994). One must be aware of the trade-offs that are a key issue in the supplier assessment process, for example, a vendor can offer inexpensive but below-average quality parts while another might offer high-quality parts with uncertain terms of delivery. This is further complicated by the nature of the criteria for evaluation such as quantitative (price, quality, etc) and qualitative (service, flexibility). It is advisable to not follow a single criterion model which makes the supplier evaluation process riskier. Therefore, it is of importance for companies to employ a method of evaluation that can adjust to the purchasing strategy of the company (Zeydan et al., 2011).

Audits that are used for evaluating and maintaining supplier quality are also a key factor in the certification of suppliers (Trent & Monczka, 1999). Certifications allow for a supplier’s processes and operating methods to be in total control and that products or services from them need not be inspected thoroughly upon receipt (Trent & Monczka, 1999). Similarly, Chen and Paulraj (2004) proposed that supplier certification is needed for the thorough investigation of the suppliers’ processes and performance which increases the supplier product quality, reduces errors in communication, and enhances buyer-supplier trust. However, it is argued that a buyer can become complacent once a supplier receives certifications, and less frequent inspections of services and products from suppliers are planned (Trent & Monczka, 1999). Even though there are benefits from certifications, buyers must be aware that supplier processes, management and workforce change over time and with it the consistency of quality guaranteed by the supplier certification (Trent & Monczka, 1999). More on certifications and quality standards will be followed in section 2.3.

## 2.3 Quality standards

Fletcher (1992) stated that customers always request the suppliers to invest time and resources to adapt their processes to the individual customer’s unique requirements. With the importance of supplier quality management, the suppliers are obliged to meet the quality requirements of a variety of quality management programs (Fletcher, 1992). Suppliers are not able to satisfy the requirements of every customer and to this end Fletcher (1992) proposed a focus on few elements that can reduce the burden on suppliers:

1. A standard quality specification that should be followed.
2. Trained and qualified Individual assessors.
3. An independent third party to assess suppliers.
4. Publication of successfully appraised firms.



Fletcher (1992) concluded that national/international and third-party assessments can drastically reduce the burden on suppliers and still work in the favor of customers to identify good suppliers. Though it is not proven with certainty, Martínez-Costa, Choi, Martínez, and Martínez-Lorente (2009) proposed that implementation of ISO standards can lead to some form of improvement in company performance.

This thesis work focuses mainly on the IATF 16949 standard. However, other quality standards like ISO 14001 are also employed in the case company and hence elaborated upon. The ISO 9001 was briefly elaborated on due to the standard's contribution to the development of the IATF 16949.

### **ISO 9001 series**

The ISO 9001/2000 version introduced continuous improvements as a requirement which was missing from the previous versions, the ISO 9001/2000 version also includes principles of Total quality management philosophy which further separates it from being a mere quality assurance system like the previous versions (Martínez-Costa et al., 2009). However, Laskurain-Iturbe, Arana-Landin, Heras-Saizarbitoria, and Boiral (2020) argues that ISO 9001 does not meet the requirements of the automotive sector. This was because the ISO 9001 is considered to be too general when compared to characteristics of the automotive sector (Laskurain-Iturbe et al., 2020). The standard has evolved to ISO 9001:2015 with a greater inclination to continuous improvement, risk management, and integration with standards related to the environment, ethics, health, safety, and application of process approach (Bravi, Murmura, & Santos, 2019), which are crucial parameters in the IATF standard (IATF, 2016).

### **ISO 14001**

Companies have come to a realization that environmental management is part of business processes, this adoption has come on the backdrop of institutional pressure and market demands for more ecological practices (Jiang & Bansal, 2003). The ISO 14001 requires companies to identify environmental goals to be achieved and develop a policy accordingly (Jiang & Bansal, 2003). However, though an internal EMS (Environmental Management System) can be modified as per the needs of the organizations, an ISO 14001 must be certified by a third party and the firm must adhere to all the specifications put forth by the standard in order to be certified (Jiang & Bansal, 2003). The intended use of being ISO 14001 certified helps to implement and employ EMS which reduces the firm's negative environmental impacts among other benefits of employing quality standards like continuous improvement and structured processes (Jiang & Bansal, 2003). The certification also helps to maintain and improve an EMS of the firm while having international credibility as opposed to an in-house EMS (Jiang & Bansal, 2003)

**IATF 16949:2016**

The IATF 16949 was prepared by the International Automotive Task Force (IATF) of the International Organization for Standardization (ISO) based on the ISO 9001 standard. The aim of implementing a global quality management system emphasizing continuous improvement and defect prevention from vehicles to components throughout the supply chain (OEM to Tier 1, 2, 3, 4, etc.) (Gruszka & Misztal, 2017). The IATF standard calls for a process-based approach with emphasis on top management commitment, contingency planning, requirements for corporate responsibility and layered process audits (Gruszka & Misztal, 2017). The IATF standard also prioritizes a risk-based thinking approach to product recalls, field returns and repairs, complaints, and the development and deployment of an internal audit program within the company that encompasses system, processes, and products (Gruszka & Misztal, 2017). This risk-based thinking approach could include analyzing nonconformities, preventive actions to eliminate nonconformities and necessary action to prevent re-emergence of nonconformities (IATF, 2016). With respect to the process-based approach, the standard requires that inputs and outputs of the processes are determined, that responsibilities and ownership for the processes are assigned, and a continuous improvement of processes and the quality management system among others (IATF, 2016). The standard also requires the organization to be able to maintain and document information to support the processes (IATF, 2016).

Furthermore, the standard requires that personnel in charge of quality defects should have authority to stop shipment and production to address the quality problems and the organization should be able to define contingency plans according to the risk and impact of the risk to the customer (IATF, 2016). The standard also specifies that personnel necessary for the operation of the process, and to achieve conformity, should be trained and managed by the organization (IATF, 2016) and that internal auditors shall have an understanding of the ISO 9001 and IATF 16949 requirements, the automotive process approach for auditing among other things (IATF, 2016). Moreover, the standard specifies that the documented information should be available and suitable to be used as per the convenience of the one using it (IATF, 2016). Finally, the standard stipulates a documented process for supplier selection which includes quality and delivery performance, and an assessment of risk with respect to product conformity and uninterrupted supply among other things (IATF, 2016).

IATF (2016) requires the change in standards and specification may lead to an update of the Production part approval process (PPAP). Shrotri and Dandekar (2012) posited PPAP as a method to provide evidence that the organization has understood and fulfilled the design and specifications put forth by the customer for its product. Shrotri and Dandekar (2012) proposed that a PPAP submission is required for new parts, process, or supplier and any changes to an existing product. With respect to the submission of PPAP the status of the approval of PPAP varies, where the approval of the submissions means that the organization ensures

production meets customer requirements (AIAG, 2006).

Types of approval in PPAP:

1. Approved: The part meets all customer requirements and the organization is authorized to produce and ship the parts in full quantities (AIAG, 2006).
2. Interim approval: The organization is approved to only ship parts on a limited time or quantity basis. Approval status can be obtained on resubmission of PPAP (AIAG, 2006).
3. Rejected: The PPAP does not meet the customer requirements and needs to be reevaluated (AIAG, 2006).

IATF (2016) stated that Advanced product quality planning (APQP) is a standardized way to share results between the organization and the customers. Mittal, Kaushik, and Khanduja (2012) proposed that APQP is a functional strategy to be used for productivity improvements and can be effectively involved in quality improvements of existing products.

## 2.4 Business Process Improvements

A process is an approach for converting inputs into outputs, and a business process is a structured approach to analyze and continually improve fundamental activities such as manufacturing, communications and other major elements of a company's existing operations (Zairi, 1997). Improving business processes enables an organization to stay competitive and increases the responsiveness to customers, the productivity of employees, and the company's return on investment (Zairi, 1997). The expertise to examine and understand the process sets you apart from the competition because of your understanding of the power and value that process delivers (Page, 2015). This is acknowledged by Zairi (1997) who argues that Business process Management (BPM) ensures consistent ability to deliver high-quality standards of product and services. The business processes we would like to focus on throughout the study are mainly that of the purchasing processes. However, the purchasing process is not always exclusively for the purchasing department where many levels in the organization are usually involved in some capacity or the other. This cross-functional discipline demands adequate communication and co-operation which requires different roles in each department to be involved in each phase in order to prevent misunderstandings and role conflicts (Van Weele, 2001).

According to Page (2015) and Zairi (1997), there are key objectives that should be considered in business process improvements. They are:

1. Effectiveness: The process is meeting the needs of the clients and producing the desired results.
2. Efficiency: The process minimizes the use of resources and saves time by eliminating red tape.
3. Adaptability: The process can adapt to the ever-changing market situations accordingly.

Finding out if a company has a process inventory or not is crucial to any business improvement actions (Page, 2015). A process inventory is a list of processes that a functional unit owns and the first step that one has to do is to build one if such a list does not exist (Page, 2015). The current state of the process, that is; how well the business process works for the functional unit that owns the respective process needs to be identified (Page, 2015).

Page (2015) proposed three criteria to be used to assess the current state:

1. Client satisfaction: It refers to how the clients or the internal customers view the business process with respect to the effectiveness of the process.
2. Pain Level: It refers to how well or poorly the process works for the department responsible for the process.
3. Process Exist: It refers to the existence of the said process and if it just remains an informal process that employees do without it being documented.

### **2.4.1 What does responsibility have to do with processes?**

Responsibility of the processes needs to be determined and specified in order to avoid confusion of duties especially in the cross-functional setting where many disciplines and levels in the organization are involved (Van Weele, 2001). This makes it very important to have respective process owners for the processes. A process owner is the one responsible for all the processes, and in business improvement, it is imperative to identify who has the responsibility and what role they play in each process even if it transcends multiple levels (Page, 2015). While considering the process owners it is also important to consider the other areas and departments in the company that can directly or indirectly affect the business process. Hence, it is important to refer to the people in these groups as stakeholders (Page, 2015).

### **2.4.2 Process design**

Zairi (1997) and Harrington (1995) stated that a key element in understanding the process and in-process redesign is flowcharting the processes. A flowchart is a graphical representation where symbols are used in order to visualize and represent data such as flow direction, processes or a solution to a problem (Aguilar-Saven, 2004). A flowchart modeling method represents the required data by employing flow charts. A flow chart is mainly employed due to the ease of use and the ease of representation. It is easy to recognize a process when described by a flow chart. Hence, the real strength of using the flowchart modeling method is the communication ability (Aguilar-Saven, 2004). Another activity that can be beneficial is the streamlining of the process such as forms, reports, and documentation. It simply means eliminating and reducing any sort of complexity in the business process such that the process becomes easy to understand and efficient. When streamlining, process maps, or processes it helps to sustain the process and it becomes more flexible to client needs (Page, 2015).

However, the method is not without its flaws. Flow charts tend to be very big and

the lack of significant difference between the main activities and sub-activities makes it difficult to read (Aguilar-Saven, 2004). Another issue being there is no natural way of describing the responsibilities or performers in the chart (Aguilar-Saven, 2004). These slight drawbacks of flow charts can be overcome by adding a line to separate different responsibilities within the respective department and functions creating a parallel process that can be visualized. This method of line separation is called swimlane presentation which gives a subtle breakdown of inter-processes (Jablonski & Goetz, 2007). Making such a cross-functional process map enables visualizing the responsibilities moving from one department or the other (Page, 2015).

### 2.4.3 Process improvements

The role of IT is more profound to the development of the business processes and business process improvements, it is more likely to have a positive impact on individual performance and organizational performance (Okrent & Vokurka, 2004). However, this is only true if it matches the business processes. This is why the importance of Enterprise Resource Planning (ERP) is stated in this thesis as it is an integral part of the improvement processes. ERP is the current progression of planning tools when computers were applied to material plannings for production (Okrent & Vokurka, 2004). Successful implementation of ERP is argued to have the potential to result in customer satisfaction, improved profits, improved quality among other things (Okrent & Vokurka, 2004). However, one of the biggest challenges of implementing an ERP system is the desire of businesses to retain their existing processes and modify the software to match the processes (Okrent & Vokurka, 2004).

According to (Okrent & Vokurka, 2004), there are three major phases in ERP Process mapping or business process redesigning. They are **As-Is, To-Be and Bridging the chasm.**

**As-Is:** To understand why the process is performed in a particular way allows the elimination of non-value-adding work during the simplification stage.

**To-Be:** An idealized process with no constraints is created for each critical process after the evaluation of what processes are critical to the business.

**Bridging the chasm:** As the name suggests the radical transition from As-Is to the To-Be process can be controlled by creating and implementing a change management program.

In order to assess the as-is situation, maturity models are a prospering method to improve a company's processes and business process management/improvement efforts (Röglinger, Pöppelbuß, & Becker, 2012). Their basic purpose is to outline the stages of maturation paths, they typically include a sequence of levels or stages that form a path from an initial state to maturity stage (Röglinger et al., 2012). Röglinger et al. (2012) argues that maturity models are used to assess the as-is situations and

to identify the desirable future maturity levels. It suggests improvements based on those observations and provides guidance on how to implement them accordingly.

Röglinger et al. (2012) argued for six models that claim to have detailed assessment criteria for an as-is analysis which is predominant in this thesis. One Model that has appeared routinely in their suggested models is the Process and Enterprise Maturity Model (PEMM). This particular model was chosen for this thesis work because it was relatively easy to use when compared to other maturity models.

## 2.5 Process and Enterprise Maturity

The Process and Enterprise Maturity Model (PEMM), was developed by (Hammer, 2007). The model does not only supervise the maturity of the processes but also facilitates the design and redesign of processes. There are predominantly 2 sets of scoring criteria that are used in the PEMM: Process Enablers and Enterprise capabilities as explained by (Hammer, 2007).

Process enablers determine how well a process is able to function over time and consists of five elements:

**Design:** Relates to the specification of the execution of the tasks and processes.

**Performers:** Relates to the ability and skills of the people working with the process.

**Owner:** A senior executive who owns the process and ensures delivery of results.

**Infrastructure:** Information technology and HR systems to supplement these processes.

**Metrics:** To assess the performance of the process over time.

Enterprise capabilities include support from top management and senior executives and consists of four elements:

**Leadership:** Senior executives or top-level management who support the creation of the process.

**Cultures:** The values of customer focus, teamwork, personal accountability, and a willingness to change.

**Expertise:** Skills and methodology for available process redesign.

**Governance:** Mechanisms for managing complex projects and change initiatives.

Companies can use the scores from these enablers and capabilities to assess and plan the progress of process-based transformations (Hammer, 2007).

Below given are two examples of an enterprise maturity and process maturity questionnaire respectively:

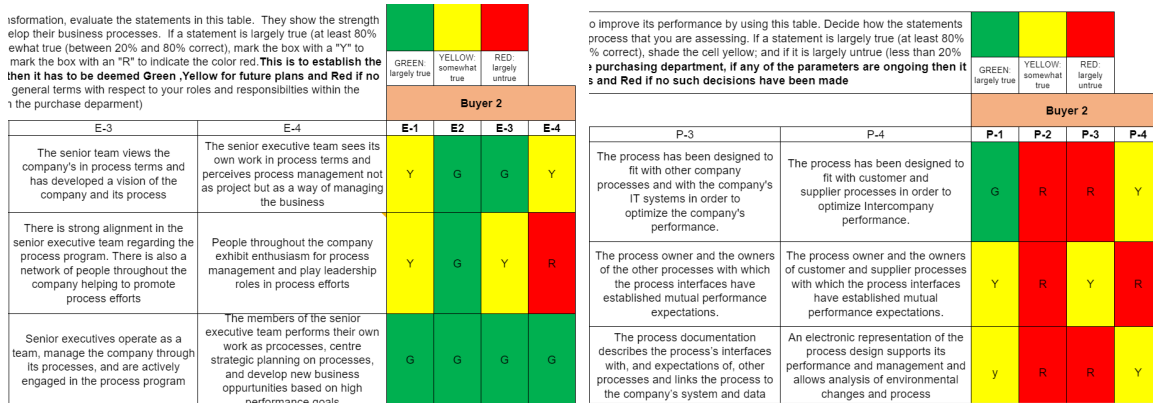


Figure 2.1: Enterprise and process maturity evaluation

There are four levels of Enterprise capability: E-1, E-2, E-3, and E-4 where E-1 is at the first level of maturity. When an organization moves to the next maturity level, different and improved versions of the criteria stated earlier need to be met. This is in order to continue elevating to the higher levels till we reach excellence in capabilities which is E-4. Similarly, for process enablers it is denoted into P-1, P-2, P-3, and P-4 and the criteria improve with each maturity level and the process is best in class at P-4.

Solid and strengthened enterprise capability enables better process performance. Therefore, when an organization or enterprise reaches capability level E-1 in all criteria it is ready to elevate all processes to P-1 level, this same logic is applied to all levels of maturity where enterprise capability in all criteria is a precursor to organizational/enterprise process elevation (Hammer, 2007). Executives can assess the enterprise and process maturity by evaluating each criterion based on if the criteria are largely true, somewhat true, and largely untrue for their organization. From Figure 2.1 which was adapted from Hammer (2007), colour codes are used to identify those aspects. If the organization welcomes the processes and is largely true to the criteria put forth it is Green. Still needing work and somewhat true will be graded in Yellow, hostile and resistant to the process and largely untrue will be Red.

For both Enterprise capability and process enablers there exists a stage when the criteria are not even met at the minimum at level 1 and are considered weak. This is stage zero and denoted as E-0 for enterprise capability and P-0 for Process capabilities (Hammer, 2007). Furthermore, the strength of the enabler or capability determines how mature the process is. If all enablers and capability criteria are at P-1 and E-1 level then the whole process/maturity itself is said to be at the first level, the levels increase only if all the criteria are at the same level or above in order for the process/maturity to be on the same level. However, if one criterion out of the rest is on a lower level with respect to the others then the process capability cannot be said to have achieved that level but will belong to the level below (Hammer, 2007).

### 2.5.1 Advantages and disadvantages of PEMM

PEMM can be applied to all the existing processes in the company, which allows for standardization throughout the organization (Hammer, 2007). This helps in sharing experiences and comparison of results (Hammer, 2007). PEMM is relatively easy to administer, personnel can be trained in the process after a brief introduction and the individual is able to interpret the model with ease (Hammer, 2007). The model is self-explanatory and the simplicity allows people to apply it themselves (Hammer, 2007). A big part of the model is that it uses testable propositions rather than opinions which factors out emotions and avoids needless arguments (Hammer, 2007).

However, the model is not without its limitations. Power (2007) brings forward several of these drawbacks. One of them being that the process maturity model does not mention any link between maturity and possible business outcomes. Strategic alignment of the organization is also not touched upon in the model which raises the question if the improvement activities are in line with the firm's strategic vision (Power, 2007). An assessment of the IT infrastructure is not included in Enterprise capability given the importance of IT in enabling process improvement (Power, 2007). The last drawback is that each organization is unique and practices for qualifying for a maturity level may make sense and adhere to one organization but might not make sense and be accurate to another (Power, 2007).

## 2.6 Knowledge Management

Companies have been focusing on their knowledge resources as a means to gain both strategic and competitive advantages (Goh & Hooper, 2009). The benefits of an established and efficient knowledge system can range from speedier decision-making to greater flexibility in dealing with change and responding to crisis (Goh & Hooper, 2009). Effective communication and knowledge management are critical elements for successful process integration (Goh & Hooper, 2009). However, knowledge management requires more than a simple transfer of information from one point to another, a common understanding of the information and open dialogue for all parties concerned add to its foundation (Fugate, Stank, & Mentzer, 2009). The Japanese approach to knowledge management is that new knowledge is not created by just processing objective information, but by tapping the tacit and highly subjective insights and intuitions of employees and making that available for experimentation and use by the whole company (Nonaka & Takeuchi, 2007). Therefore, similar to the Japanese approach, members of an organization should purposely participate in certain behaviors that foster a shared interpretation of available information and also helps to drive a uniform knowledge base (Fugate et al., 2009). Valuable knowledge resources will be wasted until and unless management openly accepts and supports the effort to gather, sort, transform, record, and share knowledge (Smith, 2001). This is corroborated by Nonaka and Takeuchi (2007) who said that top management is responsible for providing the employees with a sense of direction by setting standards for justifying the value of the knowledge that is being constantly developed.



### 2.6.1 Types of knowledge

Smith (2001) stated that individuals usually use two types of knowledge when applying their knowledge in unique ways. They are tacit knowledge and explicit knowledge. Tacit knowledge is the knowledge that is accumulated over a period of time due to experience and explicit knowledge is the knowledge that can be communicated and shared via print or data storage. Nonaka and Takeuchi (2007) described the spiral of knowledge where one form of knowledge is converted to another by a specific mechanism. The mechanisms are **socialization, internalization, externalization, and combination**. Socialization is the process of converting tacit to tacit knowledge where the knowledge never becomes explicit and cannot be leveraged by the organization as a whole. Externalization is the process of converting tacit to explicit knowledge by the articulation of knowledge in the form of figurative language and symbolism. Internalization is the process of converting explicit knowledge into tacit knowledge and it can be shared across the organization. Externalization and internalization are critical mechanisms that involve strong communication and integration throughout the organization.

Sharing knowledge in a timely manner assists in making the knowledge accessible to the recipients which allows furthering the likelihood of collective agreements being achieved (Fugate et al., 2009). Fugate et al. (2009) further argued that effective knowledge dissemination requires quick transfer of knowledge. Failure to share the knowledge in a timely manner could result in a dynamic change in the business environment and make the knowledge outdated and irrelevant. The study focuses on purchasing functions, therefore the integration of Logistics operations (LO) personnel has become important to the management of global supply chains because of their opportunities to acquire inbound supply knowledge through their involvement in the relevant activities (Fugate et al., 2009). Since they interact with customers, third parties, and suppliers, LO personnels can capture and timely share important outbound and inbound knowledge of the business environments.

### 2.6.2 How ERP helps knowledge management

ERP helps in integration and creating a synergistic knowledge-based management environment by taking in the functions of operational planning and control and links them with all other business functions (Okrent & Vokurka, 2004). This is corroborated by Dwivedi, Papazafeiropoulo, and Metaxiotis (2009) who proposes that when integrating ERP systems with knowledge management, a central database and knowledge base is built which collect information and knowledge from all functions, filtering based on content while establishing links and relationships among the elements. This information is then fed into the decision support applications supporting all of the company's business activities (Dwivedi et al., 2009). The database is automatically updated when new information is entered into the system (Dwivedi et al., 2009).

There are a number of barriers to knowledge management, one of the most important barriers being a lack of trust to share knowledge and a lack of sharing

knowledge under the perception that holding on to knowledge is power. Others can include a company policy of zero tolerance of mistakes leading to withholding crucial information (Goh & Hooper, 2009).

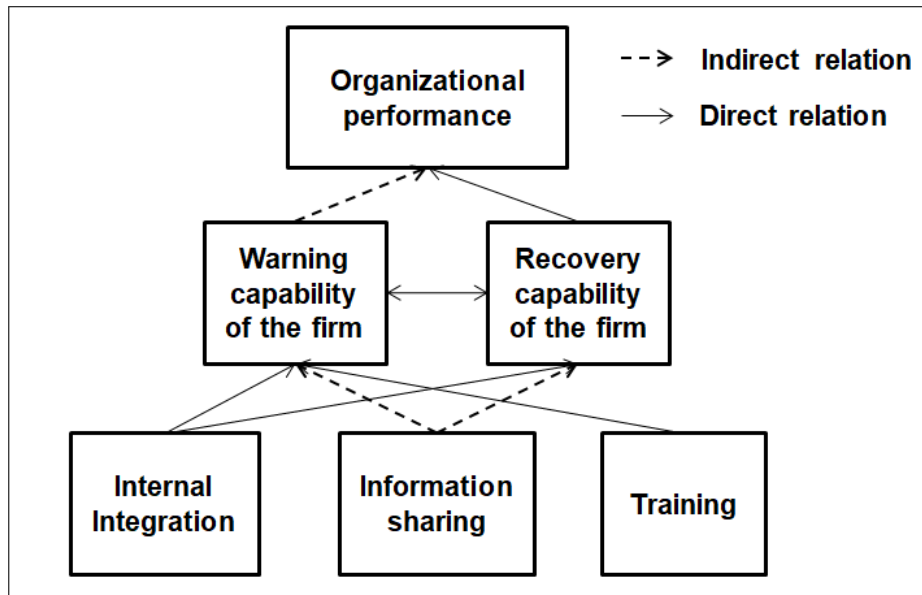
## 2.7 Risk Management

Hallikas, Karvonen, Pulkkinen, Virolainen, and Tuominen (2004) proposes that risk management in a company consists of processes that are interconnected and dependent on each other, these processes are given below:

1. **Risk identification:** It is a crucial process in risk management, by identifying the risk, the stakeholders of the processes are aware of the events that caused the disruptions (Hallikas et al., 2004). The main objective of risk identification is to be more proactive so as to identify future uncertainties (Hallikas et al., 2004). Hallikas et al. (2004) concluded that not all risks are easy to be identified and feedback loops and cascading events can be challenges to risk identifications that companies must overcome.
2. **Risk Assessment:** Risk assessment is needed to choose the suitable action that is required to mitigate the identified risks (Hallikas et al., 2004). The impact and effect of the risk to the company and the probability of the disturbance also needs to be assessed (Hallikas et al., 2004).
3. **Risk management actions:** Risk identification and risk assessment gives the company an idea on where to focus the management action, a few risk management actions are risk transfer, risk-taking, risk elimination, and risk reductions where the company must choose which action to follow based on circumstances (Hallikas et al., 2004).
4. **Risk monitoring:** Risks once identified and managed have a potential to reemerge, in addition; new risk factors can appear which makes it imperative to monitor the supply chain network for disruptive changes (Hallikas et al., 2004).

Supply chain risks refer to the variations or disruptions in the supply chain and the possible outcomes from these disruptions (Riley, Klein, Miller, & Sridharan, 2016). Disruptive events in the supply chain can proportionally affect the financial bottom line of respective stakeholders affected in the supply chain (Craighead, Blackhurst, Rungtusanatham, & Handfield, 2007). Craighead et al. (2007) posited that the density of the supply chain is positively correlated to the severity of the supply chain disruption where density refers to entities in the supply chain that are situated in close proximity to one another geographically (Craighead et al., 2007). Riley et al. (2016) postulated that supply chain risk management refers to the coordination of resources and collaboration among the partners to return the supply chain back to functionality. These risks need to be managed by managing disruptions across the entirety of the supply chain and not just to their organizations (Riley et al., 2016). To

this extent, Riley et al. (2016) proposed a model consisting of internal integration, information sharing, training, warning capability, and recovery capability of the firm which explains the factors affecting operational performance in a firm and the interrelationship among them in Figure 2.2 which is adapted from Riley et al. (2016).



**Figure 2.2:** Factors affecting Firm performance and risk management and their interrelationships

**Internal Integration :** It indicates how well the organization deals with different internal processes (Riley et al., 2016). Similarity Chen and Paulraj (2004) stated that internal integration is a means through which firms are enabled to integrate and collaborate through traditionally established boundaries between functional units. Managers can develop the integrated processes to improve the flow of goods and information between different functional units (Riley et al., 2016). The authors argued that Enterprise resource planning systems (ERP) can be used to achieve internal integration by accumulating data from different functional units of the organization. In an integrated organization, managers can leverage this ERP system to fast forward detection activities and quickly be able to address the disruption accordingly (Riley et al., 2016). Ellegaard and Koch (2012) argues that a lack of internal integration can have severe negative effects on the buying company's performance.

**Information sharing:** Information sharing allows the organization to manage and change operational settings when necessary by being able to search through the data in real-time (Riley et al., 2016). Information sharing between functional units and the employees in the organization can be regulated by having protocols that specify how the information should be transferred (Riley et al., 2016). Riley et al. (2016) concluded that when employees and departments in an organization share information, it reduces uncertainty (Hallikas et al., 2004), improves decision-making capabilities and greatly increases the risk mitigation component

in supply chain risk management (Riley et al., 2016). Information sharing leads to a positive buyer-supplier relationship and improved visibility and understanding of different tasks that can affect the supply chain and its partners (Riley et al., 2016).

**Training:** Training is a process of facilitating knowledge transfers, managers use training to teach employees on the different supply chain risks to diagnose and the appropriate responses to handle the disruptions once they occur. It is not limited to the employees but even managers can be trained in risk identification and rectification (Riley et al., 2016). Active organizations embrace training as a method to prepare for the worst and the impending; therefore, organizations with a higher capacity for training and embrace training tend to have higher warning levels (Riley et al., 2016). (Riley et al., 2016) further argued that in the absence of an understanding of using risk management tactics, employees can delay adequate responses and recovery efforts.

**Warning capability:** It is the capability that represents the interactions and coordination among the supply chain resources and partners to identify and warn about potential disruptions or anomalies and their possible impact on the supply chain (Riley et al., 2016) & (Craighead et al., 2007). They mainly consist of identification of the risk and communicating the risks to the affected members in the supply chain effectively (Riley et al., 2016). Warning capabilities do not affect the performance directly, but a combination of recovery capability is able to improve overall performance (Riley et al., 2016).

**Recovery capabilities:** It is a capability that represents the interactions and coordination among the supply chain resources to return the supply chain back to normality and planned levels of product flow (Riley et al., 2016) & (Craighead et al., 2007). If these interventions and measures were anticipated early on before the occurrence of the respective disruption then the recovery capability is said to be proactive in nature (Craighead et al., 2007). Similarly, if these interventions were implemented after the disruption had occurred then the capability is said to be reactive (Craighead et al., 2007). The most ideal scenario would be to have a proactive nature in recovery capability with predefined actions put in place which are triggered by specific disruptions (Craighead et al., 2007).

### 2.7.1 Sourcing strategies

As mentioned by Riley et al. (2016) supply chain disruption can happen at any time and it is imperative to have protocols in place in order to mitigate such disruptions. Yu, Zeng, and Zhao (2009) proposed that there are mainly two main risks inherent with supply chains:

**Operational risks:** It refers to inevitable uncertainties like uncertain customer demand, uncertain supply among others.

**Disruption risk:** It is referred to as major disruptions caused by both natural (earthquake, tsunami) and man-made (economic crisis, strikes)

Sourcing is found to be directly related to disruptions in the supply chain and hence can also be used to mitigate disruption (Yu et al., 2009). Ramsay and Wilson (1990) & Yu et al. (2009) proposes that there are namely 2 types of sourcing strategies employed by companies that can be an effective tool in dealing with unexpected supply chain disruptions:

**Single sourcing:** Single sourcing is a strategy of buying from a single supplier based on factors such as geographical location, design ownership, and customer requirements (Ramsay & Wilson, 1990). This is supported by Yu et al. (2009) who said that single sourcing is when a company sources from one supplier even with the existence of other suppliers in the market. The advantages of this strategy are that it is cost-effective, improved communications and understanding between each other among other (Ramsay & Wilson, 1990). Disadvantages of single sourcing which is a greater risk of supply chain disruptions due to reliance on a single source of supply (Yu et al., 2009) & (Ramsay & Wilson, 1990).

**Multi sourcing:** Multi sourcing refers to a buyer who does business with multiple suppliers and a significant advantage being the buyer enjoys best price advantages and multiple alternatives in the event of a supply disruption (Yu et al., 2009). However, a disadvantage can be perceptions of lack of commitment of buyers from the supplier side leading to uncertainty and lack of security (Ramsay & Wilson, 1990).

Yu et al. (2009) proposes that the choice of a single source strategy or a multi-source strategy depends on the trade-offs of these methods. The authors conclude that single sourcing is the preferred strategy when the capacity of suppliers is large when compared to the demand of the product, but in all other instances, it is better to go with other strategies.

In order to mitigate a few of the disadvantages stated above one strategy that can be used is the contracting strategy (Ramsay & Wilson, 1990). Ramsay and Wilson (1990) proposes 2 main types of contracts:

**Short-term contract:** They have very low contractual liabilities and are the preferred contracts when dealing with new products or new suppliers. They can also be used to produce short-term improvements in the supplier which are generally short-lived. They usually bring uncertainty to the suppliers because short term contracts can be used to punish the supplier and to extract desired behavior (Ramsay & Wilson, 1990).

**Long-term contract:** Firms are able to get the advantages of single sourcing and avoid the disadvantages of multi-sourcing through the help of long-term contracts. Other advantages can be that it can be used as a means to reward supplier performance, insurance against future shortage of prices and to amplify the buyers spending power. However, the firms become heavily liable and committed to sup-

pliers and make it difficult to change or cancel the contract (Ramsay & Wilson, 1990).

### 2.7.2 Corrective action planning

Corrective action is an action employed by organizations to tackle and eliminate the identified root causes of nonconformities so that the chance of re-emergence is eliminated (Tomić & Brkić, 2011). A corrective action process should include reviewing the nonconformities, arbitrate the root cause of the nonconformities, evaluate the necessary action to eliminate the nonconformity, implement the action, document the result of the action, review the corrective action and propose course correction if the corrective action were not achieved (Tomić & Brkić, 2011). Tomić and Brkić (2011) concluded that solutions and corrective actions need to be determined if it is feasible, effective, if the budget allows for the particular solution, and the level of employee involvement.

Effective corrective actions have multiple solutions proposed where the most appropriate solution is accepted and the best fit is selected (Tomić & Brkić, 2011). Considering multiple solutions enhances the value of the final solution drastically (Tomić & Brkić, 2011). Maintaining a feedback channel when implementing the solution helps to continuously monitor the actual events with respect to the expectations (Tomić & Brkić, 2011).

#### 2.7.2.1 Eight disciplines (8D) model

8D method is a corrective action planning method that focuses on the root cause and helps identify the origin of the problem (Kaplík, Prístavka, Bujna, & Viderňan, 2013). It is a method that is usually employed by quality engineers especially in the automotive industry to identify, correct, and eliminate recurring problems to further process improvement (Kaplík et al., 2013).

The various disciplines of 8D are given as proposed by Kaplík et al. (2013):

**D0:** Planning the stage to solve the problems.

**D1:** Establishing a team with respective knowledge to tackle the problem.

**D2:** Define the problem and describe the problems in terms of who, what, where, when, Why, how, and how many.

**D3:** Develop and define interim containment plan actions.

**D4:** Scrutinize all possible causes that explains the occurrence of the problems and why it was overlooked at first.

**D5:** Quantitatively confirm the effectiveness of chose corrective measures towards the problem.

**D6:** Develop and define the corrective actions.

**D7:** Develop preventive measures to mitigate recurrence.

**D8:** Celebrate the win with the team and recognize their efforts by congratulating them.

## 2.8 Change management

Businesses and managers are faced with highly competitive and complex environments where the pace of change has dramatically increased (Paton & McCalman, 2008). Paton and McCalman (2008) proposed that the management of change is a complex, challenging, and progressive process. Hence, managers and the organizations they are part of will be judged based on their ability to navigate change effectively and efficiently (Paton & McCalman, 2008). For industry, the market conditions are a force for change which can also affect customers buying behaviors, and hence the most effective way to establish a familiarity with the customer is to understand their buying behavior and to change and sustain the supply chain accordingly (Huan, Sheoran, & Wang, 2004).

Many change models exist which can be of assistance to managers and organizations to implementing, managing, and sustaining change. Most literature on change management suggested Kotter et al. (1995) or used his change model as a groundwork. Another model referred by the authors was the "ADKAR" model by Hiatt (2006) which gives an understanding of change at the grass root and individual level and had 5 steps. The model by Kotter et al. (1995) was chosen since it considered as a base for all other change management models. The model introduced by Kotter et al. (1995) suggested an 8 step model. These 8 steps were:

1. Establish a sense of urgency: Top management should be able to create a sense of urgency as to why the change is required and to convince the employee of the need to transform (Kotter et al., 1995).
2. Forming a competent team: Transformation initiatives fail without a dedicated leadership and top management support, the team must be dedicated to achieving the change and should comprise both top executives and members not from senior management to create coherence among the team (Kotter et al., 1995).
3. Establishing a vision: Establishing a vision of the future that the transformation team hopes to achieve along with a strategy to achieve that vision is the key to a successful transformation (Kotter et al., 1995). The vision should be easily understood and communicated with an appeal to employees, shareholders and customers (Kotter et al., 1995).
4. Communicating the vision: The transformation and the vision for the future can entail job losses, so communicating the vision must include growth possibilities and fair treatments to those being laid-off (Kotter et al., 1995). Managers must use all forms of communicating techniques to communicate the vision in both words and deeds with more importance to the latter (Kotter et al., 1995). Another important aspect of communicating the vision is that top-level leaders and the transformation team should embody and become a "living symbol" of the future and change they envisioned (Kotter et al., 1995).

5. Empowering others embrace the vision: Transformation, in order to be successful, requires the participation of a large number of people (Kotter et al., 1995). Communication can be used as a means to empower but it is not sufficient by itself (Kotter et al., 1995). Obstacles, both external and internal can be inhibiting factors for change with respect to an individual, and removing these obstacles is part of empowerment (Kotter et al., 1995).
6. Celebrating the short term wins: It is advisable to celebrate the short term wins that are achieved during the transformation process in order to maintain the urgency level of the transformation process since people can become disinterested during the transformation process as major changes take a long time (Kotter et al., 1995). Commitment to cultivating short-term wins can be a useful element in the change effort (Kotter et al., 1995).
7. Reinvigorating the change: Celebrating a win can be a boost to the change effort but declaring the transformation success as soon as a major win is accomplished can be detrimental to the overall change effort (Kotter et al., 1995). Instead of declaring victory, managers and team leaders should catapult on these wins to tackle bigger challenges which can include new re-engineering projects with bigger scope (Kotter et al., 1995).
8. Sustaining the change: One way to sustain change is to communicate periodically to the employees and stakeholders how the new culture and corporate attitude have helped improve the performance and making sure that the new employees integrate the new policies into their way of work (Kotter et al., 1995). People should not be left to their own devices to make assumptions on the change effort in order to avoid inaccurate assumptions and unclear and bad succession of the change effort to new employees can undermine years of hard work gone into the transformation process (Kotter et al., 1995).

The model talks about the role of management, especially that of top management. Balogun (2007) stated that middle managers play an important role in the change process as they act as liaisons or “linking-pins” between top management and grass-root employees, they are also responsible for effective communication of the vision and having them on the side can accelerate the change process.

Kotter et al. (1995) argues that a significant number of transformation efforts fail, putting the number at 70% of failure rates for transformation efforts undertaken by the company. Kotter et al. (1995) said that the reason for such a significant percentage of failure is skipping steps to save time and create an illusion of progress and critical mistakes in following the phases suggested to achieve change. However, the 70% failure rate proposed by Kotter et al. (1995) and the reasons behind it is disputed by Hughes (2011) who argued that there is a lack of empirical evidence behind the reasoning.

The concept of transformation teams and their importance in change effort were



elaborated by Hiatt (2006) & Kotter et al. (1995). Drawing parallels, Battilana and Casciaro (2013) proposed the role of change agents in the transformation. Battilana and Casciaro (2013) argued that change agents who played a central role in the organization's informal network, bridged disconnected groups and cohesive networks were beneficial for establishing both dramatic and minor changes regardless of the change agents position in the formal hierarchy. Battilana and Casciaro (2013) stated that the shape of the network of the change agent matters, whether it is a cohesive network or a bridged network.

**Cohesive Network:** In a cohesive network, the people and the change agent are connected to each other. The benefits of a cohesive network are that it builds trust, coordinated information sharing, and leads to a mutual understanding with each other (Battilana & Casciaro, 2013).

**Bridged Network:** In a bridged network the change agent is the focal point of the network, the change agent is connected to people who aren't connected to each other. The benefits of such a network are controlling of information and adaptation and sharing of information according to each person in the network (Battilana & Casciaro, 2013).

The use of these networks depends on the type of change effort and if the company is going through a divergent change or non-divergent changes (Battilana & Casciaro, 2013).

**Divergent change:** This is a change that makes organizations diverge and undergo dramatic changes from their current ways of working entirely. For divergent changes, a bridged network is more suitable because of the advantage of information control that allows for framing messages to individuals as per their needs to achieve the goal (Battilana & Casciaro, 2013).

**Non-divergent change:** Non-divergent changes are minor and not disruptive to the existing ecosystem and build on the existing policy and practices of the company. A cohesive network is more suited for such a change because of the trust that exists in the network system and non-believers in the change can be convinced by others to cooperate since the change is not too disruptive (Battilana & Casciaro, 2013).

As mentioned by Hiatt (2006) & Kotter et al. (1995), supporting the people who are part of the change effort can lead to a successful transformation. This also includes recognizing the obstacles and personal opinions that these people have to overcome. To that extent, Battilana and Casciaro (2013) proposed that organizations tend to have mainly 3 types of people who can enable or inhibit change efforts. They are:

**Endorsers:** They are people who are excited and positive about the change, identifying these endorsers in the early stage of the transformation process is crucial for the success of the transformation. Their engagement cannot be further

increased with any additional resources or personal interaction because they are willing to take part in the change effort regardless of their relationship with the change agent (Battilana & Casciaro, 2013).

**Resisters:** Resisters must be handled with care. The type of resistance offered and their remedies to the resistance vary according to the type of change effort. Close interactions with the resisters can make them rethink their stance against the change in non-divergent change. However, in the case of divergent change, they are less prone to peer pressure and can present significant hindrance that change agents must be varied about (Battilana & Casciaro, 2013).

**Fence-sitters:** Fence-sitters bring to the table both drawbacks and benefits of the proposed change. Personal interaction with them and the change agents where the need, the effects and the urgency of the change is explained can lead the fence-sitters to support the change and vice-versa (Battilana & Casciaro, 2013),

As proposed by Thomas and Hardy (2011), resisters and resistance should be celebrated. To this extent, Ford and Ford (2010) argued that resistance can be used as a catalyst to keep the conversation of change within the organizations circulating, where it can lead to deep conversations and discussions related to change. Ford and Ford (2010) posited that resistance can also be due to the apprehension and confusion about the change process. Hence, resistance helps to revisit the need for change and helps to bolster a sense of urgency which is important as mentioned by Hiatt (2006) & Kotter et al. (1995). Change agents should take a close look at the change proposals put forth by the resistance instead of trying to ignore it by classifying it as resistance. Overcoming this temptation to overlook the suggestion and instead of inviting and capturing it can lead to improvements in plans, proposals, and new information which can be helpful to the transformation process (Ford & Ford, 2010). With respect to knowledge gained from the resisters Ford and Ford (2010) proposed that changes are complex and carry with them many unknown variables, to this end local and specialized knowledge can help to shed light on the uncertainties and fill the gaps in the plans. Change agents must be welcoming and not defensive to such input as it can lead to them losing credibility and the specialized knowledge along with it (Ford & Ford, 2010). When such corrective inputs are put forth, instead of dismissing them, change agents should first look internally to see if there are any flaws in their plans to warrant such inputs and criticism instead of being critical and vocal about it (Ford & Ford, 2010).

Ford and Ford (2010) highlights some of the factors that can be attributed to resistance to change:

**Cognitive biases:** People tend to attribute success to their own capabilities, skill and effort while attributing failures to bad luck, unforeseen circumstances or even actions of other people. Similarly, change agents tend to blame drawbacks in change efforts to external factors and resisters (Ford & Ford, 2010).

**Social dynamics:** In order to avoid embarrassment and diminishing social stature people tend to downplay difficult situations and try to excuse their way out of failure in such a way it maintains their social standing. Similarly, managers and change agents who encounter problems or difficulties choose to downplay the situations and shift the focus of the problem to the resisters because it is socially acceptable. The author concludes that admitting mistakes can instead evoke attention, support and empathy and be able to garner resources managers and change agents might not have otherwise obtained (Ford & Ford, 2010).

**Managerial missteps:** Managers breaking agreements and the ensuing loss of trust, managers overselling and overstating the benefits of a change effort and understating the drawbacks, managers lack of commitment and reluctance to change efforts and managers taking shortcuts and breaking rules leading to a loss of credibility. These are few missteps managers make that can be detrimental to change efforts and can affect transformation goals drastically (Ford & Ford, 2010).

# 3

## Methods

*This chapter provides an overview of the research strategy, research design, data collection techniques, quality of the research work and ethical considerations for this thesis work.*

### 3.1 Research Process

Figure 3.1 illustrates the methodology followed in this thesis work. The thesis started off with the company supervisor meeting explaining the scope and outcomes of this project. After the discussions, a short summary was documented and sent to the university for approval. Throughout the course of this thesis work, the authors were constantly in touch with the company supervisor and university supervisor to align the requirements of the thesis work from both academic and company perspectives. Several activities were performed in this thesis work, some of them were done in series and some of them were done in parallel. The literature study throughout this work was highly helpful in guiding the thesis in the right direction, and the purchasing process documentation available in the company helped us to develop the purchasing process mapping at both overall and sub levels. The PEMM was used to assess both the organization's relative maturity and purchasing function's maturity. The Semi-structured interviews were conducted to collect the data required for the thesis work. The pilot studies for the PEMM questionnaire and Semi-structured interviews were conducted to refine and select the relevant subjects. Further, the data were synthesized, refined and finally analysed according to the theoretical framework. The Improvement actions were framed building on the results with applicable literature and presented to the company's management and university.

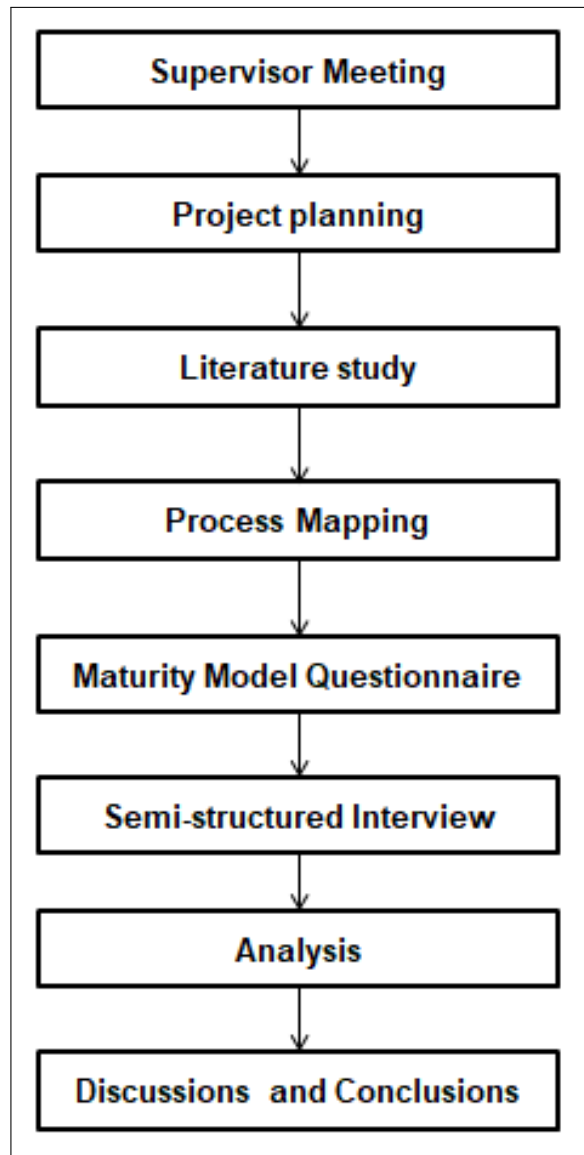


Figure 3.1: Thesis work process

## 3.2 Research Strategy

According to Bell, Bryman, and Harley (2018), there are two types of research strategies. They are quantitative research strategy and qualitative research strategy. Figure 3.2 adapted from Bell et al. (2018) shows the distinction between quantitative and qualitative research studies.

Quantitative	Qualitative	Author's Interpretation of Quantitative Vs Qualitative
Numbers	Words	<ul style="list-style-type: none"> <li>• Social life is measured by applying measurement</li> <li>• Analysis of the society is based on words</li> </ul>
Point of view of researcher	Point of view of participants	<ul style="list-style-type: none"> <li>• Investigation is based on researcher's content</li> <li>• Investigation is based on researcher's point of orientation</li> </ul>
Researcher distant	Researcher close	<ul style="list-style-type: none"> <li>• Researcher and subject of investigation is not in contact</li> <li>• Researcher and subject of investigation is closely involved</li> </ul>
Theory testing	Theory emergent	<ul style="list-style-type: none"> <li>• Based on theory, instruments are used to collect data</li> <li>• Theoretical framework emerges from the collected data</li> </ul>
Static	Process	<ul style="list-style-type: none"> <li>• Social setting is presented as static image</li> <li>• Social setting open out events over a period of time</li> </ul>
Structured	Unstructured	<ul style="list-style-type: none"> <li>• Researcher follows structured way of examination to the study</li> <li>• Researcher follows unstructured way to enhance the emerging concepts</li> </ul>
Generalization	Contextual understanding	<ul style="list-style-type: none"> <li>• The research findings are generalized to the whole population</li> <li>• The researcher findings are based on specific context</li> </ul>
Hard, reliable data	Rich, Deep data	<ul style="list-style-type: none"> <li>• Data is outlined as "robust and unambiguous" from the measurement</li> <li>• Data is outlined from prolonged involvement with the subject</li> </ul>
Macro	Micro	<ul style="list-style-type: none"> <li>• Interrelationship between variables and large scale social trends are outlined</li> <li>• Social reality trends are outlined in small scale aspects</li> </ul>
Behaviour	Meaning	<ul style="list-style-type: none"> <li>• People's behaviour is a concern to researcher</li> <li>• Meaning of action is a concern to researcher</li> </ul>
Artificial settings	Natural settings	<ul style="list-style-type: none"> <li>• Researchers carry out study in artificial settings</li> <li>• Researchers carry out study in natural environments</li> </ul>

**Figure 3.2:** Differentiation between quantitative and qualitative research study

For this thesis work, the authors utilized the qualitative research strategy to yield results. The reason for choosing a qualitative research strategy was due to the nature of data available for this thesis; that is the available data for this thesis work was more of words rather than numbers. The key steps to be followed in qualitative research strategy are generating research questions, selecting relevant subjects, collecting relevant data, data interpretation, theoretical framework and conclusions (Bell et al., 2018). For our work, three research questions were formulated, see section 3.1. Even though there are numerous advantages to qualitative research work, there are also some drawbacks to a qualitative study. Bell et al. (2018) listed some disadvantages of qualitative research work. They are, subjective nature of the study where researchers were often influenced by the participants' views. Also, the same study cannot be truly replicated by another researcher due to a lack of standardized procedures. This study cannot be horizontally deployed to other functions in the organization since it has the problem of generalization.

### **3.3 Research Approach**

For this thesis work, the authors decided to proceed with an inductive research approach due to the vast presence of qualitative data. Bell et al. (2018) classified research approaches into three types. They are the inductive approach, deductive approach and abductive approach. The inductive approach translates the observation/findings to a valid theory. A deductive approach is an approach where a hypothesis is framed and it is tested. However, there are some limitations in the inductive and deductive approaches according to Bell et al. (2018). First, sometimes the data from the inductive approach is not capable of drawing conclusions. Second, the deductive approach suffers from the falsification of the framed hypothesis. To overcome these drawbacks, an abductive approach can be used (Bell et al., 2018), which is a combination of the deductive and the inductive approach. Based on the data collected from the PEMM questionnaire and semi-structured interviews, the interpretations were made. Refer 3.4.1 for detailed data collection tools used for the data collection process.

### **3.4 Research design**

According to Bell et al. (2018), there are four different types of research designs. They are experimental research design, cross-sectional design, longitudinal design and case study design. The case study design addresses the “How” part of the research work (Denscombe, 2014). The authors decided to proceed with the case study research design since the work is carried out in the purchasing department in an organization. The research questions described in section 1.3 motivated the authors to address the “How” part of the research question. This makes the case study approach more suitable for the thesis work. One of the advantages discussed by Denscombe (2014) was the case study approach is capable of capturing data from the natural setting of an organization. Since the project is also focused on measuring the “As-Is” situation of the purchasing process, the decision for selecting

a case study approach for this thesis work was justified. Bell et al. (2018) stated that the case study approach is widely used in organizational research studies. Bell et al. (2018) further argued that it is suitable for a single organization, a single location, a single person and a single event. There are different types of cases. They are the critical case, unique case, revelatory case, representative or typical case and longitudinal case (Yin, 2003). This thesis work falls under the representative or a typical case where it describes the “As-Is” situation in the organization and focuses on areas of improvement in the near future. Yin (2003) states the representative case as “*a case that exemplifies an everyday situation or form of organization*”. While the authors decided to choose a qualitative research strategy, the case study approach was the most appropriate research design (Bell et al., 2018).

Denscombe (2014) claims that organizational processes can be studied in depth using the case study design. Denscombe (2014) further stated that the case study design can incorporate multiple data collection tools in the research work. This thesis work uses the PEMM questionnaire and semi-structured interview as a data collection tool. The use of multiple data collection tools and in-depth analysis are some of the cutting edge advantages of the case study approach. Though the case study approach has numerous advantages, there are some disadvantages. Some of the cons; they produce soft data rather than measurable data. If access is not provided to the researchers the data collection work and analysis work will become complex (Denscombe, 2014).

### 3.4.1 Data collection

Data collection plays a crucial role in a project and the two most widely used data collection tools are the self-completion questionnaire and interviews. These two data collection tools help in an inductive research approach (Bell et al., 2018). In this thesis work, the PEMM questionnaire and semi-structured interviews are the two main tools used for collecting data. In addition to these two data collection tools, company documents have been used to collect data about existing procedures. This documentation has been utilized to develop the process flow charts for the purchasing function in the organization.

#### 3.4.1.1 Sampling in the data collection process

Denscombe (2014) stated that sampling in qualitative research helps the researchers to save time and money invested in the project. Figure 3.3 represents the classification of samples adapted from Denscombe (2014). There are two types of samples (i.e) representative sample and exploratory sample. Representative samples are used for quantitative studies and exploratory samples are used for qualitative studies. So, the authors decided to choose exploratory samples due to the nature of the study. To select samples, there are two types of sampling procedures. They are probability sampling and non-probability sampling (Denscombe, 2014). Figure 3.4 shows the different type sampling techniques adapted from Denscombe (2014). There are various techniques in collecting samples in probability and non-probability sample procedures. In probabilistic sampling, there are different types of sampling procedures.



They are random sampling, systematic sampling, cluster sampling, stratified sampling and multi-stage sampling procedures. Similarly, for non-probabilistic sampling five different sampling procedures are available. They are quota sampling, purposive sampling, theoretical sampling, snowball sampling and convenience sampling. Bell et al. (2018) claimed that probability sampling is unfeasible for qualitative studies.

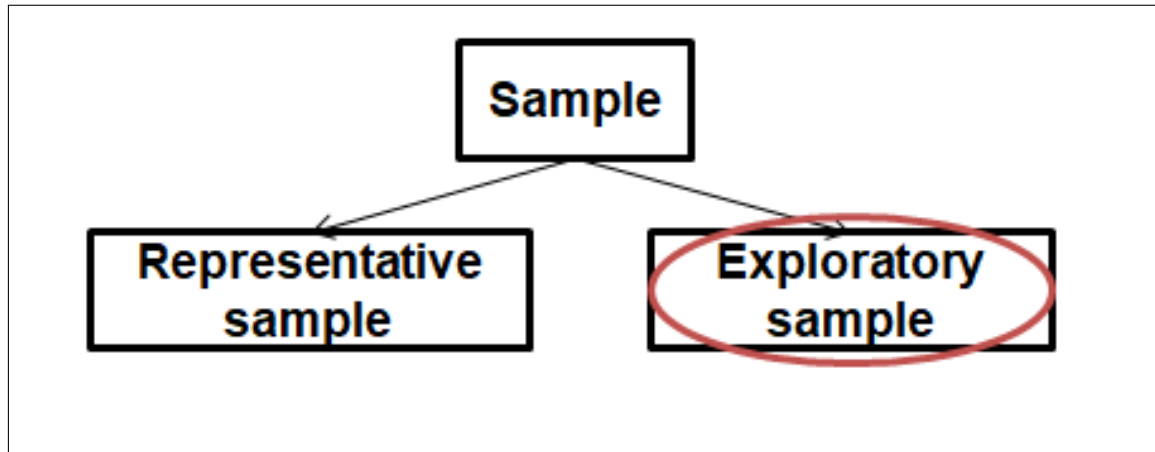


Figure 3.3: Types of sample

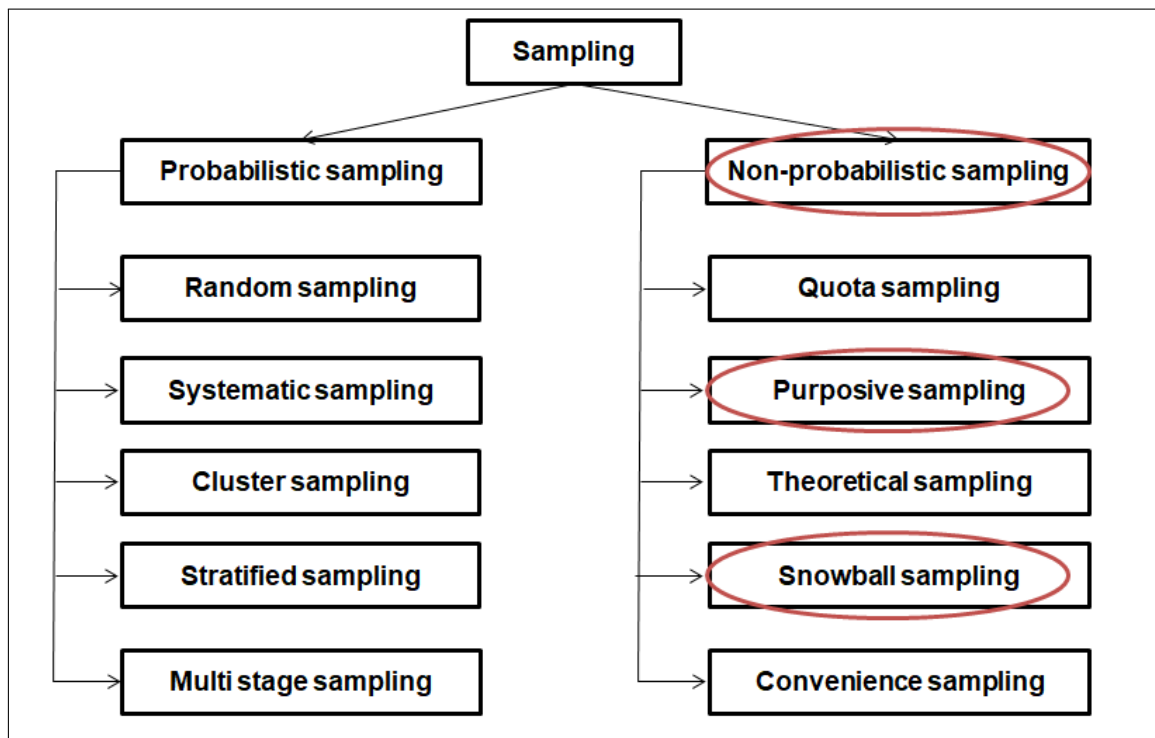


Figure 3.4: Different types of sampling techniques

The authors decided to choose a non-probability sampling procedure for the thesis work. Denscombe (2014) stated that purposive sampling is the most suitable sampling procedure for the exploratory samples. For this thesis work, the authors

utilized two different sampling procedures for the data collection process. The purposive sampling procedure is selected for the PEMM questionnaire since it is sent to only relevant people in the purchasing function and the snowball sampling procedure is selected for the semi-structured interview process since there are few people in the purchasing department. The samples that are selected based on the relevance and knowledge to the study are called purposive sampling and the samples that are selected based on the nomination from the interviewee are called snowball sampling (Denscombe, 2014).

### 3.4.1.2 PEMM questionnaire

Denscombe (2014) stated that self-completion questionnaires are used to collect data relating to the study. A successful questionnaire is built on the basis of response rate, completion rate and validity of responses (Denscombe, 2014). In this thesis work, a self completion questionnaire built on Hammer (2007) enterprise and process maturity model has been used to assess the organization's and purchasing function maturity. The cheap talk script is utilized by the authors in the questionnaire to minimize the bias. The cheap talk script is a technique that provides a short description of the questionnaire to prevent the bias occurring to the respondents who are answering the questionnaire. (Van Loo, Caputo, Nayga Jr, Meullenet, & Ricke, 2011). Figure 3.5 represents the cheap talk script in the PEMM questionnaire.

Section 1 How Mature Is Your Company?		To determine if your organization is ready to support a process-based transformation, evaluate the statements in this table. They show the strength levels, E-1 to E-4, of the capabilities that enterprises need in order to develop their business processes. If a statement is largely true (at least 80% correct), mark the box with a "G" to indicate the color green; if it is somewhat true (between 20% and 80% correct), mark the box with a "Y" to indicate the color yellow; and if it is largely untrue (less than 20% correct), mark the box with an "R" to indicate the color red. <b>This is to establish the As-is situation in the company, if any of the parameters are ongoing then it has to be deemed Green, Yellow for future plans and Red if no such decisions have been made</b> (Please think of these questions in general terms with respect to your roles and responsibilities within company specifically within the purchase department)				GREEN: largely true	YELLOW: somewhat true	RED: largely untrue
						Buyer 1		
		E-1	E-2	E-3	E-4	E-1	E-2	E-3
Leadership	Awareness	The Company's senior executive team recognizes the need to improve operational performance but has only a limited understanding of the power of business processes	At least one senior executive deeply understands the business process concept, how the company can use it to improve performance, and what is involved in implementing it	The senior team views the company's in process terms and has developed a vision of the company and its process	The senior executive team sees its own work in process terms and perceives process management not as project but as a way of managing the business	Y	Y	Y
	Alignment	The leadership of the process program lies in the middle management ranks	A senior executive has taken leadership of and responsibility for the process program	There is strong alignment in the senior executive team regarding the process program. There is also a network of people throughout the company helping to promote process efforts	People throughout the company exhibit enthusiasm for process management and play leadership roles in process efforts	Y	Y	Y

**Figure 3.5:** Cheap talk script in the PEMM questionnaire

The authors utilized the questionnaire which is built in such a way that it maximizes the response rate, completion rate and validity of responses. A pilot study for this questionnaire was carried out to a respondent to gather feedback for the time taken to complete the questionnaire, ambiguous words and ease of answering questions (Denscombe, 2014). The respondent stated that it took 20 minutes to complete the questionnaire and further stated that it was easy to understand the statements and words used. The respondent suggested replacing the word enterprise with the company since it would be most appropriate for the organization. The feedback was taken into consideration and the questionnaire was modified. The details of the respondents were not asked in the questionnaire since it affects the response rate (Hise & McGinnis, 1976). After this pilot study, the questionnaire was sent to 10 people situated in the different purchasing functions within the company around the EU region. 8 respondents fully completed the questionnaire without any errors hence

the response rate for this questionnaire was 80 percent. Williams (2003) claimed that a response rate of more than 75 per cent is extremely good for the research study. A sample response to the questionnaire is provided in the Appendix A.3.

#### **3.4.1.3 Documents**

Bell et al. (2018) stated that documents are a vital source of organizational information and can be utilized in the process of preparing qualitative interviews. Bell et al. (2018) further states that organizational documents provide valuable information for the case study approach. However, the main problem faced with documented information is authenticity (Bell et al., 2018). The realistic representation of the organization can be viewed in the documentation. The organizational documents consist of organizational issues, participants and actions. The authors studied all the documents available in the Enterprise Resource Planning (ERP) system. The organizational documents described every purchasing process activity, purpose, scope, responsibility, embedded forms and documents. In total 48 process documents from the ERP system were studied by the authors. According to Bell et al. (2018), the information in a document can be analyzed by a qualitative content analysis approach, also called ethnographic content analysis. First, the documents are categorized based on certain criteria. Second, the information from the documents is analyzed and the information can be further used for making process flow charts which is one of the sub aims of this thesis work. The authors categorized the documents based on supplier management, project purchasing and supplier management in serial production because these were the three main categories representative of the purchasing function.

#### **3.4.1.4 Interviews**

According to Denscombe (2014), interviews are utilized in collecting data in the research when the researcher needs rich, valuable and in-depth information. Bell et al. (2018) stated that there are three types of interviews. They are structured interviews, unstructured interviews and semi-structured interviews. It further claims that structured interviews are mostly used for quantitative research and unstructured and semi-structured interviews are used for qualitative research. In this thesis work, both unstructured and semi-structured interviews are used by the authors. Denscombe (2014) stated that the structured interview involves “Tight control” between the interviewer and interviewee during the interview process. The semi-structured interview involves the open-ended questions put forth by the researcher to facilitate discussions between the interviewer and interviewee. This type of interview is flexible when compared to a structured interview process. Unstructured interviews focus on the interviewee’s thoughts and ideas about the interview topic. This type of interview enhances the knowledge of the researcher (Denscombe, 2014). In this thesis work, the authors utilized the unstructured interview process to interview the company supervisor to enhance the knowledge about the company documented information and ERP system. The interviews were scheduled once a week to improve the author’s knowledge of the company’s purchasing process. The company supervisor is referred to as “Interviewee 0” in this thesis work.

The semi-structured interviews were conducted with the employees in the purchasing function. All the interviews were conducted online due to the current Covid situation. Bell et al. (2018) categorized the online interview into synchronous and asynchronous online interviews. This synchronous online interview enables the interviewee and interviewer to interact with each other in real-time. Bell et al. (2018) stated that online interviews are flexible and it saves valuable cost and time for both interviewer and interviewee. Six people from the purchasing department were interviewed by the authors through the semi-structured interview and the company supervisor was interviewed through an unstructured interview. Suppliers were not interviewed by the authors, only the company stakeholders were interviewed. Figure 3.6 presents the interviewees, the duration of the interview and the date when the interview was performed.

<b>Interviewees</b>	<b>Date</b>	<b>Duration</b>
Interviewee 0 (Company supervisor)	Every week	2 hours
Interviewee 1	14.04.2021	2 hours
Interviewee 2	11.05.2021	1 hour
Interviewee 3	26.04.2021	2 hours
Interviewee 4	12.04.2021	2 hours
Interviewee 5	09.04.2021	2 hours
Interviewee 6	13.04.2021	35 minutes

**Figure 3.6:** Semi-structured interview details

### **The interview process**

The interview process took place in a series of four steps. They are preparatory work, execution, transcription and verification of the data.

### **Preparatory work**

A pilot interview was conducted with the company supervisor with a list of questions framed by the authors. The feedback provided from the supervisor after the pilot interview session consisted of two main parts. First, it was suggested to introduce the reasoning questions into a list of interview questions from the PEMM questionnaire after the data analysis is one of the valuable pieces of feedback that he had provided. Secondly, the authors were advised to ask more open-ended questions regarding the interviewees' responsibilities in the organization. These

feedbacks were considered, the questions were modified and later utilized in the real interview process. As indicated earlier, the interviewees were selected following the snowball sampling procedure. First, the company supervisor directed us to a stakeholder, then that stakeholder directed us to another stakeholder and so on. The interview questions and the process flow charts made by the authors were sent to interviewees in advance as preparation material. This was sent along with the meeting invitation to manage time effectively during the interviews. Following Bell et al. (2018), the authors asked introducing questions, follow up questions, probing questions and direct questions during the interviews which addressed the research question. The sample interview questions are attached in Appendix A.4.

### **Execution**

At the start of the interview, the authors introduced themselves and provided a short verbal description of the project to all the interviewees. Bell et al. (2018) stated that the recordings and field notes would help the researcher to collect every data during the interview process. All the interviews were recorded to prevent missing data. Since the employees are busy with their work, these recordings helped the authors to revisit the interview if they had any doubt in the transcription of the interviews. One author asked the questions while the other took notes. Based on the notes, follow-up questions were asked to the interviewees. The interview notes helped the authors to capture the necessary information for the research question (Denscombe, 2014).

### **Transcription and verification of data**

After the completion of every interview, the authors visited the field notes and recordings. Further, the authors transcribed the interviews. The transcription was done in a question and answer format. When the transcription was completed, the authors sent those transcripts to the interviewees to check if the information was interpreted in the right way. The interviewee reviewed the transcripts to ensure there was no misinterpretation of the information. This final follow up took place via a Microsoft team's conversation.

#### **3.4.1.5 Benchmarking**

Anand and Kodali (2008) refers to benchmarking as a method of adapting the organization's performance, products and services by measuring against an organisation which has established best practices and best performance. Benchmarking can also be used to help the organization identify improvements which can be either incremental improvement or dramatic improvement (Anand & Kodali, 2008).

#### **3.4.1.6 Brainstorming**

Furnham (2000) suggested three reasons to choose brainstorming when compared to traditional processes :

1. The stakeholders feel that they have contributed to the outcome of the process.
2. Multiple personnels with different knowledge helps bring a different perspective to the problem and possible solution.
3. Specialization of labour allows for individuals specialized in certain processes to point out flaws and improvements.

Furnham (2000) does not acknowledge brainstorming as a good strategy and should be used to discuss ideas that were individually brainstormed and not in groups. However, since this thesis required data and knowledge for some processes that were beyond our knowledge the authors chose to use brainstorming which led to realising new information that didn't show up during the interviews.

### 3.5 Research Quality

According to Bell et al. (2018), qualitative research can be evaluated with two criteria. They are reliability and validity. It further stated that reliability is defined as “*The question of whether the results of a study are repeatable*” and validity is defined as “*The integrity of conclusions that are generated from a piece of research*”. There are four categories for qualitative research to be trustworthy. They are external reliability, internal reliability, internal validity and external validity (LeCompte & Goetz, 1982). The authors decided to choose (LeCompte & Goetz, 1982) criteria for evaluation of this thesis work since it mitigates low research quality.

According to LeCompte and Goetz (1982), external reliability is the measure in which the research work can be replicated with identical results. In qualitative research, this criterion is very tough to meet as it is non-viable to freeze a social setting. Internal reliability is the agreement of the data between different observers in the interview. The data can be affected by the social circumstances in the research work. Internal validity is the correlation between the concepts developed and observations made in the research work. It is the most important task in qualitative research. External validity is a measure in which the findings of the research can be generalized across various situations. It is usually very tough to generalize the findings in qualitative research (Bell et al., 2018).

#### 3.5.1 Aspects enhancing reliability and validity

First, the data for developing the process flow charts for the purchasing function is taken from the company documents. These documents were framed according to IATF 16949 standard by the respective stakeholder in the purchasing function. Furthermore, the PEMM questionnaire was developed based on the concept described by Hammer (2007). This is argued to enhance the external reliability of this thesis work. Second, the interviews were carried out with indirect materials, direct materials and supplier development function stakeholders. Also, the PEMM questionnaire collected data from various stakeholders in the purchasing function across the EU region. Due to this diversity in the interview and PEMM questionnaire, it has provided a variety of information to the authors. This will provide

collective information about the organization as well as purchasing function. This possibly enhances the internal reliability of this thesis work.

The company has an ideal communication culture throughout all their departments. The procedure utilized for making process flow charts in the purchasing function can be utilized by other functions within the company. This arguably enhances the external validity of this study. The process flow charts made by authors based on the information from the company documents were verified with all the interviewees during the interview process and the pilot studies performed during the PEMM questionnaire and interviews enhance the internal validity of this thesis work. The interview transcripts made by authors from the interview recordings were sent back to the interviewees after the interview process to cross-check the information in the transcript. This work further enhances the internal validity of this thesis work.

### **3.5.2 Aspects reducing reliability and validity**

Different people within the purchasing function are interviewed. The knowledge they had on the process and roles & responsibilities varied to a larger extent. This can lower the external reliability of this work. The employees interviewed are only from the purchasing function. This limits the author's knowledge from other departments. Hence, it will limit the internal reliability of this study.

The interview process and PEMM questionnaire yielded the qualitative information for this study. The employees provided the qualitative information for the above-mentioned data collection tools under their social circumstances. These social circumstances might impact the qualitative information that they have provided which in turn makes it hard for generalization, hence it impacts the external validity of this work. Due to Covid, the authors have not had the opportunity to meet the employees often in person. This might affect the social interaction of the authors with the interviewees. This social interaction in turn might affect the internal validity of the study.

## **3.6 Ethical considerations**

According to Diener and Crandall (1978), four ethical principles should be considered in a research study. They are avoidance of harm, informed consent, privacy and deception. For the PEMM questionnaire and interview process, the employees from the organization were not stressed to receive responses. Also, the pilot interview with the supervisor ensured that the interview questions framed by the authors were not offensive to the interviewees. The aforementioned activities would help prevent employees in the purchasing function from feeling uncomfortable. During the interview process, all the interviewees were asked in advance about a consent for recording the interview for the ease and quality of the data synthesis process. Asking for this informed consent establishes a relationship between the interviewer and interviewee (Gubrium, Holstein, Marvasti, & McKinney, 2012). The anonymity of the employees was secured throughout the data collection process. The Microsoft

team's conversations with the employees were kept confidential. The respondents of the PEMM questionnaire are assigned with random buyer numbers from 1 to 10 by the authors since the same file is shared with all the people from senior management to first level employees. This anonymity increased the total number of responses in the survey (Hise & McGinnis, 1976). Furthermore, this confidentiality established the trust between the interviewer and interviewee (Gubrium et al., 2012). The interview transcripts prepared by the authors were sent to check for any misinterpretation of the information from the interview. With this activity, the authors prevented deceptions in their research. Finally, the information gathered from the company documents to create process flow charts and the interview recordings are kept confidential to prevent data leakage to the society.

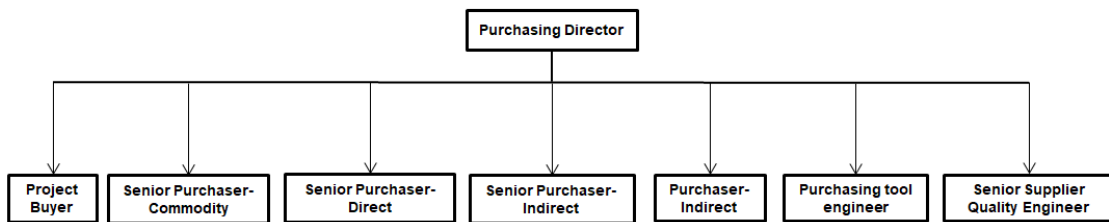


# 4

## Empirical Findings and Analysis

*This section begins with an overview of the case company structure followed by a presentation of organizational documents, findings from the semi structured interviews and PEMM questionnaire data. The data analysis work is also presented in this section.*

### 4.1 Purchasing organizational structure



**Figure 4.1:** The purchasing organization

The purchasing function in the company is responsible for providing all necessary products and services to the organization. This function is led by the purchasing director. The team members in the purchasing function includes project buyer, senior purchaser-commodity, senior purchaser- direct, senior purchaser- indirect, purchaser-indirect, purchasing tool engineer and senior supplier quality engineer, see Figure 4.1. All the team members are located in Gothenburg except the purchasing tool engineer. The purchasing tool engineer is located in China and reports to the purchasing director. This function's main objectives are to reduce the cost of the product, enhance profitability without compromising the quality and improve the supplier relationships.

### 4.2 Organizational Documents

There were numerous organizational documents in the company ERP system. These documents were prepared by the purchasing team members. All the documents were prepared according to the quality standards, (i.e) IATF 16949 standard. The navigation panel of the ERP system contained numerous department tabs under corporate processes. The authors focussed only on the purchasing function

documents which were found under the purchasing function tab.

A short description of the purchasing process documents are provided in Table 4.1. The purchasing strategies and frame agreements contains list of documents which are as follows:

**1. Purchasing strategies for:**

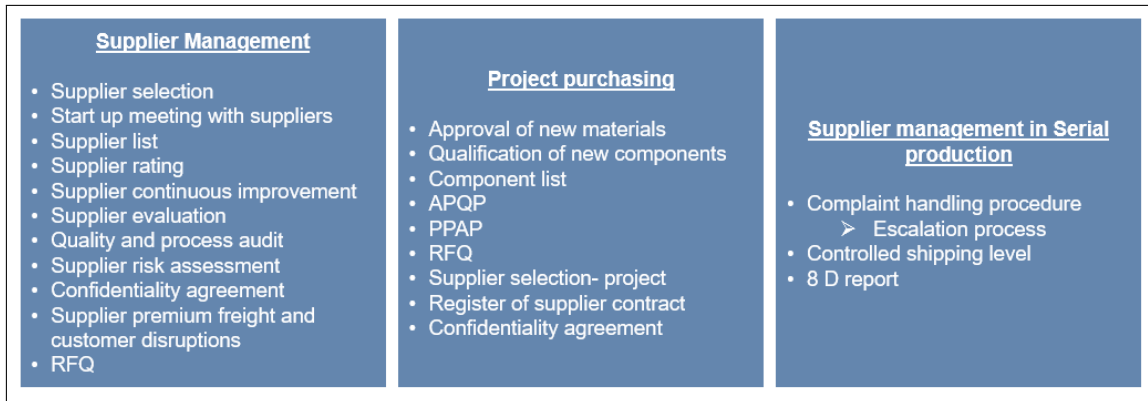
- Metal components
- Plastic raw materials
- Paint products
- Indirect materials and services
- Tools and production equipment
- Fasteners
- Logistics
- Injection moulded and extruded parts
- Masking and protection tapes
- Foams
- Packaging
- Surface treated components
- Customer directed material

**2. Frame agreements for :**

- Paint raw materials
- Plastic raw materials
- Components

The key activities, responsible stakeholders for the activities and embedded forms & documents were identified and noted from the process documents and a detailed process flow chart for each process document was made to visualize the sequence of activities in all processes. These process documents were categorized based on three categories. They consist of supplier management, project purchasing and serial production.

Figure 4.2 shows the categorization of documents. These are the sub processes where the activities are utilized to create an overall process flow chart for the supplier management, project purchasing and supplier management in serial production. The 'As-is' situations of the aforementioned processes were described in section 4.2.1. All these process flow charts played a crucial part in the interview process. The data from semi structured interviews were presented in section 4.3.



**Figure 4.2:** Process documents categorization

Process Documents	Description
Request for Quotation (RFQ)	Explains the bidding process followed in the company for the suppliers
Supplier selection	Explains how the new suppliers are selected and criteria followed in the company to send RFQ to suppliers
Startup meeting with the suppliers	Explains about the purchase needs and deliverables to be delivered by the supplier
Supplier list	Explains how to approve the supplier from the supplier list based on rating
Supplier rating	Explains about the different criteria to classify the supplier
Supplier continuous improvement	Explains how the performance of the existing supplier can be improved
Supplier evaluation	Explains the performance assessment of existing suppliers in the company
Quality and process audit	Explains the auditing process for the suppliers
Supplier risk assessment	Explains how to perform risk assessment process for the suppliers
Supplier premium freight and customer disruptions	Explains about the actions to take when there is delivery disturbance
Register of supplier contracts	Explains about the procedure for registering contracts in the database
Supplier confidentiality agreement	Explains how the confidentiality agreement is related with the supplier rating process
Purchasing strategies	Explains about the strategies followed for different materials to adhere to the purchasing policy
Complaint handling procedure	Explains how the company should act in case of any quality and/or delivery deviations

<b>Process Documents</b>	<b>Description</b>
Approval of new materials	Explains how the company should act in approving the new materials for the production
Qualification of new components	Explains about different processes for qualification for materials and how to coordinate with different departments
Controlled shipping levels	Explains about the containment actions to take in case of quality and delivery deviations
Frame agreements	Explains about the changes and approvals in the agreement with the supplier
Purchasing policy	Explains about the guidelines to be followed by purchase department
General conditions of purchasing-tools	Explains about the terms and conditions for tool suppliers
8 D report	Explains about the 8D problem solving for quality and delivery disturbance made by the suppliers
Preferred terms and conditions of purchase	Explains about the agreements and contracts for the suppliers
Component list	Explains about the availability of information for the purchased components
APQP process	Explains the project preparation with respect to time schedule
PPAP	Explains about the 18 elements involved in the PPAP documentation
Instruction for purchase orders	Explains about the mandatory and optional information in the purchase orders
Routine for Injection Moulding (IM) tool feasibility analysis	Explains about the feasibility of IM tool with the production process
Routine for technical evaluation of IM tool supplier	Explains the evaluation procedures for IM tool suppliers
Routine for IM tool design review	Explains the fulfillment of design parameters for production process
Routine for IM tool project tracker	Explains about the timeliness of IM tool project
Routine for IM tool trial	Explains about the different tasks which have to be performed by different stakeholders
Routine for IM tool run-in plant	Explains how to counteract and report problem during the production trial
Routine for in-production IM tool review	Explains how the tool should be reviewed after the deployment of tool in the production

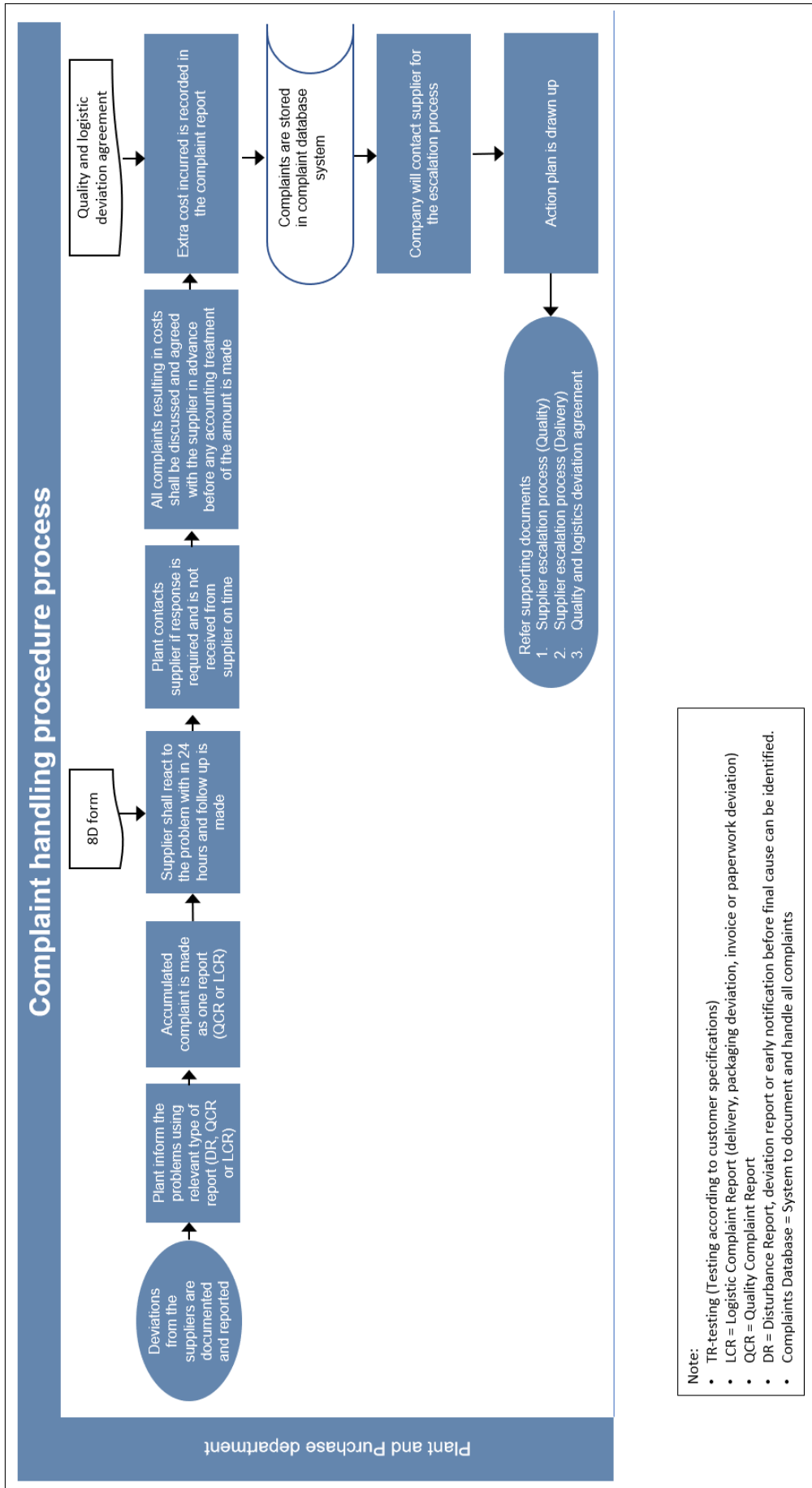
**Table 4.1:** Description of process documents

### 4.2.1 “As-is” situations of the process in the company

Based on the organizational process documents, the process flow charts were created. Figure 4.3 represents an example of the sub process. Figure 4.3 shows the complaint handling procedure process flow chart which is a sub-process in “supplier management in serial production”. All the process flow charts are not attached in this report as it has confidential information. Totally 48 sub-process flow charts are created in the same way. The activities in these process flow charts are utilized to create overall supplier management, project purchasing, and supplier management in serial production process flow charts. The process flow charts related to purchasing strategies and IM tools are not considered for the overall process mapping since they are not related to the aforementioned processes. The authors are improving only the overall supplier management, project purchasing, and supplier management in serial production process due to the time constraint of the thesis.

#### **Example: Complaint handling procedure process flow chart**

The purpose of this process flow chart is to display what actions the company should take in case of quality or delivery deviations from the suppliers. All the abbreviations used in this process flow chart are listed as “Note” in the process flow chart. The responsibility for this procedure is mentioned on the left side of the process flow chart. The plant and purchase department is responsible for this process. When quality and/or delivery deviation is raised by the company to the supplier then the supplier has to react to the deviation by submitting the 8 D form within 24 hours. This 8 D form along with the extra cost incurred for the company is then updated in the database. Finally, the action plan is made by the company. During this process, the responsible people can refer to supporting documents pertaining to the complaint handling procedure for a detailed understanding of this process.



**Figure 4.3:** Complaint handling procedure process flow chart

#### 4.2.1.1 'As-Is' situation- overall supplier management process

Figure 4.4 shows the process flow chart for the overall supplier management process in the company for direct purchasing. The authors created the overall supplier management process flow chart based on the activities in the subprocess. The sub-processes considered for this process flow chart are supplier selection, startup meeting with the suppliers, supplier list, supplier rating, supplier continuous improvement, supplier evaluation, quality and process audit, supplier risk assessment, and supplier premium freight & customer disruption process. The responsibilities in the overall supplier management process include the purchaser and supplier development function in the purchasing department.

The process begins by seeking the requirements of the customer. The purchaser looks into the company database for the suppliers based on the customer requirement. If the suppliers are already available in the database, the purchaser checks the supplier list but if the suppliers are not available in the database, the purchaser is responsible for finding a new supplier. The purchaser then sends the confidentiality agreement to the supplier before proceeding to the supplier approval for the prevention of information leakage to the market. The supplier development conducts the qualitative assessment and supplier evaluation questionnaire to know complete information about the supplier. Post this step, the supplier development function conducts the audit at the supplier location to cross-verify the information specified in the questionnaire. Once the auditing is completed, the results of the audit are registered by the supplier development function in the database. If the new supplier is adhering to the standards set by the company, the supplier development function approves the supplier. On the contrary, if the new supplier does not meet the company standards, the supplier is not approved. After the supplier approval, the new supplier is updated in the database following which the new supplier is registered to the company and the supplier is added to the supplier list.

Meanwhile, there are some parallel activities carried out by the supplier development function throughout the year. The supplier development function is responsible for evaluating both old and new suppliers throughout the year. During this evaluation, they use the supplier risk assessment template focusing on technical aspects to evaluate the risk. If the supplier is a low-risk supplier, the supplier performance is evaluated based on supplier rating for continuous improvement in the near future whereas if the supplier is a high-risk supplier, the supplier development function takes necessary actions against the supplier and hence updates it in the database to prevent the negative impact to the company.

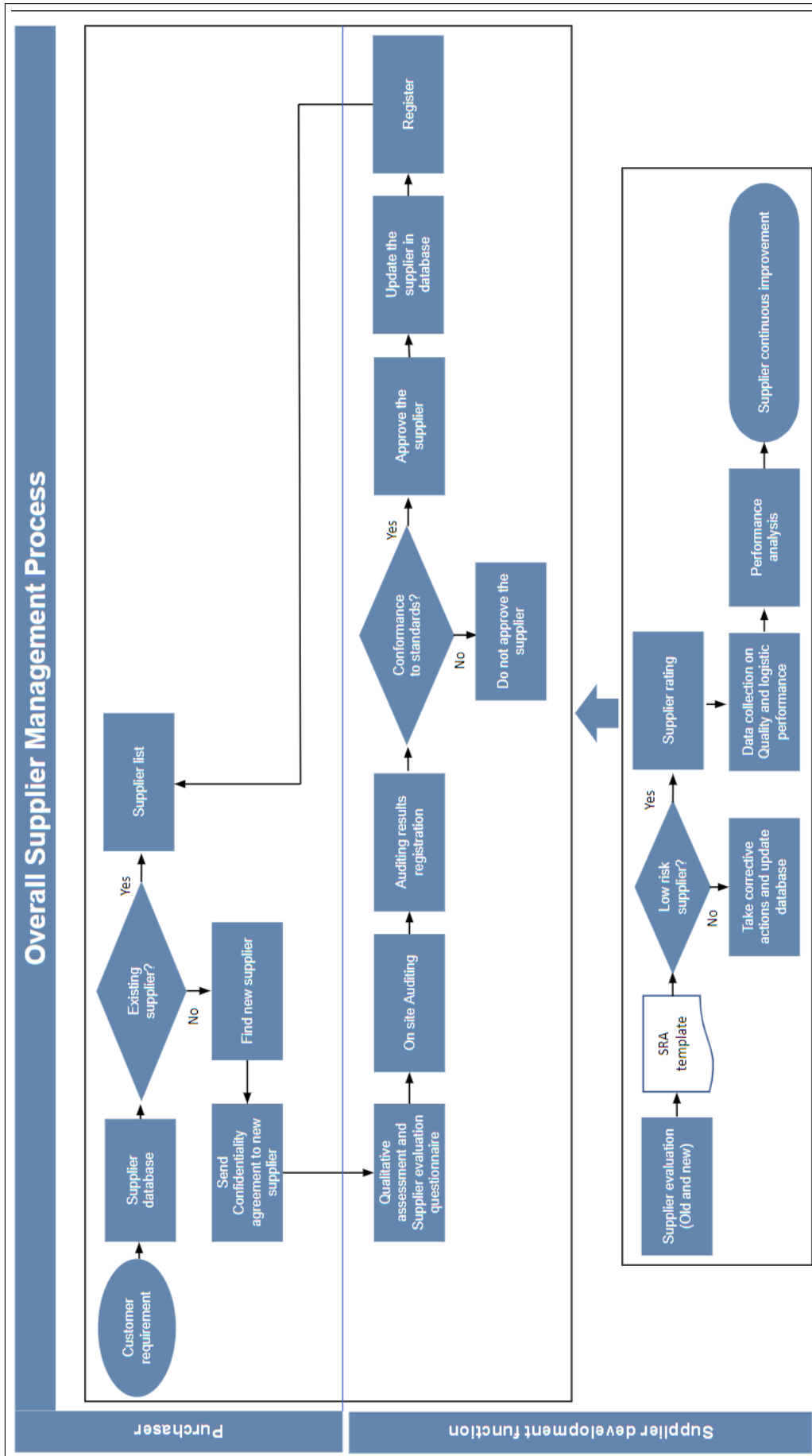


Figure 4.4: "As-is" overall supplier management process flow chart



#### 4.2.1.2 'As-Is' situation- overall project purchasing process

Figure 4.5 represents the overall project purchasing process for direct purchasing. The overall project purchasing process flow chart was created based on the following sub-process. They are the approval of new materials, qualification of new components, component list, APQP, PPAP, supplier selection, register of a supplier contract, and confidentiality agreement. There are three responsible people for this process which include the purchaser, supplier and supplier development function. Purchaser is responsible for project requirements to APQP plan approval, the supplier is responsible for testing of new materials to PPAP and the supplier development function is responsible from document review to production start.

The project purchasing process kicks off with the project requirement. The project purchaser searches for the supplier in the suppliers list based on the requirement of the project. If the supplier is available for the quotation process, the purchaser checks the performance and rating of the supplier but if the supplier is not available as per project requirement then the purchaser needs to find a supplier for the project which will be interlinked with the overall supplier management process. After checking the performance and rating for the suppliers, the purchaser shortlists the suppliers for the RFQ process. Before proceeding to the RFQ process, the purchaser sends the confidentiality agreement to the supplier to prevent the leak of confidential information. The RFQ is sent to the shortlisted suppliers and the price is negotiated.

After the RFQ process, a meeting invite is sent by the purchaser to the supplier for the startup meeting. In the start-up meeting, the purchaser together with the supplier have discussions based on the RFQ. The deliverables by the supplier for the project are then set by the purchaser and the contractual discussions would happen. After the contracts are signed, the suppliers are evaluated and approved as per the overall supplier management process. Once the approval is completed, the APQP plan is then initiated by the purchaser to track the progress of the project. The GP12 requirements are checked by the purchaser and as well as the supplier. GP 12 are the containment actions during the project purchasing phase. Once the GP 12 requirements are checked by the purchaser, the APQP plan is approved.

The supplier tests the new materials at their site after the APQP approval. The testing of materials yields the test results which are compiled into a test report by the supplier. After the test report is made, the trial production run at the supplier begins. The supplier is responsible for storing the sampling parts and initiating the PPAP. During the trial production run, the supplier development function supervises the production process. The supplier development is responsible for reviewing the documents attached during the PPAP. Once the documents are verified, the PPAP is approved and the production is started in the company.

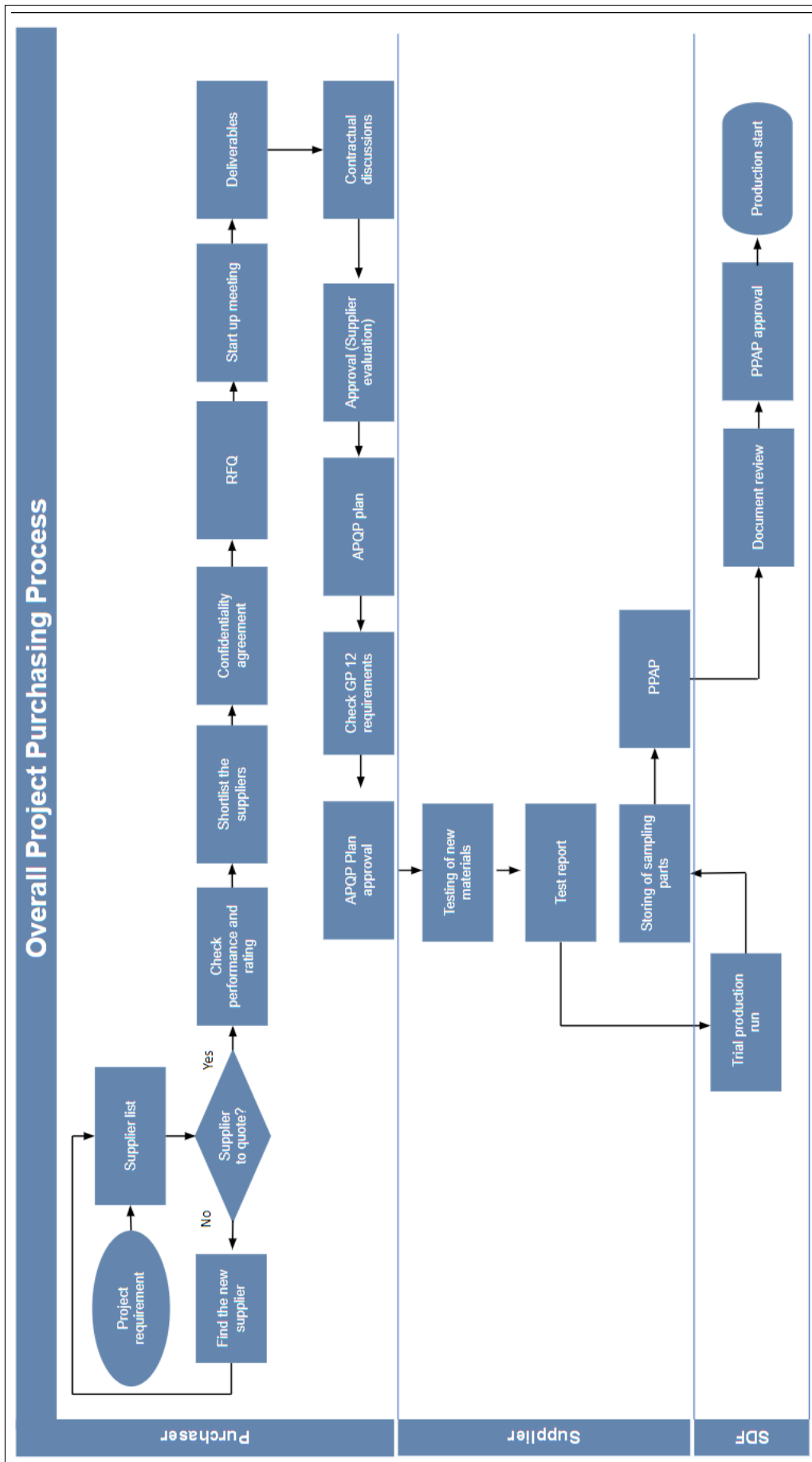


Figure 4.5: "As-is" overall project purchasing process flow chart

#### 4.2.1.3 'As-Is' situation- overall supplier management in serial production process

Figure 4.6 represents the overall supplier management in serial production process. The supplier management in serial production process is based on three main sub-processes. They are complaint handling procedure, controlled shipping level, and 8 D report. The responsible people for this process are the quality manager, logistics manager, plant, and the purchaser. The responsibilities in this process are not clearly defined in the process documents. The process is initiated when there is a nonconformity in the quality and/or delivery from the supplier. This conformity is handled by the respective department initially. For example, the quality deviation is handled by the quality department in the plant. If the department is not able to solve the problem it is escalated to higher officials. The escalation process follows the escalation model in the company. The escalation model has a set of instructions for the escalation process. When the problem is escalated, the kick-off meetings are initiated at the supplier end. The respective department then requests the 8 D report to address the complaint created by the supplier. The supplier fills the 8 D and sends it to the respective department. The total cost incurred during this deviation is then calculated and communicated to the supplier.

After the communication is completed, the action plan is made by the respective department and it is sent to the supplier development function in the purchasing department. If the supplier problem is recurring, the company will enter the control shipping procedure. The control shipping procedure is a procedure that encloses the containment actions for the company and supplier if there are any repeated deviations. The decision to deploy the control shipping level (CSL) process has to be made by the respective department. If the department wants to proceed with the CSL process, it has to make a decision to deploy CSL 1 or CSL 2. CSL 1 is the inspection at the supplier end and CSL 2 is the inspection at the company site. Both CSL 1 and 2 come at the expense of the supplier. If the department does not want to deploy a CSL process, it escalates to the VP operations about the problem. On the other hand, If the CSL is implemented, then the performance of the supplier is analyzed over a period of time and an improvement program is planned by that respective department. Finally, the department decides to remove the CSL process based on the supplier performance.

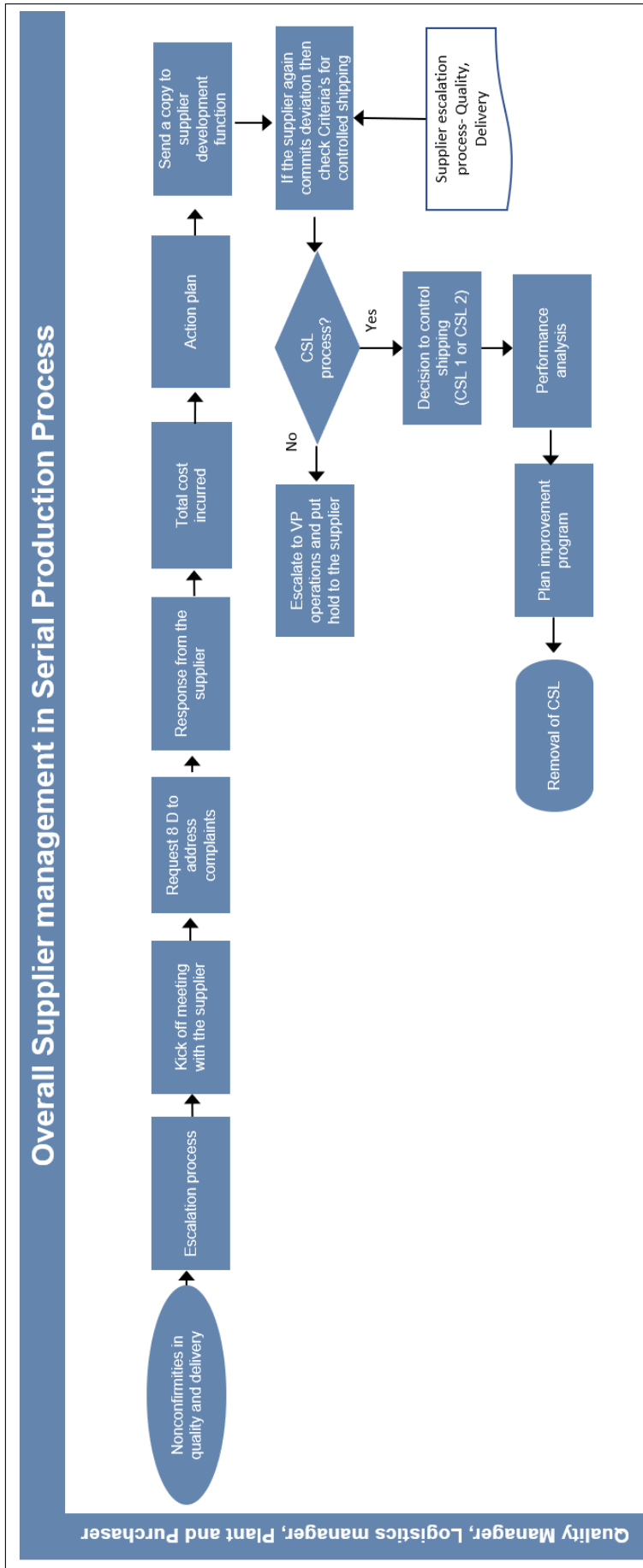


Figure 4.6: “As-is” overall supplier management in serial production process flow chart

Figure 4.7 shows the “As-is” escalation process for the quality deviation in the company. This escalation process is interlinked with the supplier management in the serial production process in the aspect of CSL and quality deviations. The “As-is” escalation process of the company has four stages. They are quality disturbances, continuing quality disturbances, continuing or severe production or customer disturbances and continuing severe production or customer disturbances. The responsible persons for the escalation process are quality engineer, quality manager, internal case leader and purchasing management.

In the escalation model, the quality disturbance stage activities encloses deviation reports and 8D and the responsible stakeholder is the quality engineer. The spot support on the first stage is interpreted as escalation by the quality engineers and the problems are escalated to purchasing management which is a drawback of this model. There appears to be no significant disparity between the continuing quality disturbances and quality disturbances in which the actions of the supplier and company are combined and displayed leading to questioning the relevance of the two stages. In the continuing or severe production or customer disturbances, the responsibilities of the buyer as an internal case leader is defined and actions to be taken by the supplier and company are displayed but not categorized according to responsibility. Similar continuing severe production or customer disturbances shares the same points as that of the previous stage hence, leading to questioning the relevance of these two stages.

This “As-is” escalation model of the company created disorientation for the stakeholders in terms of similarities between the stages, lack of criteria, taking actions, responsibility and supplier reaction & response. It should be noted that only the quality escalation procedure was redesigned by the authors and the delivery escalation process was determined to be out of scope.

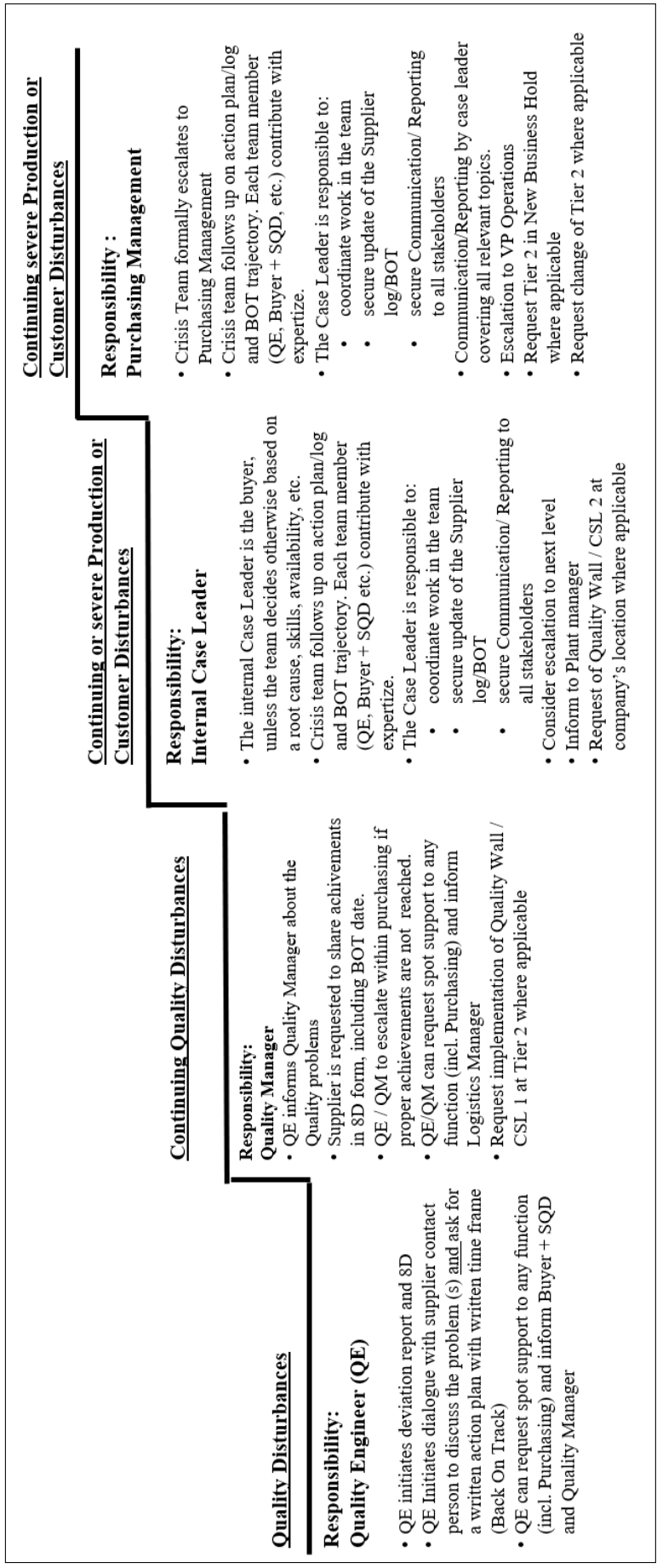


Figure 4.7: “As-is” Escalation model for quality deviation

### 4.3 Semi-structured Interview

The questions for the interview process were prepared from the process flow charts created by the authors. The interviews were carried out with the purchasing team members to collect data about their roles and responsibilities in the purchasing process. The interview data of direct purchasing and indirect purchasing are presented in Appendix A.1 and Appendix A.2 respectively. When the purchased product is directly utilized in the finished product, it is referred as direct purchasing. When the purchased product is not directly utilized in the finished product, it is referred as indirect purchasing. For Example: Tools in the production. Based on the data, the major findings from the interviews are summarized in Table 4.2.

Summary of findings		
Organizational documents	Requirement of Process flow chart for all processes in purchasing	
	CapEx process is not documented	
Process	Direct purchasing	Indirect purchasing
Request for Quotation (RFQ)	The offer comparison template is not standardized within the purchasers	Tool purchaser is responsible for sending RFQ after consultation with tool engineers
	Offer comparisons done by purchaser is not updated in database	Purchaser uses offer comparison template for cost breakdown structure
	The purchaser is responsible for sending RFQ to suppliers	Purchaser is not involved in maintenance RFQ process
		Purchaser conducts RFQ to suppliers based on past performance
	RFQ process is not applicable for fasteners and CDM's	RFQ for services is complex
Purchaser is not having access to supplier database		
Relationship with the suppliers	Most of the relationships with the suppliers are long term	Long term relationship with indirect materials and services suppliers
		No negotiation with supplier for maintenance services
Supplier selection	Supplier quality engineer is responsible for conducting audits to new suppliers	Suppliers are selected based on hard and soft criteria

<b>Summary of findings</b>		
Supplier selection	Supplier selection is based on inputs from other departments and criteria set by the purchaser based on IATF standard	Tool suppliers are selected based on historical data and consultation with the plant
	The purchaser considers the B and C rated suppliers if the suppliers are limited for the requirement	For maintenance services, the production will select the supplier
	The supplier selection is not applicable for fasteners and CDM's	Suppliers are not selected based on ratings
Startup meeting with the suppliers	Participants are project manager, supplier quality engineer, purchaser and supplier	Participants of startup meeting with tool suppliers are supplier, manufacturing engineer, purchaser and tool engineer
	No startup meeting with existing suppliers	Purchaser is responsible for sending the invitation for start up meeting
	Purchaser is responsible for sending meeting invite and sometimes supplier quality engineer	Participants for indirect materials and services include purchaser, project manager and supplier
	Cross verification and clarification of RFQ's information with suppliers	For maintenance services, the production is responsible for conducting meetings and the purchaser is not involved Frequent meeting with new suppliers and non frequent meeting with old suppliers
Supplier auditing and evaluation	Supplier quality engineer is responsible for conducting audits at supplier location	Supplier audits and supplier evaluations are not applicable for indirect materials and services
	No supplier audits carried out for resins and paint suppliers	For tool suppliers, the auditing form was used and evaluation was based on past performance
	Financial and quality aspects are considered for auditing	No audits conducted for tool suppliers due to Covid-19



<b>Summary of findings</b>		
Supplier auditing and evaluation	No clear responsibility defined for material specialist and supplier quality engineer in resins and paint purchasing process	Indirect Purchasers are not fully educated on auditing procedures
	Supplier quality engineer tracks and updates the certification expiry in the database	For indirect materials and services, only financial audits are done
Supplier confidentiality agreement	Confidentiality agreement is modified as NDA	NDA for indirect is not good as direct purchasing
	Purchaser works together with PLM coordinator for sending NDA	Purchaser works together with PLM coordinator for sending NDA
Customer directed materials (CDM)	No checklist is followed for CDM's	No checklist is followed for CDM's
	Data is not stored and accessible in the database	
	No standardized template available for CDM's	CDM for indirect is few when compared to direct
	Biased responsibility between sales and purchaser	
Approval of new materials	Supplier quality engineer reviews PPAP for approval of new materials	New materials approval is the responsibility of materials engineer for tool purchase
	Materials department is responsible for approving new materials for resins and paints	Approval of new materials are not related to indirect materials and services
	Project lead is responsible for approving new materials for project	
Qualification of new components	Supplier quality engineer is responsible for qualifying new components	Qualification of new components is not applicable for tool and indirect purchasing activities

Summary of findings		
Qualification of new components	Plant is responsible for storing sample parts during trial runs	
	APQP and PPAP encloses the qualification of new components	
	Project buyer is responsible for communicating the deliverables to the supplier	
	Quality engineer is responsible for qualification of new fasteners	
Frame agreements	No frame agreements for resins and paints suppliers	Frame agreements are not suitable for tool purchasing
	The purchaser is responsible for sending frame agreements	Purchaser is responsible for sending frame agreements
	Purchasing director is the process owner and approves the changes in agreements	Frame agreements are utilized for production equipment purchase
Terms and conditions of purchase	Purchaser is responsible for verifying the terms and conditions before sending to suppliers	Terms and conditions are standardized for direct and indirect purchasing but it is not specific for indirect materials and services
	Terms and conditions of purchase renamed to General purchasing conditions	Service suppliers are confused due to common terms and conditions
Component list	Component list does not exist for project purchasing process	Component list is not applicable for indirect materials and services
	Project buyer and plant together are responsible for creating the component list	Tool engineer together with purchaser works to update the component list
Containment actions	Containment actions are part APQP process	No containment actions for tool purchasing

<b>Summary of findings</b>		
Containment actions	Supplier quality engineer is responsible for containment actions during APQP	APQP is not applicable for indirect purchasing
	Plant is responsible for containment actions for resins and paints	No containment actions for indirect purchasing
	Materials specialist is responsible for APQP process for resins and paints	
PPAP	Supplier quality engineer is responsible for the evaluation PPAP	Not applicable for indirect purchasing
	Commercial aspects of supplier is clarified by project buyer	
Purchase orders	Purchaser is responsible for verifying the terms and conditions in purchase orders	Purchaser verifies the mandatory data in the purchase orders
	PO's are modified according to past experience by the purchasers for both components and raw materials (resins and paints)	No standardized purchase orders across various plants for tool purchasing
Communication	Good communication within the company and with the suppliers	Good communication within the company and with the suppliers
	Communication between the suppliers and the company are not well documented	No communication with the customers except CDM
		Room for improvement of knowledge transfer for newcomers
Supplier rating	Supplier ratings are based on quality and logistic deviations	No supplier rating system tool, indirect and services suppliers
	Supplier quality engineer is responsible for rating process	Tool suppliers do not notify the changes in the certifications

<b>Summary of findings</b>		
Supplier rating	Purchaser and supplier quality engineer is responsible for improving the performance of B and C rating suppliers	Indirect purchaser wishes to have rating system for the suppliers
	Plant is responsible for updating the data in the database	Purchasers used their own criteria for rating the suppliers
	Purchasers are following their own criteria for rating the suppliers based on past experience	In indirect materials and services, the small companies do not notify the changes in the certifications
	Purchasers are not aware of "board on wall" concept	
	Purchasers are not intimidated when there is a change in supplier's certifications	
Supplier risk assessment	Supplier quality engineer and purchaser are responsible for supplier risk assessment	Finance department is responsible for performing financial risk assessment and tool engineer is responsible for performing technical risk assessment for tool purchase
	For both old and new suppliers risk assessment process involves financial and supplier evaluations	Only financial checks are done for indirect materials and services
	Suppliers risk assessment is not done currently due to Covid-19	Project engineer is responsible for project delivery in indirect purchasing
		Quality analyst is responsible for checking the indirect equipment
Supplier contracts	Purchasers are responsible for updating the changes and sending the contracts to the supplier	Suppliers contracts takes place through ERP system for tool suppliers
	ERP system is not updated with the supplier contracts	Indirect purchasers prefer to have proper documentation of all supplier contracts

Summary of findings		
Supplier premium freight and customer disruptions	Logistics department is responsible for generating claims and updating database	Purchaser is responsible for tool logistics
		Logistics department, purchaser and plant is responsible for the disruptions
	Logistics department escalates the problem to purchaser if it is not solved	Disruptions data is collected but it is not updated in database
		Logistics department escalates the problem to purchaser if it is not solved for external logistics
Controlled shipping procedure	Depending on the escalation the responsibility varies from quality manager to purchaser	8 D report within 24 to 48 hours for tool purchasing
	The supplier has to respond to the deviation within 24 hours	Terms and conditions of deviations are communicated to indirect materials supplier prior to shipping
	A need for common process that encloses controlled shipping procedure, complaint handling procedure and escalation process	Indirect purchaser is not responsible for control shipping procedure
	Quality and delivery deviations are specified in the contract and communicated to supplier before project purchasing	
Complaint handling procedure	Plant is responsible for updating the data in the database and intimating purchaser	Plant is responsible for addressing deviations in tool purchasing
	Responsibility is not clearly defined for the deviations	Quality engineer is responsible for addressing tool complaints

Summary of findings		
Complaint handling procedure	In project purchasing, project team receives information from purchaser and communicate to the customer	Purchaser is responsible for addressing deviations in indirect materials and services
		Indirect Purchaser escalates to purchasing director if the problem is not solved
Digital systems	Suppliers understands everything from the documents	Purchaser is responsible for clarifications of doubts from suppliers
	The information in the forms are cross verified by purchasers	
Supplier continuous improvement	Continuous improvements are based on board on wall and monthly performance of the supplier	Tool engineer along purchaser is responsible for continuous improvement of tool suppliers
	Continuous improvement activities are root cause analysis, monthly performance analysis and internal audits	Tool suppliers are continuously improved based on historical data
	For resins and paints suppliers, the purchaser and materials specialist are responsible for continuous improvements	Supplier continuous improvement is not applicable for indirect materials and services
	Absence of supplier quality engineer in the resins and paint suppliers continuous improvement activities	

**Table 4.2:** Summary of interview findings

The major gaps identified by the authors from the ‘As-is’ situation and interview data are tabulated in Table 4.3. These gaps were addressed in section 5 and the respective processes were improved.

<b>Gaps in the 'As-is' Situations</b>		
<b>Direct purchasing</b>		
<b>Supplier Management</b>	<b>Project purchasing</b>	<b>Supplier management in serial production</b>
Confidentiality agreement name is changed but isn't updated	Project requirement is not the responsibility of the purchaser	A need for integrating escalation ladder, complaint handling & controlled shipping process
Suppliers are not checked based on relevance to customer requirement but on existence in database	New supplier is not updated in database	Specific responsibility is missing
Number of suppliers are not checked for the customer requirement	Confidentiality agreement name is changed but not updated	Non conformities are not updated in the database
Shortlisting of suppliers is missing	RFQ as a connection to sub process does not exist	Report containing all the complaints does not exist
Sending RFQ is missing	Supplier selection is missing	Communication to supplier not mentioned
Selection of suppliers is missing	Supplier nomination is missing	Escalation as a process exists but it needs improvement
Specific responsibility in supplier development function is missing	Start up meeting with supplier as a connection to sub process does not exist	Supplier continuous improvement does not exist
Supplier evaluation as a connection to sub process is missing	Presenting APQP plan and checking GP 12 requirement is a single process	De-escalation process is not defined
In addition to conformance of products, satisfaction of company requirements are missing	Tool trials during material testing is missing	Responsibilities in the escalation process are not clearly defined
Registration of supplier does not exist	Supplier is responsible for trial production run	Criteria for escalation and de-escalation process are not clearly defined

<b>Gaps in the 'As-is' Situations</b>		
Parallel process-specific responsibility is missing	PPAP as a connection to sub process does not exist	The company and supplier actions are not clearly defined
Supplier evaluation and supplier risk assessment as a connection to sub process is missing	Storing of sampling parts is a part of the trial production run	Deescalation does not exist in the escalation process
Supplier rating and supplier continuous improvement as a connection to sub process is missing	Supplier capacity check is absent	An appropriate visual representation of the escalation process is not present
For commodity purchase, SQE involvement in continuous improvement, the rating is not present	Interim PPAP approval is not present	
No standardized rating process for raw materials and components	Notification of supplier about PPAP rejection is not present	
<b>Indirect purchasing</b>		
Supplier rating does not exist	No project purchasing process documentation available	
Technical risk assessment (audits) does not exist, only financial risk assessment exist		
Supplier continuous improvement does not exist since there is no supplier rating		
No standardized RFQ process in Indirect (maintenance and material services)		
A standardized supplier database does not exist and cannot be accessed by the purchaser		

**Table 4.3:** Gaps in "As-is" processes



## 4.4 PEMM Questionnaire

The process and enterprise maturity model was used to determine the current maturity of the organization and its processes. Below is an example of a buyer’s answer to the enterprise maturity questionnaire in the PEMM.

Section 1 How Mature Is Your Company?		To determine if your organization is ready to support a process-based transformation, evaluate the statements in this table. They show the strength levels, E-1 to E-4, of the capabilities that enterprises need in order to develop their business processes. If a statement is largely true (at least 80% correct), mark the box with a "G" to indicate the color green; if it is somewhat true (between 20% and 80% correct), mark the box with a "Y" to indicate the color yellow; and if it is largely untrue (less than 20% correct), mark the box with an "R" to indicate the color red. <b>This is to establish the As-is situation in the company, if any of the parameters are ongoing then it has to be deemed Green, Yellow for future plans and Red if no such decisions have been made</b> (Please think of these questions in general terms with respect to your roles and responsibilities within the company specifically within the purchase department)				GREEN largely true	YELLOW somewhat true	RED largely untrue	
						Buyer 9			
		E-1	E2	E-3	E-4	E-1	E2	E-3	E-4
Leadership	Awareness	The Company's senior executive team recognizes the need to improve operational performance but has only a limited understanding of the power of business processes	Atleast one senior executive deeply understands the business process concept, how the company can use it to improve performance, and what is in involved in implementing it	The senior team views the company's in process terms and has developed a vision of the company and its process	The senior executive team sees its own work in process terms and perceives process management not as project but as a way of managing the business	R	G	G	G
	Alignment	The leadership of the process program lies in the middle management ranks	A senior executive has taken leadership of and responsibility for, the process program	There is strong alignment in the senior executive team regarding the process program. There is also a network of people throughout the company helping to promote process efforts	People throughout the company exhibit enthusiasm for process management and play leadership roles in process efforts	G	G	Y	R
	Behaviour	A senior executive endorses and invests in operational improvement	A senior executive has publicly set stretch performance goals in customer terms and is prepared to commit resources, make deep changes, and remove roadblocks in	Senior executives operate as a team, manage the company through its processes, and are actively engaged in the process program	The members of the senior executive team performs their own work as processes, centre strategic planning on processes, and develop new business	G	Y	Y	Y

Figure 4.8: The Enterprise maturity questionnaire answer by Buyer 9

As can be seen in Figure 4.8 adapted from Hammer (2007), the maturity of each sub-criteria was calculated based on the highlighted colour. In the case of the sub-criteria- “awareness” which is under the criteria of “leadership” the enterprise maturity was found to be E-4, the highest level of maturity, this was because the levels E-2, E-3, and E-4 were marked “Green” which according to the questionnaire is 80-100% true (Hammer, 2007). One box was marked as “Red” which signifies “not true” or less than 20% correct. However, the box which was marked red corresponds to “*The Company’s senior executive team recognizes the need to improve operational performance but has only a limited understanding of the power of business processes*” which is the basic level of maturity, E-1. The box marked as “Red” or “not true” implies that the senior executives do in fact have the knowledge and understanding of the business process and hence satisfy the criteria to qualify as E-1 (Hammer, 2007). The questionnaire states that if all levels are adequately satisfied the maturity level can be promoted to best in class maturity or E-4. Similarly, all the sub-criteria were measured to find their respective maturity level (Hammer, 2007). The same concept of determining the maturity of the criteria and subcriteria was employed for the process maturity questionnaire. By following this logic we arrive at Figure 4.9 for enterprise maturity which is a culmination of all the levels for all criteria.

Enterprise Maturity		Buyers								Consolidated level of maturity for each sub-criteria	Consolidated level of maturity for each criteria	Overall enterprise maturity level
		1	2	3	4	6	7	9	10			
Leadership	Awareness	E-2	E-3	E-4	E-2	E-4	E-3	E-4	E-4	E-2	E-2	E-2
	Alignment	E-2	E-2	E-1	E-1	E-2	E-2	E-2	E-3	E-3		
	Behaviour	E-2	E-4	E-1	E-2	E-1	E-1	E-1	E-2	E-2		
	Style	E-2	E-2	E-2	E-2	E-4	E-2	E-3	E-3	E-2		
Culture	Teamwork	E-2	E-1	E-4	E-1	E-2	E-1	E-4	E-4	E-2	E-2	
	Customer Focus	E-4	E-1	E-4	E-1	E-2	E-3	E-3	E-3	E-3		
	Responsibility	E-4	E-1	E-2	E-2	E-2	E-2	E-0	E-3	E-2		
	Attitude towards change	E-2	E-2	E-4	E-1	E-1	E-1	E-1	E-2	E-2		
Expertise	People	E-2	E-2	E-1	E-1	E-1	E-2	E-3	E-4	E-2	E-2	
	Methodology	E-2	E-1	E-3	E-2	E-4	E-4	E-3	E-4	E-3		
Governance	Process Model	E-2	E-1	E-2	E-1	E-1	E-4	E-1	E-3	E-2	E-2	
	Accountability	E-2	E-3	E-2	E-3	E-2	E-2	E-2	E-3	E-3		
	Integration	E-2	E-1	E-1	E-1	E-2	E-1	E-1	E-3	E-1		

**Figure 4.9:** Enterprise maturity model, Maturity level synthesis

Following the method, as stated above the maturity level of each criterion (marked in yellow) and subcriteria (marked in orange) of the enterprise maturity was determined (Hammer, 2007). Hence it can be observed that the leadership is at E-2, culture at E-2, expertise at E-2, and governance at the E-2 maturity level. It was further found that based on the maturity levels of the criteria the overall enterprise maturity (marked in green) of the company was at an E-2 maturity level (Hammer, 2007).

Similarly, the Process maturity model is shown in Figure 4.10.

Process Maturity		Buyers								Consolidated level of maturity for each sub-criteria	Consolidated level of maturity for each criteria	Overall process maturity level
		1	2	3	4	6	7	9	10			
Design	Purpose	P-2	P-1	P-3	P-3	P-1	P-3	P-2	P-4	P-2	P-2	P-2
	Context	P-2	P-1	P-3	P-3	P-0	P-2	P-3	P-4	P-2		
	Documentation	P-2	P-1	P-2	P-2	P-4	P-1	P-3	P-4	P-2		
Performers	Knowledge	P-2	P-0	P-0	P-2	P-2	P-2	P-3	P-3	P-2	P-2	
	Skills	P-2	P-1	P-3	P-2	P-2	P-2	P-2	P-4	P-2		
	Behaviour	P-2	P-1	P-2	P-1	P-2	P-2	P-2	P-4	P-2		
Owner	Identity	P-2	P-2	P-1	P-0	P-0	P-2	P-0	P-3	P-1	P-2	
	Activities	P-2	P-2	P-0	P-1	P-2	P-2	P-1	P-3	P-2		
	Authority	P-2	P-2	P-2	P-1	P-1	P-4	P-2	P-4	P-2		
Infrastructure	Information system	P-0	P-2	P-3	P-2	P-1	P-1	P-1	P-3	P-2	P-2	
	Human Resource System	P-2	P-2	P-3	P-0	P-1	P-2	P-2	P-4	P-2		
Metrics	Definiton	P-2	P-3	P-1	P-2	P-1	P-3	P-1	P-2	P-2	P-2	
	Uses	P-2	P-4	P-0	P-0	P-0	P-3	P-2	P-4	P-2		

Figure 4.10: Process maturity model, Maturity level synthesis

From Figure 4.10, it was observed that design is at P-2, performers at P-2, owner at P-2, infrastructure at P-2, and metrics at P-2 maturity levels. Taking into consideration the maturity levels of the criteria (marked in yellow) the overall process maturity (marked in green) of the company was found to be P-2 (Hammer, 2007). It can be concluded that both enterprise and process maturity is at level one maturity E-2 and P-2 respectively (Hammer, 2007). Therefore, since the enterprise maturity is at the E-2 level, it has the capability to support the processes at the P-2 maturity level (Hammer, 2007).

In order to come to a conclusion of overall enterprise maturity at E-2 and overall process maturity at P-2 certain calculations were employed, which will be discussed below.

One of the drawbacks of the PEMM questionnaire employed for this thesis work was that the interpretations of the maturity level are left to the author of the questionnaire and are not standardized. As shown in Figure 4.8, the explanation for determining the maturity level of sub-criteria and criteria is based on the assumption that the respondent answers in a predetermined and predictable fashion as explained in Figure 4.11:

Section 2 How Mature Is Your Purchasing Processes?		You can evaluate the maturity of a business process and determine how to improve its performance by using this table. Decide how the statements defining the strength levels, from P-1 to P-4, for each enabler apply to the process that you are assessing. If a statement is largely true (at least 80% correct), color the cell green; if it is somewhat true (between 20% and 80% correct), shade the cell yellow; and if it is largely untrue (less than 20% correct), make the cell red. <b>This is to establish the As-is situation in the purchasing department, if any of the parameters are ongoing then it has to be deemed Green, Yellow for future plans and Red if no such decisions have been made</b>				GREEN largely true	YELLOW somewhat true	RED largely untrue				
		P-1	P-2	P-3	P-4	Buyer 6						
Design	Purpose	The process has not been designed on an end-to-end basis. Functional managers use the legacy design primarily as a context for functional performance improvement.	The process has been redesigned from end to end in order to optimize its performance	The process has been designed to fit with other company processes and with the company's IT systems in order to optimize the company's performance.	The process has been designed to fit with customer and supplier processes in order to optimize Intercompany performance.	Green	Yellow	Red	Green	Yellow	Red	Green
	Context	The process's inputs, outputs, suppliers, and customers have been identified.	The needs of the process's customers(end users) are known and agreed upon.	The process owner and the owners of the other processes with which the process interfaces have established mutual performance expectations.	The process owner and the owners of <b>customer and supplier</b> processes with which the process interfaces have established mutual performance expectations.	Red	Yellow	Red	Yellow	Yellow	Yellow	Yellow

Figure 4.11: Example of Predictable answering of the questionnaire

Figure 4.11 which is adapted from Hammer (2007), we can see that the maturity level for sub-criteria “purpose” is P-1 and sub-criteria “context” is P-0, this is because according to the questionnaire tool-kit if the first level is not fulfilled then the entire sub-criteria will be at level P-0, and hence why sub-criteria “context” is given that level (Hammer, 2007). In the case of sub-criteria “purpose”, level 1 is satisfied (marked by green) but the subsequent levels are marked in yellow meaning that it needs more work, so the level is at P-1 (Hammer, 2007). This has been satiated by the questionnaire and is easy to follow provided the respondent answers like Figure 4.11.

Section 2 How Mature Is Your Purchasing Processes?		You can evaluate the maturity of a business process and determine how to improve its performance by using this table. Decide how the statements defining the strength levels, from P-1 to P-4, for each enabler apply to the process that you are assessing. If a statement is largely true (at least 80% correct), color the cell green; if it is somewhat true (between 20% and 80% correct), shade the cell yellow; and if it is largely untrue (less than 20% correct), make the cell red. <b>This is to establish the As-is situation in the purchasing department, if any of the parameters are ongoing then it has to be deemed Green, Yellow for future plans and Red if no such decisions have been made</b>				GREEN largely true	YELLOW somewhat true	RED largely untrue					
		P-1	P-2	P-3	P-4	Buyer 9							
Design	Purpose	The process has not been designed on an end-to-end basis. Functional managers use the legacy design primarily as a context for functional performance improvement.	The process has been redesigned from end to end in order to optimize its performance	The process has been designed to fit with other company processes and with the company's IT systems in order to optimize the company's performance.	The process has been designed to fit with customer and supplier processes in order to optimize Intercompany performance.	Red	Green	Yellow	Red	Red	Green	Yellow	Red
	Context	The process's inputs, outputs, suppliers, and customers have been identified.	The needs of the process's customers(end users) are known and agreed upon.	The process owner and the owners of the other processes with which the process interfaces have established mutual performance expectations.	The process owner and the owners of <b>customer and supplier</b> processes with which the process interfaces have established mutual performance expectations.	Yellow	Green	Green	Yellow	Yellow	Yellow	Yellow	Yellow

Figure 4.12: Example of Unpredictable answering of the questionnaire

However, as shown in Figure 4.12 adapted from Hammer (2007) the respondents need to answer according to the description of each level, in this case, P-1, P-2,

P-3, and P-4. As shown in Figure 4.12, we are taking the example of “purpose”, it has multiple colour codes which are hard to interpret the actual maturity level of the subcriteria (“purpose”). In this example the maturity level for sub-criteria is at P-2 level, the description for P-1 as mentioned in Figure 4.12 is “*The process has not been designed on an end-to-end basis. Functional managers use the legacy design primarily as a context for functional performance improvement*” and this was marked “Red” or “largely untrue”, which implies that the process is designed from end to end and hence qualifies to be P-1 level and can be considered as marked “green”. In this case, the marking of “Red” or “largely untrue” leads to a positive since it is largely untrue on a negative statement (the description of P-1), hence, the explanation of the markings is vague and open to interpretation and can change according to the description of the maturity levels which are not explained by the questionnaire.

The description for the P-2 level is “*The process has been redesigned from end to end in order to optimize its performance*” and was marked “green” or “largely true” (Hammer, 2007). With both P-1 and P-2 satisfying the requirements for the maturity level while the other maturity level (P-3) was marked “yellow” or “somewhat true” we can conclude that the maturity level for sub-criteria “purpose” is P-2. For sub-criteria “context” we come to a conclusion of maturity level P-3 because the first level P-1 is marked “yellow” or “somewhat true” and P-2 and P-3 were marked “green” or “largely true”, the conclusion was reached based on the descriptions and that P-1 level was “somewhat true” and the subsequent levels were “true”. If the P-1 level was marked “red” or “largely untrue” then the maturity level for the sub-criteria would be at P-0 level as it does not qualify the minimum requirements of maturity level P-1 (Hammer, 2007).

However, one of the additional dilemmas with respect to the open interpretation is the determination of the consolidated maturity level of the criteria and subsequently determining the overall process and enterprise maturity level of the company. The respondents mark the criteria green, yellow, or red according to the current state of the maturity level they think that their company or processes are at. The determination of the overall maturity level is left to the authors of the questionnaire. Though its apparent limitations, the questionnaire allows the author to determine the maturity level of each sub-criteria for each respondent (buyers) of the questionnaire. However, the questionnaire does not explain how to determine the consolidated maturity level of the criteria from all the respondents.

In order to determine the consolidated maturity level of the criteria and the overall maturity level, the authors assigned numeric values ranging from 0-4 to the maturity levels where E-0 is 0, E-1=1, E-2=2, E-3=3, and E-4=4 similarly P-0=0, P-1=1, P-2=2, P-3=3, and P-4=4. Assigning these values to the maturity levels we obtained from the questionnaire, we were able to calculate the mean value for each sub-criteria, each criterion, and overall maturity level.

Figure 4.13 shows an example of the calculation used to determine the ma-

turity level of criteria “Design” in the process maturity questionnaire:

P-0=0	P-1=1	P-2=2	Buyer 1	Buyer 2	Buyer 3	Buyer 4	Buyer 6	Buyer 7	Buyer 9	Buyer 10	Consolidated level of maturity for each sub-criteria	Consolidated level of maturity for each criteria
P-3=3	P-4=4											
Design	Purpose	2	1	3	3	1	3	2	4	2.37(P-2)	2(P-2)	
	Context	2	1	3	3	0	2	3	4	2.25(P-2)		
	Documentation	2	1	2	2	4	1	3	4	2.37(P-2)		

**Figure 4.13:** Example of mean calculator for Design criteria

As shown in Figure 4.13 the mean values are calculated for each sub-criteria and subsequently, the mean for the overall maturity level is calculated as seen in Figure 4.10. To make the calculation of the mean and hence assign the maturity level, the authors decided to establish “0.5 “ as a median where anything above “0.5” will be the higher level and anything below “0.5” as the lower level. Using this method we determined the maturity levels for sub-criteria, criteria, and the overall process and enterprise maturity. A complete result of the maturity levels is shown in Figure 4.9 and Figure 4.10 .

# 5

## Discussion

*The purpose of this thesis was to improve the supplier management of the company by developing and suggesting improvements in supplier quality along with detailed process flow charts with sub-processes for the respective purchasing process as per IATF standard and corporate requirements. This section represents the discussion of the empirical data and analysis with respect to the theoretical framework.*

### 5.1 "To-be" processes

The authors will attempt to discuss the various findings from the thesis and analysis in terms of the research questions which were identified for this thesis work:

- **RQ1: How to improve the existing purchasing process to support a robust supplier management in purchasing function?**

The motive of the authors is to design the process flowcharts which can be applied to both direct and indirect purchasing processes. In this section, the authors designed the common process flow chart for the overall supplier management process for both direct and indirect purchasing. All the “To-be” processes were created with brainstorming technique along with the company supervisor and purchasers.

#### “To-be” Overall supplier management process

The gaps in the overall supplier management process have been displayed in Table 4.3. All the gaps from the direct and indirect purchasing were addressed and the ‘To-be’ process flow chart is made. Figure 5.1 shows the ‘To-be’ process flow chart designed by the authors. From Figure 5.1, the overall supplier management consists of two processes that work in tandem with each other. The overall supplier management starts from the customer requirement or the need and ends at approval and updation of the supplier. The evaluation, risk assessment, rating, and continuous improvement process run parallel to the selection and approval of the supplier process. The responsibility for the overall supplier management process includes the purchaser, supplier quality engineer (SQE), and the material specialist (only for resins and paints). The addition of the materials specialist responsibility was an improvement from the “As-is” process since the existence of materials specialists in the supplier management of direct purchasing for resins and paint was only brought up during the interview and was identified as a gap.

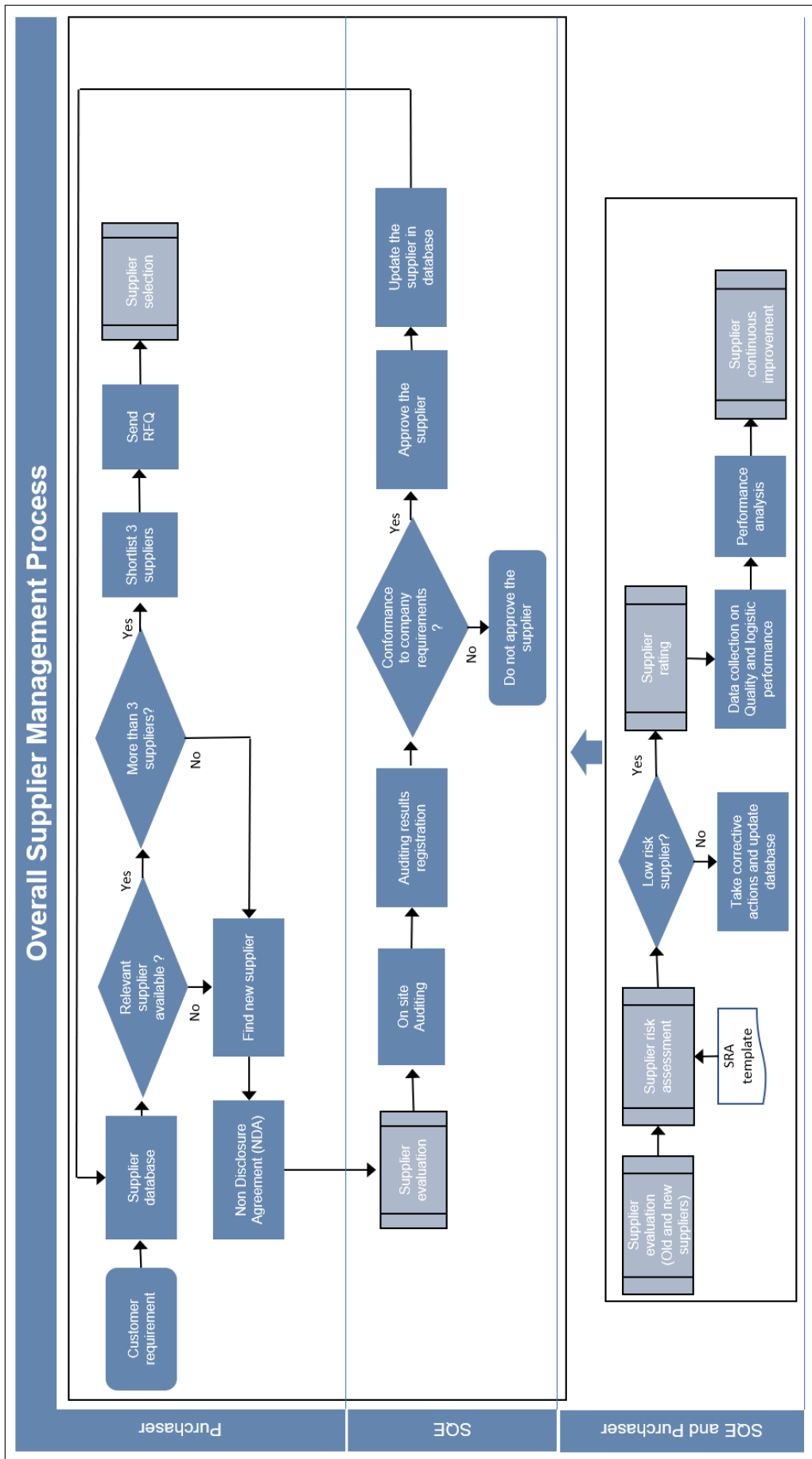


Figure 5.1: "To-be" overall supplier management process flow chart



At the start of the process the purchaser searches the supplier from the supplier database based on the customer requirement. The relevant supplier availability is checked in the supplier database for the customer requirement. This is a change with respect to the “As-is” situation where the purchaser checks whether it is the existence of the supplier in the supplier database. This improvement leads to the elimination of non-value adding tasks and streamlines the process according to Benner and Tushman (2003) by having the purchaser search the database only for the relevant supplier and making an appropriate decision. If the relevant suppliers are available for the customer’s needs, the purchaser shortlists 3 suppliers for the RFQ process which is supported by Yu et al. (2009) to enable the buyer to have multiple choices where they can compare suppliers based on best-price advantage, quality and other deliverables. For indirect purchasing, the “To-be” process flow chart has to be followed till the shortlisting of supplier processes. During RFQ, the purchaser is the process owner and responsible person in the maintenance services and indirect materials purchase which is in line with Page (2015) who proposes that a process owner for the process needs to be identified and to be determined what role they play when the process has multiple levels. This is contrary to the “As-is” process where production is doing all purchasing activities and has no room for purchaser involvement. In the “To-be” process, the purchaser is involved in the RFQ process where he/she negotiate the prices with the suppliers for services parts which in turn results in cost reduction for the company. The process ownership lying only with the purchaser leads to improvement in interactions with suppliers and operations personnel and successful initiatives, this is because of the purchasers existing relationship with suppliers and understanding their uncoordinated behaviours which is posited by Ellegaard and Koch (2012).

If the relevant supplier is not available and/or the suppliers are less than 3 then the purchaser needs to find a new supplier based on the customer’s need. In the “As-is” process, the process was incomplete where it stops with the list of suppliers. After the RFQ, the supplier is selected based on the criteria set by the purchaser to satisfy the customer requirements which was an improvement from the “As-is” process. The criteria are predefined and can range from company requirements like purchasing strategy, production capacity, project capacity, quality and cost. In the “To-be” process the supplier selection is included as a connection to the subprocess (displayed as “Grey color” box), where by clicking on it in the ERP system will pop out the supplier selection process. When the purchaser finds the new supplier, he/she sends the NDA to prevent the data leakage from the supplier side. With the help of the ERP system and the connection to the subprocess, the purchaser gets a border view on the supplier and the criteria that were used to select the supplier as put forth by Okrent and Vokurka (2004) who proposed that ERP helps in integration and helps to link with other business processes and functions. This is a minor change with respect to the “As-is” process where the confidentiality agreement has been replaced with NDA.

During the new supplier approval process, the supplier evaluation was done to evaluate the supplier with respect to the company and customer requirements.

When compared with the “As-is” process, only qualitative assessment and supplier evaluation questionnaires were carried out for direct purchasing and indirect purchasing does not have any evaluation process other than a financial check. This can be seen as a major gap in the “As-is” process since Zeydan et al. (2011) argued that instead of having both qualitative and quantitative assessments, focusing on just one criterion can lead to risks in evaluating the supplier. It is also argued by Purdy et al. (1994) & Trent and Monczka (1999) that supplier evaluation can minimize undesirable variations from the supplier and the company can assess the supplier’s process capability and commitment to continuous improvement. Therefore it is suggested in the “To-be” process that the supplier evaluation is included as a connection to the subprocess. The suggested activities in the supplier evaluation should include a financial assessment, supplier evaluation questionnaire, and quantitative and qualitative assessment valid for both direct and indirect purchasing in the future.

To cross-verify the assessment in the supplier evaluation, the onsite auditing was carried out by the SQE for direct purchasing activities in the “To-be” process. However, for indirect purchasing in the “As-is” situation, there is no SQE involvement, and auditing is not carried out for the indirect material suppliers. According to IATF (2016), the evaluation can be done by the employees and in this case the purchasers, provided that they are adequately trained in the processes and familiarised with the required quality standards in the industry which is an improvement for “To-be”. According to Purdy et al. (1994) & Trent and Monczka (1999), auditing can be a means for the company to make sure that the supplier is adhering to the quality standards and emphasising on audits and certain documentation can lead to suppliers having a closer look at their own processes and improve by themselves. Furthermore, the process owners like SQE and purchaser register the auditing results in the database for future reference. There is no common database for both direct and indirect in the “As-is” processes which hinders information sharing and proper knowledge transfer. Having a central database that collects information and knowledge from all functions possibly helps to filter the relevant information and establish links as proposed by Dwivedi et al. (2009).

After the auditing, the suppliers are checked for conformance to company requirements whereas in “As-is” it was only conformance to standards. These company requirements include corporate requirements which were stated for the supplier selections process and quality standard requirements. For indirect, the suppliers are approved based on the soft criterias determined by the purchaser which are not documented. This calls for standardized evaluation and approval criteria involving both qualitative and quantitative assessment which is supported by Okrent and Vokurka (2004) & IATF (2016).

For both direct and indirect, this decision gate in the “To-be” process can be applied to make decisions for the approval of the supplier. If the suppliers conform to the company requirements, the suppliers are approved and updated in the database. Meanwhile, there are some activities done in parallel to the above mentioned process

throughout the year. In the “To-be” process, the supplier evaluation and supplier risk assessment were modified as a connection to the sub process when compared to the “As-is” process. In the “As-is” process only the supplier risk assessment (SRA) template is used for the risk assessment process whereas in “To-be” supplier risk assessment includes the SRA template and financial risk assessment for both direct and indirect material suppliers.

Risk assessment of the suppliers is argued to help companies to determine the appropriate actions that the company should pursue in order to mitigate the risk (Hallikas et al., 2004). Risk assessment also includes the impact caused by the risk and the possible disturbance it can cause to the company. To this extent it is imperative for companies to focus on other risk factors such as delivery and quality and not just financial risks. Proceeding the risk assessment process, the high risk suppliers are shortlisted and corrective actions are taken to mitigate the risks. Afterwards, the actions taken to overcome risks are updated in the database. As argued by Riley et al. (2016) & Craighead et al. (2007), companies must focus on developing proactive warning capabilities to foresee risks and plan ahead for possible countermeasures. This is also in line with the conclusions made by Riley et al. (2016) since accumulating data from different functional units can increase internal integration and lead to faster risk detention activities. If the supplier is a low risk supplier then the performance of the supplier is assessed from the rating process by the responsible stakeholders to continuously improve the supplier’s performance. The supplier rating and supplier continuous improvement are displayed as a connection to subprocess in the “To-be” situation (displayed as “Grey color” box) whereas it is not in the “As-is” situation.

### **“To-be” Overall project purchasing process**

The overall project purchasing process and overall supplier management process are interrelated to each other till the supplier selection process. Figure 5.2 shows the “To-be” project purchasing process of the company for direct materials. This process flow chart was prepared by a brainstorming session with the purchaser and SQE which according to Aguilar-Saven (2004), allows us to get a better understanding and ease of representing the process and map the process with the inputs. Indirect project purchasing is a separate process that is completely different from direct project purchasing. The gaps in the project purchasing process of the direct materials are listed in Table 4.3. There are four responsibilities in the project purchasing process. They are project manager, purchaser, supplier, and SQE. The project requirements are shared with the project team by the project manager. When compared to the “As-is” process the inclusion of project manager in the “To-be” chart is an improvement that was lacking in the former.

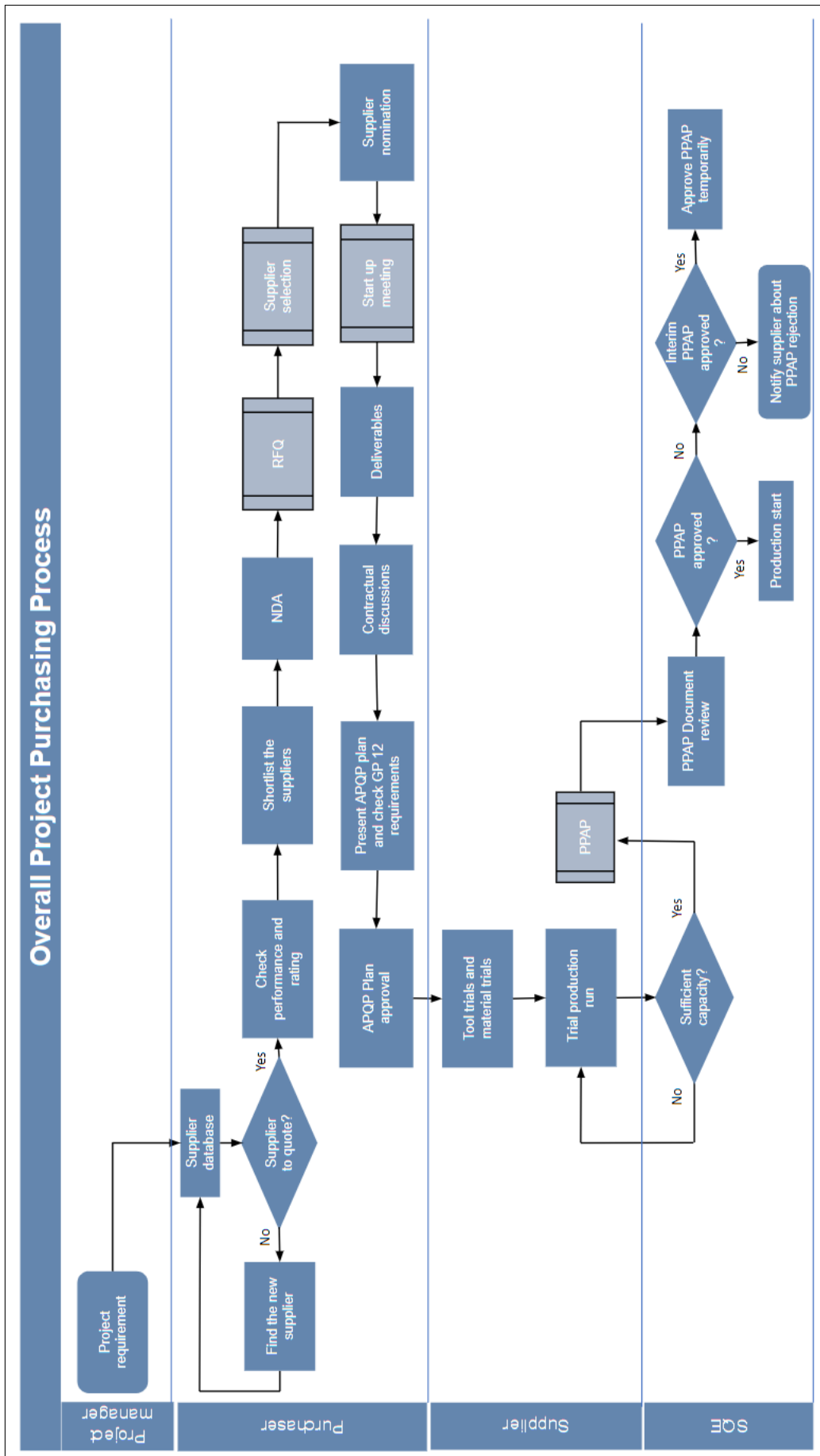


Figure 5.2: "To-be" overall project purchasing process flow chart

The purchaser receives the project requirement from the project manager and based on the project requirement he/she searches for the supplier in the supplier database. Supplier databases are not available in the “As-is” process when compared to the “To-be” process. Fugate et al. (2009) proposes having a shared database of knowledge and information helps for making knowledge accessible which leads to collective agreements being achieved on a decision and failure to do so will lead to outdated knowledge and hence becomes irrelevant. If there is a supplier to quote for the bidding process, the purchaser checks the performance and rating of the supplier for shortlisting. If there is no supplier to quote based on the project requirement, the purchaser has to find a new supplier and he/she should update the database. This process is connected to the overall supplier management process during this new supplier approval for the company. After the shortlisting of suppliers, the purchaser sends the NDA to the supplier to protect confidential information. In the “As-is” process the purchaser sends the confidentiality agreement whereas in “To-be” the purchaser sends the NDA. The RFQ and supplier selection process is displayed as a connection to subprocesses in the process flow chart when compared to the “As-is” process. The supplier nomination is a process where the purchaser sends the nomination letter made from the purchase requisitions after the supplier selection.

In the “As-is” situation, none of the process documents provided insights regarding supplier nomination. The supplier nomination process was found out by the authors during the brainstorming session with the company supervisor and purchaser. When the supplier is nominated, the purchaser along with the project team members have a start up meeting to discuss the deliverables with the supplier. The startup meeting can be a means for the company to marshal their internal resources such as the employees along with the external resources such as supplier as argued by Sanchez-Rodriguez and Martnez-Lorente (2004). This is followed by the contractual discussions with the supplier. Contracting strategy and choosing the appropriate contract is a good way to mitigate the risks and disadvantages of a single sourcing or a multi sourcing strategy as proposed by Ramsay and Wilson (1990). The supplier approval process does not exist in the “To-be” process when compared to the “As-is” process since it is related to the overall supplier management process. The APQP process and the GP 12 requirements checking are performed together by the purchaser where it was performed in separate steps in the “As-is” process. When the APQP plan is completed and it is approved the responsibility moves to the supplier in the “To-be” process.

The supplier is responsible for the key activities in the project purchasing. After the APQP plan approval, the supplier begins the tool trials and material trials at their location. In the “As-is” process it was testing of new materials which has been replaced by tool trials and material trials to be more accurate to the APQP in the “To-be” process. The tool and material trials are followed by the trial production run. The trial production run encloses the test report and storing of sampling part activities. These activities are displayed separately in the “As-is” process whereas “To-be” trial production encloses the above-mentioned activities. When the trial

production run is complete, the SQE checks the capacity of the supplier to meet the company requirements which was found to be in accordance with Prajogo et al. (2012) who suggests that continuous monitoring of the supplier is required in order to determine if the key suppliers can meet the current demands.

If the supplier has sufficient capacity then SQE intimates the supplier to initiate the PPAP. When the supplier finishes the PPAP, the SQE checks the PPAP documentation and reviews all documentation attached to PPAP. Based on the documentation review, the SQE makes a decision for the PPAP approval. If all the requirements are satisfied, the SQE approves PPAP and production will start at the company. If some of the requirements in the documentation review are not met, then the SQE temporarily approves the PPAP. If there are major requirements missing, the SQE will reject the PPAP of the supplier and notify the supplier about the rejection. When compared to the “As-is” process the PPAP is much more detailed in the “To-be” process which is a major improvement for this overall project purchasing process since the authors incorporated the sub-processes in the PPAP with respect to approvals of the PPAP. This was in line with the Automotive Industry Action Group (AIAG) proposed levels of approval in the PPAP process which are “approved”, “interim” and “rejected” AIAG (2006), whereas in the “As-is” only PPAP approval was mentioned.

- **RQ2: How to incorporate the risk-based thinking approach as per IATF standard in the existing business process?**

#### **“To-be” Overall supplier management in serial production process**

Figure 5.3 represents the overall supplier management process in serial production. The gaps in the “As-is” process of the supplier management in serial production are listed in Table 4.3. The “To-be” process of the overall supplier management in serial production is created by the brainstorming technique with the SQE and purchaser. In the “As-is” process the responsibilities of the stakeholders are not clearly defined. This is not in line with Page (2015) who argues that it is important to identify the responsibilities inherent in each process especially when the process has multiple levels. The identified gap is also not in line with IATF standard requirements which requires clear responsibilities being defined with respect to product requirements and corrective actions (IATF, 2016). Therefore, it is suggested to include in the “To-be” process of the overall supplier management in serial production, the quality engineer, material controller, SQE and purchaser as responsibilities. The overall supplier management in serial production is a combination of the complaint handling procedure, controlled shipping level, 8 D report and escalation process. This improvement is in line with Riley et al. (2016) & Craighead et al. (2007) who argues that internal integration where the organization can collaborate between different functional units and act as a cohesive unit helps to develop the warning and recovery capabilities of the firm.

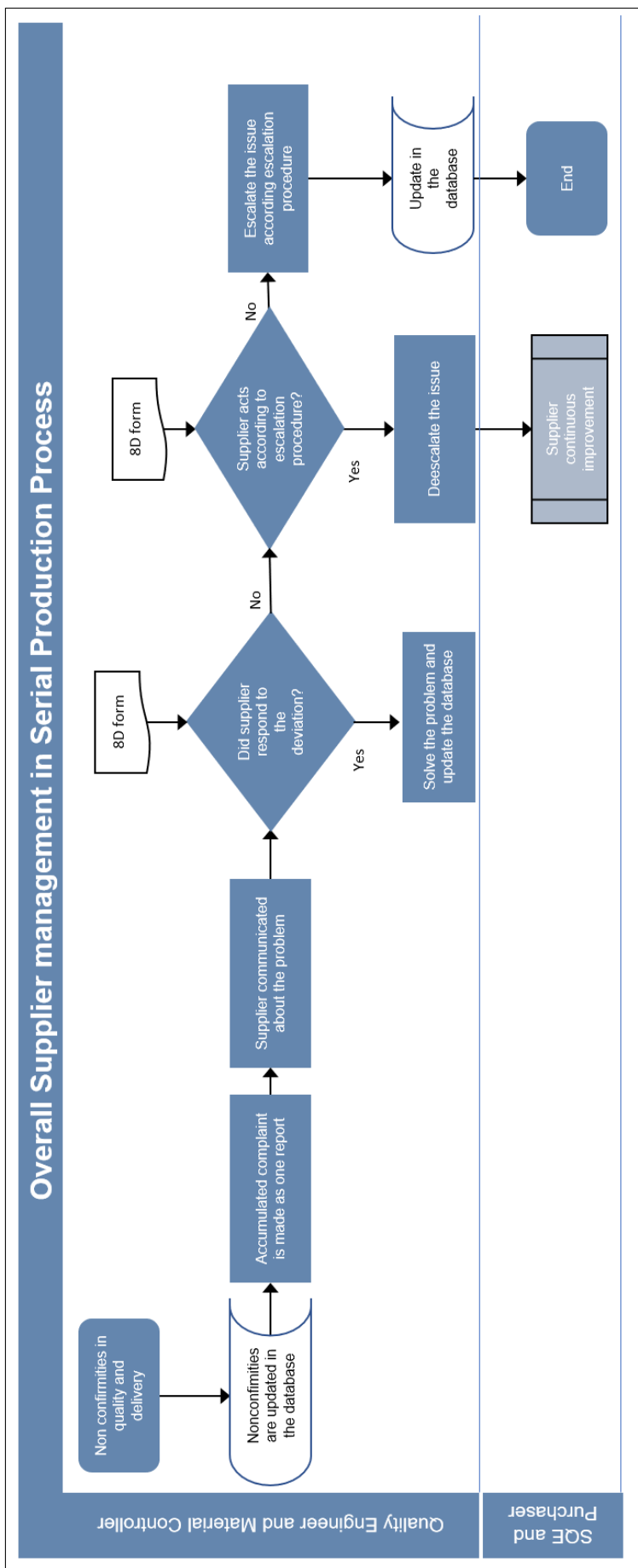


Figure 5.3: Overall supplier management in serial production process flow chart

8 D is a process employed in corrective action planning which is used to eliminate recurring problems which are in line with the Kaplík et al. (2013) and with the IATF standard requirements of risk assessments and correction (IATF, 2016). The escalation process is designed as a separate process for the quality and delivery deviations. The escalation model is a major part of this “To-be” process and it is discussed further in this section.

Firstly, the nonconformities in the quality and delivery are identified by quality engineer and material controller. The material controller is responsible for delivery deviations from the supplier and the quality engineer is responsible for quality deviations from the supplier where the identification of responsibility and roles is in line with IATF requirements IATF (2016) and conclusions of Page (2015). Hence, this responsibility definition is a major improvement with respect to the “As-is” process since it directly started with a quality manager and delivery manager. These nonconformities are updated in the database by the respective stakeholders and it has been accumulated into one report called “Deviation report”. Having a report like “Deviation report” is beneficial since having a shared and accessible database helps to disperse knowledge faster according to Dwivedi et al. (2009) and streamlining forms, reports and documents can lead to improved processed design as concluded by Benner and Tushman (2003).

The IATF standards require that documents should be available and ready to use when required so the process fulfills the IATF requirements (IATF, 2016). The standard also specifies retention of these documents like PPAP and contracts among others for the period of time the product is active for, plus one calendar year (IATF, 2016). This deviation report is sent to the supplier and communicated about the problem. Since the sequence of activities in the “As-is” process was taken from the “As-is” escalation model of quality and delivery, the overall “As-is” supplier management process in serial production needed an improvement as a whole because the quality escalation model required a lot of improvements. When the supplier is communicated about the problem in either quality or delivery, the supplier needs to respond to the deviation with the aid of a standardized 8 D form. If the supplier responds to the deviation, then the quality engineer and material controller responsible for this process solves the problem and updates about the deviation and corrective actions taken in the database. If the supplier does not respond to the deviation then the escalation procedure is followed by the company. If the supplier then acts according to the escalation procedure of the company with the support of 8 D form then the respective stakeholders deescalate the problems.

When the problems are de-escalated, the SQE and purchaser perform supplier continuous improvement activities to improve the rating and performance of the supplier. If the supplier is not acting according to the escalation procedure, then the escalation process will be carried out as mentioned in the “To-be” escalation model. When the escalation process is complete according to the “To-be” escalation model, the responsible stakeholders such as the quality engineer and material controller update the database about the events that happened with the supplier.



### **“To-be” Escalation process for the quality deviation**

Figure 5.4 shows the redesigned escalation model for the quality deviations in the company. The “To-be” escalation model for quality deviations is prepared by authors based on the benchmarking technique. The two Tier-1 suppliers of the industry’s escalation model were considered for benchmarking purposes. One Tier-1 supplier is a world leader in producing Airbags for the automotive industry and the other Tier-1 supplier is a world leader in producing power transmission elements for the automotive industry. Hence, the companies chosen for benchmarking are situated in the same industry as the case company in the thesis. By benchmarking technique, the authors found various gaps in the “As-is” escalation model for the quality deviation and it has been listed in Table 4.3. The process was redesigned by the authors in the absence of literature on relevant escalation processes and to mitigate the issues related to escalation the company is facing today. The redesign of the process was achieved with benchmarking and a brainstorming session with SQE.

From Figure 5.4, it can be inferred that the criteria for the escalation and de-escalation process are mentioned in red colour, the company’s actions are mentioned in green colour, the supplier’s actions are mentioned in blue colour and responsible stakeholders are mentioned in purple colour. This colour coding differentiates the company’s actions from the supplier’s actions based on the criteria considered which eliminates the confusion existing in the “As-is” escalation model. This improvement is in line with the IATF standard which requires responsibilities to be defined and have a defined flow of information (IATF, 2016). The inputs from the CSL process document were incorporated in the “To-be” escalation model since the information is interlinked to each other. The “To-be” escalation model is divided into stage-0, stage-1, stage-2 and stage-3 of the escalation process.

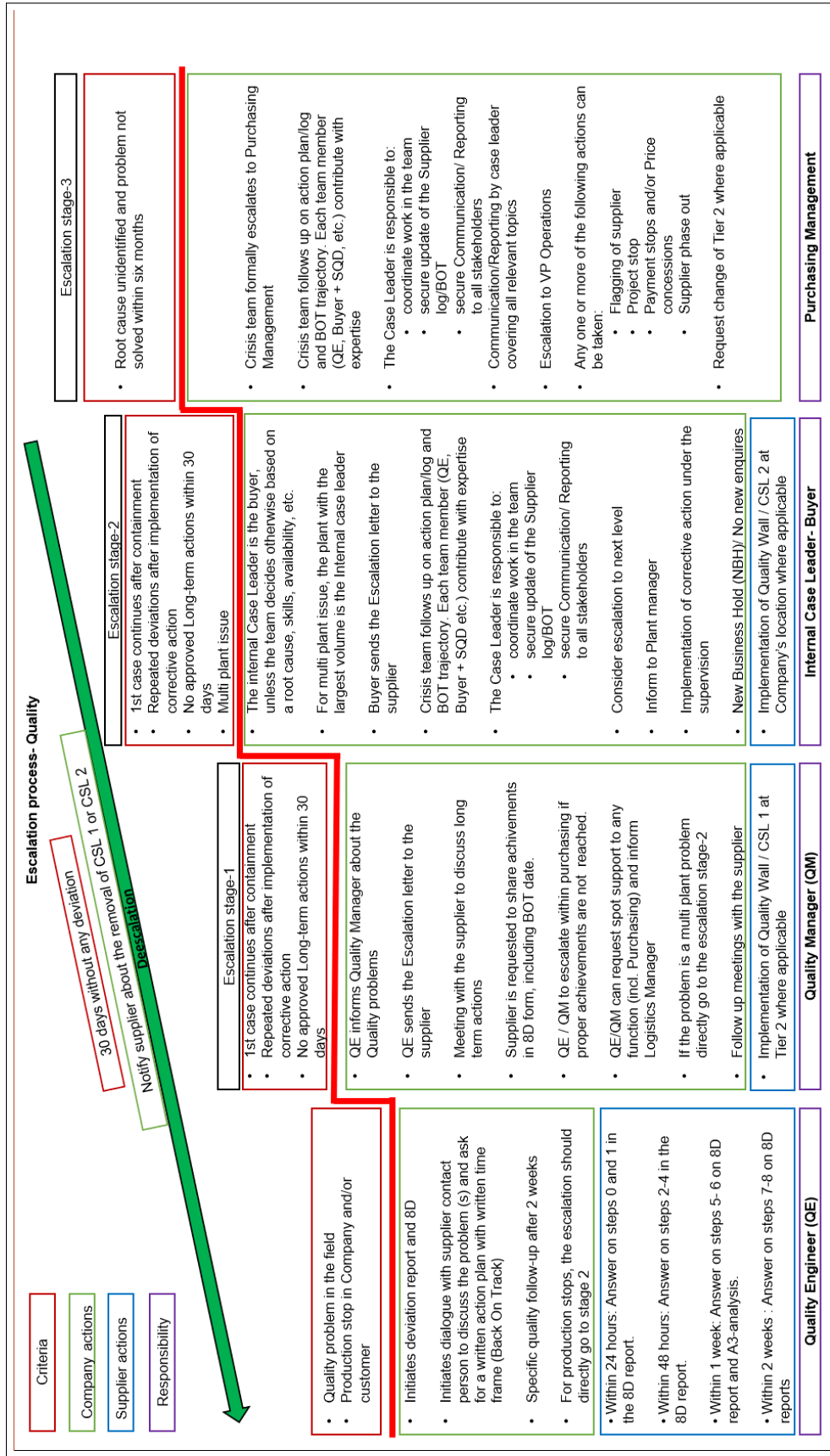


Figure 5.4: “To-be” Escalation model for quality deviations

**Escalation process:**

1. **Stage 0:** The responsible stakeholder in this stage is the quality engineer where he/she is responsible for initiating deviation report & 8 D, initiating the talks with the supplier and making a specific quality follow up to the supplier after two weeks of the problem identification. The quality engineer is also responsible for escalating the issue to stage 2 if there is a production stop in the company and/or customer. The supplier should follow the guidelines for sending the 8D form as specified in the escalation model time duration where the D7 in 8D is developing preventive actions which are in line with what was proposed by Tomić and Brkić (2011) and IATF standard which suggests having risk assessments processes and corrective action planning to evaluate necessary actions to eliminate nonconformity and documentation of the results (IATF, 2016).
2. **Stage 1:** The criteria considered for this stage are the first case that continues after containment (problem continues during the established CSL process), repeated deviations even though after the implementation of corrective actions and supplier have not sent the long term actions within 30 days. The responsible stakeholder in this stage is the quality manager where he/she is responsible for escalating to the purchaser when proper achievements are not achieved in the previous stage. The quality engineer or quality manager can request support from other functions during this stage. In this stage, the quality engineer sends the escalation letter to the supplier notifying them that they have been escalated to stage 1. Suppliers have a meeting and follow up with the quality manager to discuss and solve the problem. If the problem is multiplant, then the quality manager escalates directly to stage 2. The supplier is responsible for implementing CSL 1 (Inspection process) at the supplier's location at the expense of the supplier.
3. **Stage 2:** The criteria considered for this escalation stage is similar to that of stage1 but multi-plant quality problems from the supplier is an addition. The key stakeholder in this stage is Purchaser. In this stage, a crisis team is formed consisting of SQE, quality engineer, etc led by the purchaser called internal case leader. For multi-plant issues, the plant with the largest volume is the internal case leader for this escalation process. The internal case leader is responsible for sending the escalation letter to the supplier notifying them that they have been escalated to stage 2 of the escalation process. The internal case leader is responsible for escalating the issue to the next level and informing the plant manager regarding the process. The crisis team led by the purchaser implements the corrective action under the supervision at the supplier's location and the new business is put on hold for the supplier. The supplier is responsible for implementing CSL 2 (Inspection process carried out by a third party) in the company's location at the expense of the supplier.
4. **Stage 3:** The criteria for the last and final stage of escalation is "Root cause

unidentified and the problem is not solved within six months”. The crisis team escalates the issue to the top management (Purchasing management). The main responsibility in this stage is purchasing management. The internal case leader communicates everything covering all the relevant topics of supplier’s escalation to the purchasing management. This will be further escalated to VP operations by the internal case leader. The purchasing management is responsible for taking the following actions against the suppliers. They are; flagging suppliers to block further business, project stop, payment stops and/or price concessions in the existing project and supplier phase-out (step by step elimination of the supplier’s business from the company). The purchase management is also responsible for requesting the change of supplier.

**Deescalation process:**

The criterion for the deescalation process is 30 days without any deviation from the supplier. If the criteria is satisfied by the supplier then the issue is de-escalated from stage 2 to stage 1 and/or stage 1 to stage 0. The suppliers are notified by the respective stakeholders regarding the removal of the CSL 1 or CSL 2 process.

- **RQ3: How can the updated processes be implemented to secure lasting improvements?**

The process improvements stated above require both drastic and minor changes in company policy, responsibilities and way of working which can be a complex, challenging and progressive process according to Paton and McCalman (2008). Process management activities are prone to increased resistance to the change as argued by Benner and Tushman (2003). Paton and McCalman (2008) concludes that organizations need to change in order to be competitive in the market and maintain the pace of improvement. Showing the success of business efficiency and improved processes like the overall supplier management process & escalation process and communicating these successes to the employees can create an atmosphere of confidence and compliance and help to realize their support towards the change initiatives. Kotter et al. (1995) argues that most change initiatives fail because of not establishing a vision for change, not communicating it in a proper way where the need and urgency of change are not established and not being able to sustain the change.

Kotter et al. (1995) suggests that having a competent team consisting of both top managers (VP operations, purchasing director, plant manager etc) along with members, not part of management like (Quality engineers, project manager, purchasers) leads to coherence in the team and a show of support from senior executives from top management showing commitment for the change efforts creates a sense of urgency. This team should be designated as change agents guiding the change effort.

When choosing change agents for the transformation effort, Battilana and Casciaro (2013) suggests choosing people who play a central role in the organization’s informal network like union representatives or a well respected foreman in the plant. These change agents are able to bridge disconnected groups and cohesive networks

are seen as beneficial for establishing both dramatic and minor changes. Change agents should identify the network they wish to employ in order to communicate the change efforts, drastic changes call for a bridged network and minor changes call for a cohesive network (Battilana & Casciaro, 2013) .

The process improvements involve both minor (project purchasing, Overall supplier management for direct) and drastic changes (escalation model, and overall supplier management in serial production, Overall supplier management for indirect purchasing). Project purchasing and Overall supplier management for direct are minor changes since it was a mere addition of processes that already existed as sub-processes, the employees are aware of the processes and it was only not formally integrated into the way of working. So it was identified as a minor change. Indirect purchasing does not have processes such as supplier rating, supplier risk assessment, supplier continuous improvement among others. The addition of these processes may disrupt company proceedings. Similarly, in the escalation models and supplier management in serial production, the changes are drastic and disruptive for the existing process since it suggests the addition of new processes and criteria which did not exist before. The responsibilities are also diversified to involve more people. This calls for change agents to use both cohesive and bridge networks to communicate.

Resistance is to be expected for every change activity but others play a pivotal role in change efforts who are endorsers and fence-sitters. Battilana and Casciaro (2013) argues that change agents should first concentrate on the fence-sitters since they need convincing to be brought on to the change efforts and Thomas and Hardy (2011) suggests to handle resisters and resistance with celebration. Every change effort is bound to be met with resistance from people who do not believe in the change based on their personal opinions, their understanding of the vision and need for the change and their relationship with the change agent (Ford & Ford, 2010). The factors causing this resistance can vary from cognitive bias of the employees, the social dynamics of their position in the organization and managerial missteps that can affect change efforts (Ford & Ford, 2010).

Change agents should take responsibilities for indiscretion in the change effort rather than shifting the blame to external factors. Similarly, admitting mistakes and asking for help during the change effort will not bring bring down the social standing of the change agents but instead might garner empathy and resources that might play a significant role in successful transformation. The employees might feel that the improved processes are additional burdens, employees working for many years in the company might feel that the new processes are a hindrance to their current ways of working. A few suggestions given by Ford and Ford (2010) is to utilize localized knowledge from the resisters and make them feel involved and valued, especially from people who have been working in the department for a significantly long time. The change agents must be welcoming to the suggestion and look at resistance as a means to improve their change effort plans (Ford & Ford, 2010).

Sustaining this change is also important and middle managers or liaisons with top management like a purchaser, quality engineer, project manager play an important role in change efforts (Balogun, 2007). This liaison personnel must be committed to the change effort as a lack of commitment can lead to employees losing interest and makes it hard to sustain the change. Managers who are identified as liaison personnel must make sure never to break the trust, and not to overstate the benefits and understate the drawbacks of the change as it can affect the transformation goals drastically. Other ways of sustaining change is by cultivating the practice of integrating new employees that join the company into these improved processes and with constant reminders to the employees of what the change effort has achieved so far with respect to performance improvements. But the company should be wary as not to leave the change effort behind in the first sign of progress (Kotter et al., 1995).

Apart from these research questions, the authors during the thesis work identified scope for knowledge management which was related to the research questions and it is elaborated on as below:

### **Knowledge management**

Knowledge management was identified to be an area of improvement in many processes in the form of supplier databases and updation of disruptions and errors as mentioned in the findings. One of the first types of knowledge management undertaken by the authors was to translate the existing company documents into process flow charts and update the ERP system accordingly. 48 processes in total were created this way and to be uploaded to the ERP system. Employing the help of the ERP system for this process was in line with Okrent and Vokurka (2004) who argues ERP helps in creating a knowledge-based environment by integrating operational functions and linking them with the overall business functions. The process of converting the existing company documents to process flow charts was a method of knowledge transfer proposed by Nonaka and Takeuchi (2007). The authors used a method “combination” in knowledge management where bits and pieces of explicit knowledge from the documents like RFQ process, supplier selection process existing in the company is transformed into new explicit knowledge in the form of process flow charts which was then “internalized” where the explicit knowledge was shared across the organization with the help of ERP. The “combination” process resulted in a draft process of the existing explicit knowledge since it was done with the author’s interpretation of the company documents. This allows employees who “internalize” this knowledge to expand upon it by adding their tacit knowledge thus further improving the knowledge documented, which is also in line with the “Spiral of knowledge” developed by Nonaka and Takeuchi (2007).

The knowledge was able to be visualized using process flow charts which is also a method proposed by Aguilar-Saven (2004) who argues that using flow charts makes it easy to recognize and understand a process and process redesign. A flow chart also helps strengthen the communication ability since it allows for an observer of

the process to track down responsibilities and processes with relative ease. One of the tasks undertaken by the authors in knowledge management was the translation of tacit knowledge to explicit knowledge. A process flow chart was developed based on the “externalization” method from Nonaka and Takeuchi (2007). During the interview process, the authors came across an important project purchasing process related to indirect purchasing which was not documented in the existing organizational documents and this process was developed into a process flow chart by having a short brainstorming session with the indirect purchaser.

### **Indirect project purchasing process (CapEx)**

Figure 5.5 shows the indirect project purchasing process of the company. The project purchasing process for indirect purchasing includes three key responsibilities. They are the requester (one who needs the product), approver (budget owner/sourcing board) and purchaser. When the need arises at the requester, he/she creates the Project Authorization Request (PAR) to the approver based on the allocated budget to the department. The approver approves the PAR if the request is in line with the need. When it is not inline with the requirements the approver rejects the PAR and the requester needs to start again. After the approval of PAR, the purchaser shortlists the suppliers along with the stakeholders from the plant. When the suppliers are shortlisted, the purchaser sends the RFQ to those suppliers which are followed by the RFQ review.

The criteria set by the purchaser to review the RFQ are quality, delivery terms, payment terms & payment plans for indirect products and interest rate, rent-in clause & buy-in clause for services. The RFQ review is followed by the negotiation process where the purchaser negotiates the price with the indirect materials and services suppliers then the purchaser presents the case to the approver (sourcing board/budget owner). If the case is approved by the approver, he/she will initiate the purchase requisition process. After the purchase requisitions, the supplier is selected by the purchaser and the purchase requisition is verified. This is followed by generating the purchase order by the purchaser based on the purchase requisitions and a weekly start-up meeting is held to discuss the deliverables from the supplier. Finally, the purchaser sends the supplier nomination letter to the supplier and the process is concluded.

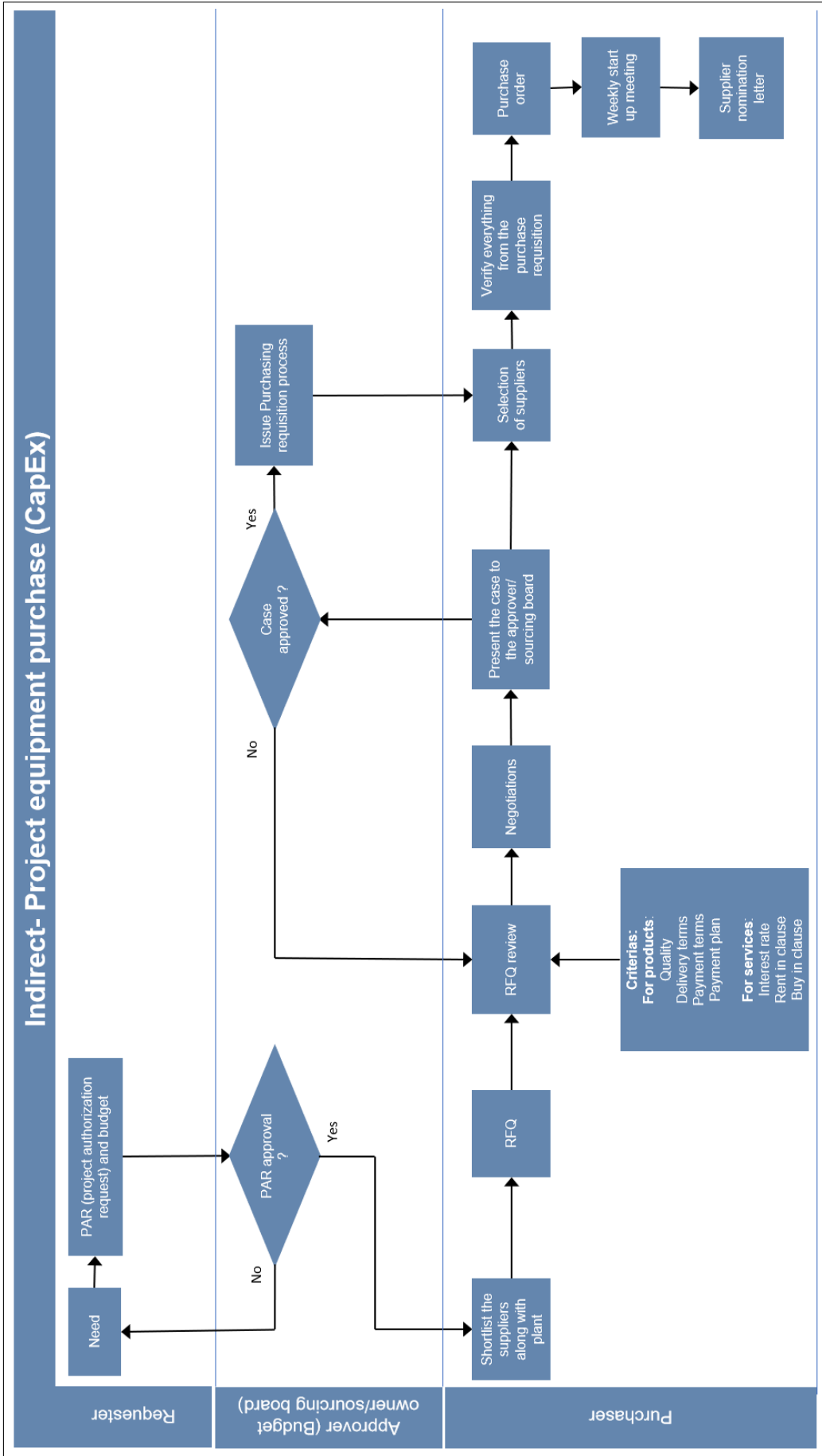


Figure 5.5: Indirect project purchasing process flow chart (CapEx)



## PEMM Questionnaire

As it was stated in the empirical findings the enterprise maturity and process maturity of the organization was found to be E-2 and P-2 maturity levels respectively. In order for the company to move to a maturity level of E-3, as seen in Figure 4.9 the company should focus more on the Integration activities as it was scored less in the sub-criteria and overall improvement in the governance criteria which are the mechanisms required to incorporate a process based thinking and approach (Hammer, 2007). Furthermore, a few other areas of improvement that were identified were Process model, attitude towards change, responsibility, teamwork and behaviour sub criteria. As argued by Hammer (2007), in order for the process maturity to be P-3 the enterprise maturity should be E-3. Once E-3 maturity level is achieved, P-3 maturity can be achieved provided the company improves the process performance (Hammer, 2007). From Figure 4.10 Ownership criteria should be improved where it relates to the responsibility of the process, infrastructure criteria, specifically information system subcriteria needs to be improved by the company to achieve P-3 maturity level.

As can be seen from the above, the criterias discussed here were incorporated into the improvement suggestion put forth by the authors through the answering of the three research questions where criterias like responsibility, information system, ownership, process model among others were identified and respective improvements were suggested. When the company reaches E-3 and P-3 maturity respectively, again the same process can be incorporated to reach E-4 and P-4 maturity in the future.

## 5.2 Limitations

The thesis work was intended for improving the purchasing process and the supplier quality of the purchasing department. During the data collection stages of the thesis, the authors came across multiple processes that required cross-functional involvement and shared responsibilities with stakeholders not part of the purchasing department. Hence, the data collection stage would have been more elaborate and the data would have been more content-rich if the authors interviewed other stakeholders such as material controllers, material specialist, quality engineer in the plant among others. Also, the authors interviewed only the case company stakeholders and the suppliers were not interviewed in this thesis work due to time constraint. Therefore, the areas of improvement from the supplier side could be have been identified if the authors had interviewed the company's suppliers.

Furthermore, the authors had developed a few significant processes that can be used as an improvement to the existing processes. However, the reliability of the process improvement could be attested if the authors had conducted a pilot study of the recommended processes to test whether the suggested improvements are feasible. This couldn't be done due to the time constraints of the thesis work and the relative time taken for results from the pilot study.

## 5.3 Recommendations

The recommendations from Figure 5.6 are categorized into short-term, medium-term and long-term recommendations for the company.

### Short term recommendations

1. Redefining the responsibilities as per flow chart will yield high efficiency and cost reduction for the company.
2. Redesigned quality deviation escalation model will adhere to IATF standard and improves customer satisfaction.
3. Integrated database for direct and indirect purchasing will have subsequent effect on supplier auditing, evaluation and continuous improvement.
  - (a) Conduct knowledge audit to make sure only relevant data is stored in supplier database.
  - (b) Common supplier portal for ease of supplier interaction.
4. Identify change agents and liaison personnel to guide the change transformation and improvements.

### Medium term recommendations

1. Documents should be retained in ERP system as per IATF standard.
2. The combination and externalization method of knowledge management should be continuously carried out by the company.
  - (a) Quality cafe can be used in gaining in-depth knowledge related to quality management from a large number of people.
3. Implementing the quantitative and qualitative supplier evaluation methods for direct and indirect purchasing will result in better supplier rating.
  - (a) A combination of mathematical evaluation tools like fuzzy AHP, DEA and TOPSIS can be used in identifying required suppliers.
  - (b) Flexible supplier evaluation questionnaires according to the company (size, business and industry) can be implemented.
  - (c) Consider different perspectives and criteria in supplier rating and supplier evaluation rather than having only the required systems and procedures in place.

### Long term recommendations

1. The business process in the company should be continuously monitored, measured and improved to reach the E-4 and P-4 maturity.
2. Monitoring risks and developing warning and recovery capability.
3. Sustaining the improvements.

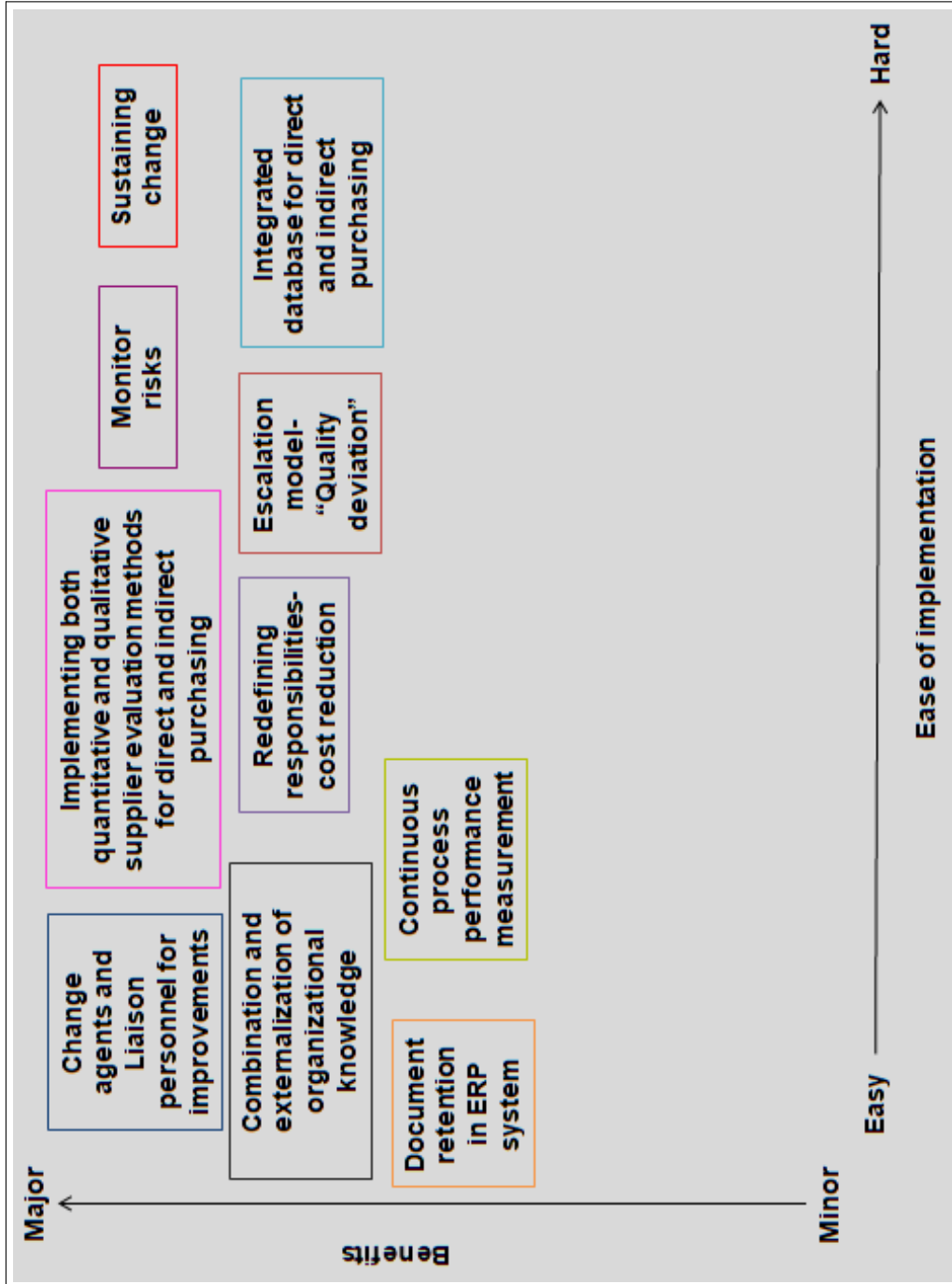


Figure 5.6: Recommendations

# 6

## Conclusion

The main aim the authors wanted to achieve from this thesis work was to improve the supplier management of the company by developing and suggesting improvements in supplier quality along with detailed process flow charts with sub-processes for the respective purchasing process as per IATF standard and corporate requirements. The authors were able to identify and map the supplier management in the purchasing process and suggest improvements in supplier quality and general process improvements. The improvements were both minor in the sense of removing unnecessary processes, identifying missing processes and requirements, and major in the sense of developing new processes, identifying databases, identifying process owners, determining critical process parameters.

The following conclusions are drawn from this thesis work. They are as follows:

1. PEMM questionnaire provided insight on "As-is" maturity level of the company and the purchasing function and can also be used to determine the "As-is" maturity in the future. However, it was not an ideal tool to determine maturity due to the extent of self interpretation the model requires.
2. Knowledge management was a significant factor in validating the role of ERP systems and shared databases for efficient business performance.
3. Interviews, Brainstorming and Benchmarking were found to be significant tools to analyse the gaps in the qualitative study. These methods can also be employed in the company to identify critical parameters and improve them.
4. Business Process flow charts helps in efficient knowledge transfer in the company and visualising the roles and responsibilities inherent in each process.
5. IATF 16949 standard was efficient in defining responsibilities and incorporating risk based thinking in the business processes to the organization. Following the requirement of the standards diligently can lead to continuous improvement and identifying & mitigating nonconformities.
6. Identifying the type of change and the associated networks are important in change transformation. Top management support must be strong for any change effort to be successful.

## 6.1 Future research

The authors improved the three main overall processes in the company. After the implementation of the aforementioned suggestions, it is suggested to analyze the effectiveness of the suggestions to improve them in the future. This thesis work provided a lot of insights on cross-functional work, it would be interesting to study the efficiency and effectiveness of cross-function work environments with plants and other functions which work with the purchasing department in the company.

There are few contributions from this thesis work to the academia. The calculations, advantages and limitations of PEMM is added to the literature. The other contribution was the Escalation model developed for quality deviation without much backing from academic sources. The criteria and actions specified in the model was developed using corrective action planning and risk based thinking approach from the IATF standard. These contributions can be used as a base for future research in Risk escalation and PEMM.

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# A

## Appendix

### A.1 Direct purchasing

*The interviewee 0, 2, 3, and a part of interviewee 1 data are related to direct purchasing and it is presented as follows:*

#### **RFQ process**

Interviewee 0 is responsible for conducting audits, APQP PPAP for suppliers and improving supplier performance for the direct material purchase (components). The Interviewee stated that the purchasers are not following the offer comparisons in the RFQ process. This is because he/she wasn't able to find relevant documentation in the database. The interviewee further claimed that there is a possibility of doing offer comparisons in this process yet the purchaser does not document the information and upload it to the database. He/she added that after the supplier nomination, the supplier updates the database with the necessary information and it is verified by the interviewee. The interviewee claims that the supplier selection depends on the purchaser based on the rating and relevance to the requirement.

Interviewee 1 is responsible for purchasing fasteners and Customer Directed Materials (CDM). The interviewee stated that they don't have any RFQ process for the fasteners. Customer-directed materials are the materials from the specific suppliers which are approved by the company's customers directly without the company's involvement. The company is responsible for getting the goods from the customer-directed supplier and payback according to the company payment terms.

Interviewee 2 is responsible for purchasing resins and paints which are the raw material source for the company production process. Interviewee 2 expressed that he/she had not seen any offer comparison forms in the RFQ process. Interviewee 2 further claimed that he/she uses a specific offer comparison template prepared by himself/herself for comparing the offers from various suppliers. The interviewee stated that the supplier quality engineer was responsible for monitoring the supplier's information in the database and that he/she wasn't aware of the supplier database information. Further, Interviewee added that he/she would consider B and C rated for the paint purchasing process since the supplier is limited whereas for the resins he/she receives the requirements from the materials engineer along with the supplier suggestion. The interviewee selects the supplier based on the

materials engineer's suggestion and requirement.

Interviewee 3 is responsible for purchasing materials that are required for a new project. The interviewee claimed that they are sending RFQ to only one specific supplier they have for the project. The interviewee further stated that they weren't able to make any comparisons since they only have one supplier for the project. The interviewee also expressed that he/she does not have any idea about the supplier database and he/she does not see any ratings for the suppliers since the project supplier is only one.

### **Relationship with the suppliers**

Interviewee 2 claimed that they have a long-term relationship with the suppliers. The interviewee further stated that the relationships with the suppliers were based on the company's customer requirements. The interviewee added that the negotiation process with the long-term relationship suppliers yields profits for the company as well as bonuses for the suppliers. Interviewee 3 expressed that they have a long-term relationship with the supplier since they have only one for the project purchasing.

Interviewee 0 stated that they are conducting audits for selecting new suppliers for direct materials purchasing. The interviewee further stated that he/she was not involved in the process of conducting audits for the old suppliers and that it was the responsibility of the buyer. The interviewee claimed that the project buyer was responsible for sending RFQ's to suppliers during the process of supplier selection.

Interviewee 1 expressed that they have a separate distributor for fasteners. The interviewee sends the requirements to the distributor, the distributor supplies the necessary products to the company. For CDM's, the company's customers would take care of the supplier selection process.

Interviewee 2 stated that they select suppliers based on inputs from the materials department. The interviewee added that they would check some criteria such as payment terms, income terms, consignment stock, technical feasibility, etc for selecting the suppliers. The interviewee added that he/she is responsible for sending RFQ to suppliers during this process and RFQ encloses technical information which is made by the materials specialist.

Interviewee 3 claimed that all the requirements from the IATF standard are used to select the supplier. Further, the interviewee stated that they previously used requirements on ISO 9001 standard to select the suppliers. The interviewee expressed that he/she is responsible for sending RFQ's during this process.

### **Start-up meeting with the suppliers**

Interviewee 0 stated that there were various participants in the start-up meeting.

The participants include the project manager, project buyer, supplier quality engineer, and supplier. The interviewee further stated that everything related to RFQ was handled by the project buyer and sometimes the senior purchaser (commodity and direct) will act as a consultant and strategist to the project buyer in this process,

Interviewee 2 expressed that there was no start-up meeting for the existing suppliers. For the existing suppliers, all the information is specified in the RFQ and the supplier gets back to the interviewee only if they need any clarification. The interviewee stated that they have a startup meeting for the new suppliers. The interviewee was responsible for sending the meeting invite and the plant is responsible for getting the necessary deliverables from the supplier. In this meeting, the material specialist was responsible for assessing the technical aspects of the supplier.

Interviewee 3 claimed that the start-up meeting participants are interviewee, supplier quality engineer, supplier, and project leader. The interviewee added that they discuss payment terms, delivery terms, price of the tool, and timing for the tools with the suppliers. The interviewee further added that the supplier quality engineer sends the invite for all participants for the meeting.

### **Supplier auditing and supplier evaluation**

Interviewee 0 claimed that he/she is responsible for conducting audits at the supplier's location. Firstly, the interviewee sends the auditing form to the supplier. Secondly, the supplier fills the form and sends it back to the interviewee. The audit form is then evaluated by the interviewee and onsite auditing is carried out by the interviewee to verify the information specified in the auditing form. If there is any nonconformity the interviewee asks for the action plan to improve the supplier's process. In addition to this responsibility, the interviewee tracks the record of quality certifications expiry from the supplier. The certification expiry is updated in the supplier database for future reference. The interviewee expressed that during auditing the purchaser and purchasing director can also be present to evaluate the supplier. The interviewee also added that they have added sustainability-related questions to the audit forms to assess the sustainability aspect of the supplier.

Interviewee 2 stated that the audit at the supplier end was usually performed by a supplier quality engineer. Further, the interviewee claimed that they do not have any auditing procedures for the resins and paints whereas they have auditing procedures only for direct components. The interviewee further added that there was no clear responsibility defined for the material specialist and supplier quality engineer for the resins and paints supplier auditing. The interviewee also stated that resins and paint suppliers are evaluated with the environmental requirements along with technical requirements but the interviewee preferred to have additional environmental evaluations for the resins and paint suppliers.

Interviewee 3 expressed that the interviewee and supplier quality engineer together are responsible for the auditing process at the supplier end. The interviewee checks

the financial results of the supplier and the supplier quality engineer then checks the quality aspects of the supplier during the supplier audits and the purchasing director approves the results of the audits completed by the project buyer and supplier quality engineer. The interviewee further stated that auditing was done only on the new suppliers for the project and they do not audit the old suppliers.

### **Supplier confidentiality agreement**

Interviewee 0 stated that the confidentiality agreement has recently been modified to a Non-Disclosure Agreement (NDA) for the suppliers. The interviewee added that the purchasers were responsible for sending NDA to suppliers during the RFQ process.

Interviewee 2 claimed that they are working with the Product Lifecycle Management (PLM) coordinator for the confidentiality agreement process and the communication between the interviewee and the PLM coordinator is good and doesn't have any issues. Interviewee 3 expressed that he/she is responsible for sending the NDA to the suppliers and he has not worked with the PLM coordinator.

### **Customer directed materials (CDM)**

Interviewee 1 expressed that they are not following any checklists for the CDM's. Further, the interviewee stated that they get the information from the sales team for the CDM's following which they sign the agreements with the suppliers. The interviewee added that he/she remembers everything for the CDM process manually. The data was not stored in the database. The interviewee claimed that the whole CDM process needs reworking. Interviewee 2 stated that there are only a few CDM's for the resins and they are not following any checklist for this process. Interviewee 3 claimed that the CDM is the responsibility of the sales department.

### **Approval of new materials**

Interviewee 0 stated that the approval of new materials is similar to the qualification of new components. The approval depends on the project requirements and specific materials used for the projects. The interviewee added that when they receive the materials, they review the PPAP documentation for further process.

Interviewee 1 claimed that the approval of new materials was done by the materials department in the research and development function. They are responsible for conducting trials for the new materials along with the respective purchasers.

Interviewee 2 expressed that the materials specialist was responsible for this process. The interviewee stated that he/she analyses the commercial aspects of the products from the supplier and the materials specialist analyses the technical aspects of the products from the suppliers.

Interviewee 3 stated that he/she follows only the bill of materials in the company. The project lead and the engineer in the team are responsible for approving the materials. After the material is approved, the interviewee sources the respective materials for the project.

### **Qualification of new components**

Interviewee 0 claimed that qualification of new components is initiated and completed in the PPAP. The interviewee further added that it is a standardized process where they will have a lot of information exchanges. In this process, the interviewee expressed that the supplier quality was responsible only for the trials done by the supplier. The plant was responsible for storing the samples during these trial runs. The interviewee added that qualification of new components is the main role for the supplier quality engineer.

Interviewee 1 stated that he provides all the information about fastener suppliers to the quality engineer in the plant. The quality engineer would take care of everything in this process. Interviewee 2 expressed that he/she wasn't involved in this process. The interviewee further claimed that this process was the responsibility of the project buyer in the purchasing department for this process. The interviewee said that the plant was also responsible for storing the samples during this process.

Interviewee 3 expressed that he/she is working closely with the supplier quality engineer in this process. The interviewee together with the supplier quality engineer was responsible for making onsite auditing plans during this process, but due to Covid-19 all supplier audit plans are cancelled. During this process, the interviewee checks the status of the project in APQP along with the supplier quality engineer to keep the project on track with the plan. The interviewee communicates about the deliverables by the supplier for the company within the stipulated time plan. The interviewee stated that he/she does not know much about the trial production run because it is the responsibility of the supplier quality engineer.

### **Frame agreement**

Interviewee 0 said that the purchaser is responsible for sending the RFQ's, NDA, and frame agreements. Interviewee 2 stated that he/she is responsible for sending the documents to the suppliers. The interviewee further stated that they had no frame agreements for the resins and paint suppliers, but they have agreements regarding consignment stocks. Consignment stocks are the stocks where the company does not pay for holding the stock on their premises. The company pays the suppliers only when they have used the stocks from their inventory. This improves the company cash flow for the company during the purchasing process.

Interviewee 3 expressed that he/she is responsible for sending RFQ, NDA, and contracts to the suppliers. Further, the interviewee said that he/she does not have any communication problems with the purchasing director.

Interviewee 6 claimed that he/she was responsible for approving the changes in the frame agreements since the interviewee is the process owner. The interviewee stated that they are working continuously to minimize the gap by framing purchasing strategies for these processes. The interviewee expressed that there was no manager in between the purchasers and interviewee. All the purchasers from direct and indirect will report to the interviewee.

### **Preferred terms and conditions of purchase**

Interviewee 0 expressed that they need to update terms and conditions of purchase to the database. The interviewee claimed that this was the responsibility of the purchaser in the purchasing department.

Interviewee 2 said that he/she checks all the information in the terms and conditions of purchase before sending it to the supplier.

Interviewee 6 claimed that it has been renamed to General Purchasing Conditions (GPC). The interviewee further expressed that GPC is old and needs some revision which can be used for both direct and indirect purchasing. The interviewee also added that he/she is currently working to improve the GPC with an external legal consultant.

### **Containment actions**

Interviewee 0 stated that the suppliers were aware of the GP 12 requirements. GP 12 requirements are the containment actions being followed in the automotive industry. These containment actions differ based on the product requirements. The interviewee added that these containment actions are a part of the APQP process. The interviewee expressed that there are different gates and milestones in the APQP process. This APQP process usually starts after the supplier is nominated by the project buyer for the project. The interviewee said that he/she would follow up closely with the project buyer during this process.

Interviewee 2 expressed that he/she is not responsible for this process. Further, the interviewee claimed that it is the responsibility of the plant to make containment actions. The problems are escalated to the interviewee only when the problems are prolonged in the plant. The interviewee further said that he/she has 1 to 2 meetings every year with the plant to discuss the action plans for the resin and paint suppliers. The interviewee also claimed that APQP is the responsibility of the materials specialist for resins and paint suppliers.

Interviewee 3 claimed that he/she is working with the supplier quality engineer for the APQP process. The APQP process has containment actions according to GP 12 requirements which would be handled by the supplier quality engineer.

### **Production part approval process (PPAP)**

Interviewee 0 claimed that he/she was responsible for sending the PPAP request to the suppliers and evaluating the PPAP. The interviewee added that there are different documents evaluated in the PPAP based on different stages. The supplier capacity, inventory, trial production runs, logistics, and tools, etc. are verified in this process. During this PPAP, the interviewee said that he/she is working along with the project buyer to clarify the commercial aspects of the supplier. The interviewee expressed that there are different embedded documents being enclosed in the PPAP document to track the progress of the PPAP at the supplier's end.

Interviewee 2 stated that the PPAP was not applicable for her responsibility. The interviewee added that it was the responsibility of the supplier quality engineer. Interviewee 3 expressed that he/she is working with supplier quality engineers in the APQP process. The PPAP is a part of the APQP process. Further, the interviewee claimed that PPAP is the responsibility of the supplier quality engineer.

### **Purchase orders (PO)**

Interviewee 0 expressed that he/she was aware of the payment terms in the PO's. The interviewee further said that the purchaser is responsible for all the purchase orders in the company.

Interviewee 2 said that he/she verifies everything the purchase orders. The payment terms, income terms were verified more than once by the interviewee. The interviewee added that the PO's are different for resins and paints when compared to direct components.

Interviewee 3 claimed that he/she verifies all the information in the PO's. The interviewee further said that before he/she sends the PO he needs the detailed purchase requisitions. Based on the information from the purchase requisitions, the interviewee modifies the PO's for the suppliers. The interviewee further expressed that they do not have any standard template for the PO's and he is creating the PO's based on his experience as a purchaser.

### **Communication**

Interviewee 0 stated that they have good communication with the old and new suppliers. However, the interviewee added that the communication between the suppliers and supplier quality engineer are not well documented in the past.

Interviewee 2 claimed that the communication with the resins and paints supplier was good. The interviewee further said that he/she does not have frequent interactions with the other stakeholders in the company.



Interviewee 3 expressed that program engineers from the plant, supplier quality engineer, supplier, and interviewee are involved in most of the communication process. In case of problems, the suppliers first contact the program engineer and when it is not solved, the interviewee would solve the problem. The interviewee added that the communication with the supplier is good for the project purchasing.

### **Supplier rating**

Interviewee 0 stated that the ERP system has the supplier's certification expiry dates. Some of the suppliers update the certification expiry in the ERP system and others do not. In this case, the interviewee visits the supplier website to know about the validity of the certificates possessed by the supplier. Currently, the suppliers are not updating any information in the ERP system. The interviewee expressed that the rating of the suppliers was calculated based on the logistic and quality deviations done by the suppliers. The interviewee further said that they do not have a common platform to integrate suppliers from all over the world. The interviewee expressed that the plant was responsible for feeding the deviations data into the ERP system. The interviewee said that there is some weightage for each criterion such as certifications, environment, quality, delivery, etc. for all the suppliers. Based on this weightage, the ERP system will calculate the rating for the suppliers. The poor rating suppliers (Rating- 'B' and 'C') are displayed on the board of the wall in the company ERP system. The suppliers on the board on the wall are selected by the interviewee and the interviewee sends the supplier report to the respective purchasers for continuous improvement.

Interviewee 2 expressed that he/she was not involved in the supplier rating process. Further, the interviewee claims that supplier rating is the responsibility of the plant and supplier quality engineer. The interviewee stated that he/she has his/her own rating system consisting of the criteria such as quality, delivery, cost, relationships with the supplier to rate the resins and paint suppliers. The interviewee added that he/she had no idea regarding the "board on wall" for the suppliers and claimed that it was the responsibility of the supplier quality engineer.

Interviewee 3 claimed that they identify the changes in supplier activities only during the onsite auditing. Most of the suppliers do not inform the purchaser when there is any change in certifications or their activities. The interviewee added that the direct materials buyer should be responsible for these activities but the interviewee is doing this work. Further, the interviewee expressed that the supplier quality engineer was responsible for doing supplier ratings and updating the database with relevant information about the suppliers. The interviewee said that he/she was not able to find the relevant supplier data in the database. The interviewee claimed that the classification of suppliers into A, B, and C should be done by the direct materials buyer but the interviewee is doing all these activities. The interviewee added that he/she is not using specific criteria to rate the suppliers but he/she is using his experience to rate the suppliers. The interviewee stated that the B and C rated suppliers are displayed on the

board on wall in the supplier database and the supplier quality engineer communicates about the poor performance suppliers (B and C rated) to the interviewee.

### **Supplier risk assessment**

Interviewee 0 expressed that the risk assessment process was performed by the interviewee along with respective purchasers. They calculated the risks of the supplier which is done once a year. The interviewee said that the risk assessment process is applicable to both old and new suppliers. The risk assessment process is difficult for the new suppliers since they don't have any financial relationship with them in the past. The interviewee stated that the supplier risk assessment for new suppliers included financial review and supplier onsite audit.

Interviewee 2 stated that the risk assessment for the suppliers was based on the financial forms and supplier evaluation forms. The interviewee expressed that they have only a few new suppliers but most of their suppliers are old. The interviewee added that almost all the resins and paint suppliers are approved suppliers for the company.

Interviewee 3 claimed that the risk assessment process was the responsibility of the supplier quality engineer. The interviewee said that it is usually done before the project and it is done once a year. Currently, the interviewee expressed that they have not done any risk assessment process for the suppliers due to Covid-19.

### **Supplier contracts**

Interviewee 0 stated that he/she does not know much about the supplier contracts and it is the responsibility of the purchaser in the purchasing department. Interviewee 2 expressed that he/she is responsible for sending the contracts to the suppliers. The interviewee added that if there were any changes from the supplier, the interviewee immediately updates everything in their contract. Interviewee 3 said that he/she was responsible for sending the contract to the supplier. Interviewee 3 claimed that he/she was not updating any supplier contracts in the database. Further, the interviewee stated that he/she had not seen any contract in the company ERP system.

### **Supplier premium freight and customer disruptions**

Interviewee 0 stated that the logistics department creates claims for the deviations in the delivery. The interviewee is not working together with the logistics department during this process. The interviewee claimed that the purchasing director will always have control over the logistics activities. Further, the interviewee said that when there are any disruptions the logistics department collects the data and updates it in the database. The logistics department communicates with the supplier and strives to solve the problems. If the problems are persisting from the suppliers then it is escalated to the concerned persons.

Interviewee 2 expressed that the logistics department generates the claims and uploads it to the complaint database. These claims are further sent to the suppliers and the action plans are updated in the database.

Interviewee 3 stated that this process is applicable only to serial production and it is not applicable for project purchasing. Further, the interviewee expressed that it is the responsibility of the logistics department to update the data in the database regarding disruptions.

### **Control shipping procedure**

Interviewee 0 claimed that the purchaser is responsible for this process. The interviewee said that the purchaser together with the quality manager communicates to the supplier in this process. The interviewee expressed that the supplier must respond to the deviation in quality or delivery within 24 hours of the claim raised by the plant. Interviewee 0 further claimed that it would be better for the stakeholders if they have a common process enclosing the control shipping procedure, complaint handling and escalation process.

Interviewee 1 stated that the plant tries to solve the quality or delivery problems by themselves with the fastener's distributors. If the problem is recurring the plant escalates the issue to the interviewee. If the interviewee is not able to solve the issue, the interviewee escalates the issue to the purchasing director. The interviewee expressed that the fastener distributor must respond to the deviation within 24 hours of the claims raised by the plant.

Interviewee 2 said that the deviations concerning quality and delivery are handled by the plant. The delivery deviations are handled by the material controller and quality deviations are handled by the quality engineer in the plant. The interviewee added that if the deviations within quality and/or delivery are persisting and recurring then the problem is escalated to the interviewee.

Interviewee 3 expressed that the deviation in delivery and quality were specified clearly in the contracts during the project purchasing phase. The interviewee communicates these details before the project to the suppliers. The interviewee said that if there is any deviation, the interviewee will act according to the contract sent to the supplier.

### **Complaint handling procedure**

Interviewee 0 claimed that the interviewee and the purchaser were responsible for the complaint handling procedure. The interviewee said that the plant updates the data in the database and the interviewee and purchaser are responsible for the improvement actions at the supplier's end.

Interviewee 2 stated that he/she was not responsible for updating the data in the database. The interviewee added that the plant updates the data in the database and informs the interviewee about the deviations caused by the supplier.

Interviewee 3 expressed that they have good cooperation from the other stakeholders involved in the project. The interviewee expressed that he/she was not involved in the escalation process during the project purchasing. If there is any problem at the supplier side, the supplier communicates the issue to the interviewee and the interviewee informs the internal project team. This project team is responsible for communicating the issue to the customer.

### **Digital systems**

Interviewee 0 claimed that the suppliers fill the forms in the right way without any errors. The interviewee further said that the information in the forms was cross verified by the interviewee to improve the supplier performance. Interviewee 2 expressed that the suppliers understand almost all the forms and documents that have been sent digitally by the interviewee. Interviewee 3 stated that the suppliers sometimes come back to the interviewee for clarifications in the forms and contracts. So, interviewee 3 is unsure of the digital aspect feasibility at the supplier end.

### **Supplier continuous improvement**

Interviewee 0 expressed that to conduct continuous improvement activity at the supplier end, the activities of the suppliers should be identified. The supplier continuous improvement is based on the monthly performance review of the suppliers and board on wall suppliers. The interviewee expressed that the interviewee and purchaser together were responsible for this process. The supplier's continuous improvement activities include root cause analysis, monthly performance analysis, and internal audits.

Interviewee 2 stated that the supplier quality engineer was not involved in this process. The continuous improvement process for the resins and paint suppliers is done by the interviewee along with the materials specialist. The interviewee claimed that the database was not updated regularly by the plant which restricts the continuous improvement process for the interviewee. The interviewee is the decision-maker in this process for the suppliers. The interviewee added that the involvement of a supplier quality engineer in this regard would be highly resourceful and helpful.

Interviewee 3 claimed that the purchaser of the direct materials was responsible for this process. The interviewee expressed that based on the supplier rating, the supplier continuous improvement process was initiated for the suppliers. The interviewee added that the B and C-rated suppliers are involved more in these continuous improvement activities when compared to A-rated suppliers.

## A.2 Indirect purchasing

*The interviewee 4, 5 and part of interviewee 1 data are related to indirect purchasing and it is presented as follows:*

### **RFQ process**

Interviewee 1 is responsible for injection moulding tool purchasing. The interviewee sends the RFQ to the tool supplier where he/she uses the cost break structure to compare the offers provided by different suppliers. The data about the environment and customers were updated in the database by suppliers. The tool engineers from the plant play a major role in this process of RFQ and supplier selection. To send the RFQ to suppliers, the buyer consults with the plant regarding the past performance of suppliers. Based on the historical performance, the buyer sends the RFQ to the specific supplier. There has been no rating system followed for the tool suppliers since there are only a few of them. The manufacturing engineer specifies the technical specifications for the tool, the buyer adds them to the RFQ. This is referred to as the tooling standard in the RFQ by the interviewee.

Interviewee 4 is responsible for purchasing chemicals for the paint shop, providing maintenance services and purchasing new machines. The interviewee claims that he/she was not involved in the production RFQ process whereas in new machines purchasing he/she was fully involved. In machine purchasing, the interviewee sends the RFQ to the suppliers whereas in production spare parts, the production department sends the RFQ directly to the selected supplier. Interviewee further said that he did not have access to the supplier database and indirect suppliers are not listed in the same. There was no rating system for the suppliers in the indirect. Even though there are a lot of suppliers for the maintenance spares and chemicals they weren't rated and displayed in the database. During the interview, the interviewee described the Capital Expenditure (CapEx) purchasing process for the indirect purchasing which was not documented by the company. Interviewee added that the RFQ process can be improved from his perspective.

Interviewee 5 is responsible for packaging materials, logistics, insurance, consulting services and IT services. The interviewee is new to the company and has only 6 months of experience with his role. The Interviewee stated that he had done one only big RFQ in the past tenure. The interviewee is doing the RFQ process according to past experience with another company. Interviewee stated that he/she has knowledge of what to purchase and how to compare from his past experience. Interviewee claims that the database for the indirect purchasing was not updated, and contains only an old list of suppliers. There has been no rating process followed for the suppliers, and the plant suggests some suppliers for the packaging materials and sends the RFQ to those suppliers. The plant suggests the suppliers based on the historical performance. Interviewee said that the RFQ process for products and services are totally different and more complex for services. To overcome this issue, the Interviewee said that he/she is working on improving the RFQ process

for the indirect materials and services. Addition of rent in clause, buy in clause and interest rate in the RFQ is an improvement point that the interviewee had listed out. Interviewee further added that RFQ is a tricky process where buyers need to pay full attention.

### **Relationship with the suppliers**

Interviewee 1 said that they maintain a long term relationship with the tool makers. The tool makers make heavy tools which serve production for a longer period of time. Interviewee 4 mentioned that he/she wasn't too involved in the maintenance services for production equipment. This affects the relationship of the company with the suppliers. Moreover, the interviewee expressed that there is also no room for the negotiation process since he/she wasn't involved whereas in the machine purchase he/she negotiates price with the suppliers. Interviewee 5 said that the relationships with the suppliers are usually long term in nature and claims that they don't change the suppliers often. Even though a supplier offers products at a cheaper price, they consider other aspects such as contracts with the suppliers. Interviewee further said that they will consider new suppliers if they are interesting.

### **Supplier selection**

Interviewee 1 said that there are many criterias to select the suppliers. They have had past experience with the supplier, knowledge of supplier and reference parts that suppliers send to the company. Internal team consisting of plant peoples and buyers would decide on the selection of suppliers for the tools and also get opinions from their factories in the whole EU region regarding the performance of the tools in the past. Interviewee 4 stated that he/she selects the suppliers based on hard and soft criteria. Hard criteria includes the financial check for the suppliers and soft criteria comprises the past experience with the supplier. Interviewee said that after supplier selection, he/she will send the RFQ for at least three suppliers for the machine purchasing post in which he/she would negotiate the price with them. However in maintenance services, the production already selected the supplier by itself and would send the RFQ to the supplier. In production, the supplier selection was not done by the buyer. Interviewee 5 said that they only select suppliers based on the past experience with them.

### **Start up meeting with the suppliers**

Interviewee 1 said that there are many criterias to select the suppliers. They have had past experience with the supplier, knowledge of supplier and reference parts that suppliers send to the company. Internal team consisting of plant peoples and buyers would decide on the selection of suppliers for the tools and also get opinions from their factories in the whole EU region regarding the performance of the tools in the past. Interviewee 4 stated that he/she selects the suppliers based on hard and soft criteria. Hard criteria includes the financial check for the suppliers and soft criteria comprises the past experience with the

supplier. Interviewee said that after supplier selection, he/she will send the RFQ for at least three suppliers for the machine purchasing post in which he/she would negotiate the price with them. However in maintenance services, the production already selected the supplier by itself and would send the RFQ to the supplier. In production, the supplier selection was not done by the buyer. Interviewee 5 said that they only select suppliers based on the past experience with them.

### **Start up meeting with the suppliers**

Interviewee 1 stated that he/she works along with manufacturing engineers in the plant during the RFQ phase. Once the suppliers are selected, the buyer sends a meeting invitation to cross verify the things specified in the RFQ. The participants for the meeting include the chosen supplier, tool engineer, manufacturing engineer and buyer.

Interviewee 4 expressed that when the RFQ is sent out they always have a quotation review. During the quotation review with the suppliers, they clarify the doubts of suppliers in the RFQ when it is a machine purchase. During the maintenance services, the interviewee claims that he/she was not much involved with the production. The deliverables that they discuss with the supplier are quality, delivery time, payment terms and payment plan. For start up meetings, the buyer sends out the invitation during machine purchase whereas during the maintenance services the production will discuss everything with the supplier.

Interviewee 5 said that they always have a start-up meeting with the suppliers. The meeting frequency for the supplier varies when the supplier is old. For old suppliers, they don't have frequent weekly meetings instead meetings are only organized when needed. For new suppliers, they have weekly meetings and hand over all the documents related to RFQ prior to the meeting. The participants are the supplier, the project manager and the buyer.

### **Supplier auditing and Supplier evaluation**

Interviewee 1 stated that they have to conduct toolmaker audits once in a year. However, due to present conditions they have not conducted any audit at the supplier's place. They have a toolmaker audit form for performing the auditing process. The formal approval of toolmakers was primarily done by a team consisting of buyer, purchasing director and tool engineer. The criterias were framed for the auditing process but they haven't performed any audits at the supplier site. This is due to the fact that all the toolmakers are present in China. Due to Covid situations, they have not done any auditing. Interviewee 1 said that the suppliers were evaluated based on the past performance. Sometimes, the tool suppliers do not answer the forms as expected by the interviewee.

Interviewee 4 expressed that there are no formal auditing procedures for indirect purchasing. Interviewee further added that they are not 100 percent educated on

the auditing procedures. The auditing at the supplier site was not applicable for indirect purchasing. The supplier site audits were only for direct materials.

Interviewee 5 stated that he/she has not seen any auditing procedures for indirect materials and services. The only audit that they do is the financial check for the suppliers where the finance department sends out a financial assessment form to the suppliers to prevent the risk of bankruptcy of their suppliers in the near future. They check the financial stability of the suppliers since contracts are long term in nature. Interviewee 5 also stated that supplier site audits are not applicable for indirect purchasing.

Interviewee 4 claimed that they don't perform any evaluation process for the suppliers. The RFQ was sent out and only the information specified in the RFQ's were verified. If the interviewee needs further information they would contact the supplier. Interviewee 5's answer was tandem to interviewee 4.

### **Supplier confidentiality agreement**

Interviewee 1 said that he/she works along with the PLM coordinator during this process. Interviewee further stated that the communication with the PLM coordinator was good and the process involves the signing of Non Disclosure Agreement (NDA) by the supplier followed by the purchasing director approval. When the confidentiality agreement gets signed, the buyer discusses everything with the supplier.

Interviewee 4 answers were similar to that of interviewee 1 in terms of working with the PLM coordinator. The interviewee works along with the PLM coordinator and the team work was good. The NDA for indirect is not as good as for direct purchasing. Interviewee further added that he/she is working hard to make the NDA more suitable for indirect purchasing.

Interviewee 5 claimed that he/she had not been involved in the process of NDA. Interviewee claimed that they have a finished template for the NDA and would send it to the supplier during the RFQ process.



### **Customer directed materials (CDM)**

Interviewee 4 stated that it is not applicable for the interviewee. Interviewee 5 expressed that CDM is not applicable for indirect materials when compared to the direct materials. Interviewee further stated that he/she does not follow any checklist for the CDM. CDM for indirect materials was only few. Interviewee feels that the process is easy when compared to the normal suppliers.

### **Approval of new materials**

Interviewee 1 stated that the materials engineer does new material trials with the existing tool. The materials engineer and purchaser work together in this process and the purchaser is responsible for sending the RFQ to the tool suppliers.

Interviewee 4 expressed that he/she wasn't involved in the approval of the new material process. Interviewee's role was to send the RFQ to the specified supplier.

Interviewee 5 stated that the approval of new materials wasn't much related to the indirect purchasing.

### **Qualification of new components**

Interviewee 1 stated that qualification of new components was not applicable to tool purchasing because the qualification of new components is applicable for company's in house production. Further the interviewee expressed that he/she wasn't involved in the PPAP process since it is not applicable for his role. Interviewee 4 and interviewee 5 said that qualification of new materials is not for whole indirect purchasing.

### **Frame agreement**

Interviewee 1 expressed that they don't have any frame agreements for the tool suppliers. They are utilizing support agreements during the development phase of the tool. Interviewee further stated that the frame agreement is usually suitable for high volume production and not for the tool makers. Interviewee stated that he/she has good cooperation from the purchase manager and they both understand each other.

Interviewee 4 expressed that he/she was utilizing frame agreements for the production equipment purchase and was responsible for sending this frame agreement to the suppliers. This frame agreement is approved by the purchasing director. The interviewee further expressed that the cooperation with the purchasing director was very good and haven't experienced any issues.

Interviewee 5 stated that he/she was responsible for sending the frame agreement to the suppliers. Interviewee expressed that the cooperation with the purchasing

director was good and he quickly approved the frame agreements.

### **Preferred terms and conditions of purchase**

Interviewee 1 stated that there are predefined terms and conditions for payment. These predefined payment conditions are applicable for tool makers and interviewee further stated that he wasn't aware of improvements in "change in terms and conditions".

Interviewee 4 stated that the terms and conditions are different for direct and indirect purchasing and had to make separate terms and conditions every time for the indirect purchasing. Further, the interviewee claimed that he/she would prefer to have common/standard terms and conditions for purchase in the future. The interviewee was aware of improvements being undertaken in change in terms and conditions.

Interviewee 5 expressed about the payment terms for the purchase. Interviewee further expressed that there were no specific terms and conditions for the indirect materials and services. When the interviewee sent the terms and conditions to the service supplier, they weren't able to understand the terms used in the purchase. The interviewee was aware of improvements in change in terms and conditions and he/she stated that the terms and conditions should include everything so that it can be used for all the suppliers.

### **Component list**

Interviewee 1 claimed that he/she was working on updating the database for the tools. Interviewee along with the tool engineer were updating the last 10 years of tool purchase data from the suppliers. Based on the data, they categorize the suppliers. Interviewee further stated that it was a process of converting tacit knowledge to explicit knowledge which would help the newcomers in the organization. Interviewee 4 and 5 stated that the updation of the component list is not applicable for indirect materials and services.

### **Containment actions**

Interviewee 1 expressed that the containment actions occur in gate 3 and gate 4 of the Advanced Product Quality Planning (APQP) process for tool purchasing. Currently, there are no containment action plans followed in the company for tool purchasing. Interviewee further added that if there was any deviation in the specs, product locality would be taken into consideration for repairing decisions. Based on the locality, tools are further repaired by inhouse or nearby tool makers.

Interviewee 4 stated that the APQP process wasn't applicable for indirect purchasing. Interviewee said that they didn't have any specific containment action plans on the paper. Instead they follow up the project status closely before the delivery.

For new suppliers, frequent meetings are held to keep the project on track.

Interviewee 5 expressed that they didn't have an APQP process for indirect and there are no containment action plans followed in the company. In case, if they have deviations in the packaging materials the plant would address the problem. The problem is only escalated to the interviewee if it is recurring.

### **Production part approval process (PPAP)**

Interviewee 1, 4 and 5 said that they weren't involved in the PPAP and that the PPAP is more suited to direct materials than indirect.

### **Purchase orders (PO)**

Interviewee 1 said that he/she verifies all the mandatory data in the purchase orders. Payment conditions, shipping conditions were some of the mandatory data in the purchase orders. Since the purchasing operations are centralised in Gothenburg, the plant located in the other countries have various PO's. In that case, the interviewee manually adds the necessary information in the PO's. Interviewee further claims that there should be some mandatory fields in the PO across all the countries so that it would reduce the manual work of the buyer.

Interviewee 4 stated that there are three mandatory terms in the PO. They are payment terms, payment plan and delivery terms. The interviewee wants the PO to be clear, so the interviewee expects the detailed information in the PO from the suppliers. Interviewee further added that PO's will contain some technical specifications in the case of welding machines.

Interviewee 5 expressed that he/she verifies the mandatory datas in the PO more than one time. Interviewee verifies everything from the purchase requisitions and verifies price, dates, payment terms, income terms, details about the products, number of items and additional agreement required in the PO's.

### **Communication**

Interviewee 1 expressed that there wasn't much communication with the customer. But in case of CDM, they contact the customer. Interviewee further added that the communications with the plant, suppliers and other departments was good.

Interviewee 4 claimed that there is no contact with customers. For internal customers, the communication between other stakeholders is good when the interviewee is involved in the process.

Interviewee 5 expressed that he/she doesn't communicate with external customers. For internal customers, the interviewee has friendly conversations with other

stakeholders. Further, the interviewee added that in the early days he faced difficulty in reaching out to the people due to covid but the stakeholders are highly supportive and guided the interviewee to the right persons. Interviewee also pointed out some knowledge transfer improvement points since the interviewee was a newcomer to the organization.

### **Supplier rating**

Interviewee 1 stated that during the supplier rating process the suppliers don't notify the changes in certifications to the company. This is because they don't ask for changes frequently. The company checks the minimum quality standard possessed by the supplier and the interviewee considers it as a minimum requirement.

Interviewee 4 expressed that supplier rating was not followed for indirect purchasing but the interviewee wishes to have one for the indirect purchasing. The interviewee wishes to have three categories of suppliers, namely "A", "B" and "C". Further, the interviewee would like to promote the suppliers from C to B and B to A based on continuous improvement activities. The changes from the supplier side in the certifications and expiry of certification were not notified to the company. Interviewee said that if the certification expired he is seeing that too late. Since they don't have any specific criterias to rate the supplier, the interviewee uses some criterias to assess the performance i.e. technical readiness, root cause analysis, project status, continuous improvement and delivery. Sometimes the interviewee uses past experience of delivery by the supplier to assess the performance of the supplier.

Interviewee 5 expressed that they don't have a specific rating process for the indirect purchasing. Interviewee further added that the big companies and larger volume suppliers would notify the changes about the certifications to the company. Small companies do not perform this process.

### **Supplier risk assessment**

Interviewee 1 expressed that risk assessment was carried out on the supplier before the project starts. Interviewee claims that there were two types of risk assessment performed in the company. They are financial risk assessment and technical risk assessment. Financial risk assessments were often performed by the finance department for big budget projects and for the new suppliers and technical risk assessment was performed by the tool engineers to ensure the quality, delivery and technical readiness. The suppliers are approved for the project only when they pass both the financial and technical risk assessment process.

Interviewee 4 said that indirect purchasing does not have any major risk assessment process other than financial checks. These financial checks were performed by the finance department. If the investment is more than 1 million SEK, the financial risk assessment is mandatory. Interviewee further adds that the project engineer

was responsible to ensure the project delivery and quality analyst was responsible for checking the equipment.

Interviewee 5 stated that they do not perform any risk assessment process for indirect purchasing. Interviewee expressed that insurance was a kind of risk assessment for the indirect services and the big insurance companies do not need financial checks and that only the small companies require the financial risk assessment.

### **Supplier contracts**

Interviewee 1 claimed that there were no separate supplier contracts for the tool makers. Interviewee feeds the order into ERP and all the process takes place through ERP system. Interviewee 4 stated that he/she communicates to the supplier regarding the supplier contracts. When the contract is signed, the interviewee uploads the contract to Ex doc (Software for storing supplier related information). The Ex doc is then updated by the interviewee but not after every process. Interviewee 5 provided the same data as that of interviewee 4 in terms of contracts in the Ex-doc. The interviewee points out a few areas of improvement in the EX doc. Ex doc is the software where the contracts of suppliers and other data are stored for indirect purchasing. Finding the supplier contract was one big issue and the improvement could be a proper numbering system for contracts.

### **Supplier premium freight and customer disruptions**

Interviewee 1 said that during the tool purchase the logistics department was not involved in the process. The purchase department takes care of the logistics. The logistics department was responsible for direct materials shipping.

Interviewee 4 claimed that the production engineer along with the interviewee were responsible for the disruption process. Interviewee further stated that they collected the data regarding the disruptions from the suppliers but it was not stored in any database.

Interviewee 5 said that the logistics department, the plant and the interviewee work together for the disruption process. They didn't have any data regarding customer disruptions and it wasn't stored in the database. They have a common Excel sheet which was used to update everything regarding the logistics process. In terms of external logistics if the shipment is delayed once, the plant will take care. If it repeats it will be escalated to the interviewee. If the company handles the logistics for the process, the disruptions would be directly addressed by the interviewee.

### **Control shipping procedure**

Interviewee 1 stated that there was a different type of control shipping procedure followed for the tool purchasing. In case of any deviations in the tool, the

suppliers were asked to submit the 8D report for the deviations within 24 to 48 hours.

Interviewee 4 expressed that he/she wasn't involved in this process. Interviewee communicates the terms and conditions to the suppliers in advance to the shipping. Further, the interviewee claimed that the process was about responsibility and liability for the deviations in quality or delivery. Interviewee 5 stated that he/she doesn't have any responsibility relating to the control shipping procedure.

### **Complaint handling procedure**

Interviewee 1 claimed that the complaints regarding the quality were addressed by the quality engineers. The databases are updated timely by the quality engineer and the escalations are handled by various stakeholders based on the escalation process. For deviations, the plant would immediately act to address the problem and calculate the cost of poor quality and then send it to the supplier.

Interviewee 4 expressed that they have a penalty for late deliveries. Interviewee would go to the supplier and escalate it there, but the purchasing director was always informed. In some cases, the interviewee escalates it to the purchasing director before escalating it to the supplier. Based on the severity, the escalation varies. Interviewee 5 stated that the plant tries to solve all the complaints by themselves. Interviewee is informed if the problems are persisting and if there is no proper solution.

### **Digital systems**

Interviewee 1 stated that the suppliers are comfortable with the digital systems. When the supplier has any questions or has any misunderstanding from the documents they contact the interviewee for a clarification.

Interviewee 4 and 5 expressed that the supplier's are generally good at digital systems. Occasionally, the suppliers produce errors in the RFQ documents. Interviewees mentioned that it is due to the misinterpretation of information from the RFQ's and the interviewees reach out to the supplier for the clarification.

### **Supplier continuous improvement**

Interviewee 1 stated that continuous improvements were performed at the supplier's end based on the historical data. Interviewee along with the tool engineer have discussions regarding the supplier's past performance and they decide which supplier to choose and which suppliers to improve.

Interviewee 4 and 5 mentioned that they don't have any discussions regarding the supplier's continuous improvement with the supplier development function and added that it is more suitable for direct purchasing.

### A.3 Example of a PEMM Questionnaire response

The PEMM questionnaire response of Buyer 3 for both Enterprise and Process maturity is give below :

Section 1 How Mature is Your Company?		To determine if your organization is ready to support a process-based transformation, evaluate the statements in this table. They show the strength levels, E-1 to E-4, of the capabilities that enterprises need in order to develop their business processes. If a statement is largely true (at least 80% correct), mark the box with a "G" to indicate the color green; if it is somewhat true (between 20% and 80% correct), mark the box with a "Y" to indicate the color yellow; and if it is largely untrue (less than 20% correct), mark the box with an "R" to indicate the color red. This is to establish the A-A-Is situation in the company if any of the parameters are ongoing then it has to be deemed Green, Yellow for future plans and Red if no such decisions have been made (Please think of these questions in general terms with respect to your roles and responsibilities within your company specifically within the purchase department)				GREEN largely true	YELLOW somewhat true	RED largely untrue	
		E-1	E-2	E-3	E-4	Buyer 3			
Leadership	Awareness	The Company's senior executive team recognizes the need to improve operational performance but has only a limited understanding of the power of business processes	Atleast one senior executive deeply understands the business process concept, how the company can use it to improve performance, and what is involved in implementing it	The senior team views the company's in process terms and has developed a vision of the company and its process	The senior executive team sees its own work in process terms and perceives process management not as project but as a way of managing the business	G	G	G	G
	Alignment	The leadership of the process program lies in the middle management ranks	A senior executive has taken leadership of and responsibility for, the process program	There is strong alignment in the senior executive team regarding the process program. There is also a network of people throughout the company helping to promote process efforts	People throughout the company exhibit enthusiasm for process management and play leadership roles in process efforts	G	Y	R	R
	Behaviour	A senior executive endorses and invests in operational improvement	A senior executive has publicly set stretch performance goals in customer terms and is prepared to commit resources, make deep changes and remove roadblocks in order to achieve these goals.	Senior executives operate as a team, manage the company through its processes, and are actively engaged in the process program	The members of the senior executive team performs their own work as processes, centre strategic planning on processes, and develop new business opportunities based on high performance goals	G	Y	Y	Y
	Style	The senior executive team has started shifting from a top down, hierarchical style to an open collaborative style	The senior executive team leading the process program is passionate about the need to change and about the process as the key tool for change	The senior executive team has delegated control and authority to process owners and process performers	The senior executive team exercises leadership through vision and influence rather than command and control	Y	Y	G	R
Culture	Teamwork	Teamwork is project focused, occasional and atypical	The company commonly uses cross-functional project teams for improvement efforts	Teamwork is the norm among process performers and is commonplace among managers	Teamwork with customers and suppliers is commonplace	G	G	Y	G
	Customer Focus	There is a widespread belief that customer focus is important, but there is limited appreciation of what that means. There is also uncertainty and conflict about how to meet customers needs	Employees realise that the purpose of their work is to drive extraordinary customer value	Employees understand that customers demand uniform excellence and a seamless experience	Employees focus on collaborating with trading partners to meet the need of financial customers	G	G	G	G
	Responsibility	Accountability for results rests with managers	Frontline personnel begin to take ownership of the results	Employees feel accountable for Company results	Employees feel a sense of mission in serving customers and achieving ever-better performance	Y	G	G	G
	Attitude towards change	There is growing acceptance in the company about the need to make modest change	Employees are prepared for significant change in how work is performed	Employees are ready for major multidimensional change	Employees recognize change as inevitable and embrace it as a regular phenomenon	Y	G	Y	Y
Expertise	People	A small group of people has a deep appreciation for the power of processes	A cadre of experts has skills in process redesign and implementation, project management, communications and change management	A cadre of experts has skills in large-scale change management and company transformation	Substantial numbers of people with skills in process redesign and implementation, project management, program management, and change management are present across the company. A formal process for developing and maintaining that skill base is also in place.	Y	G	Y	Y
	Methodology	The company uses one or more methodologies for solving execution problems and making incremental process improvements	Process redesign teams have access to a basic methodology for process redesign	The company has developed and standardized a formal process redesign and has integrated it with a standard process improvement	Process management and redesign have become core competencies and are embedded in a formal system that includes environment scanning, change planning, implementation, and process-centered innovation	Y	Y	Y	Y
Governance	Process Model	The company has identified some business processes	The company has developed a complete enterprise process model, and are senior executive team has accepted it	The process model has been communicated throughout the company. It is used to drive project prioritization and is linked to enterprise-level technologies and data architectures	The company has extended its process model to connect with those of customers and suppliers. It also uses the model in strategy development	Y	Y	Y	Y
	Accountability	Functional managers are responsible for performance, project managers for improvement projects	Process owners have accountability for individual processes and a steering committee is responsible for the company's overall progress with processes	Process Owners share accountability for the companies performance	A process crucial operates as the most senior management body performs share accountability for company performance; and the company has established steering committees with customer and supplier to drive intercompany process change	Y	Y	Y	Y
	Integration	One or more groups advocate and support possibly distinct operational improvement techniques	An informal coordinating body provides needed program management with a steering committee allocates resources for process redesign projects	A formal program management office, headed by a chief process officer, coordinates and integrates all process projects, and a process council manages interprocess integration issues. The company manages and deploys all process improvement techniques and tools in an integrated manner	Process owners work with their counterparts in customers and supplier enterprises to drive intercompany process integration	Y	Y	Y	Y

Figure A.1: Buyer 3 response for PEMM questionnaire - Enterprise Maturity

Section 2 How Mature Is Your Purchasing Processes?		You can evaluate the maturity of a business process and determine how to improve its performance by using this table. Decide how the statements defining the strength levels, from P-1 to P-4, for each enabler apply to the process that you are assessing. If a statement is largely true (at least 80% correct), color the cell green; if it is somewhat true (between 20% and 80% correct), shade the cell yellow; and if it is largely untrue (less than 20% correct), make the cell red. This is to establish the As-is situation in the purchasing department, if any of the parameters are ongoing then it has to be deemed Green, Yellow for future plans and Red if no such decisions have been made				GREEN: largely true	YELLOW: somewhat true	RED: largely untrue	
						Buyer 3			
		P-1	P-2	P-3	P-4	P-1	P-2	P-3	P-4
Design	Purpose	The process has not been designed on an end-to-end basis. Functional managers use the legacy design primarily as a context for functional performance improvement.	The process has been redesigned from end to end in order to optimize its performance	The process has been designed to fit with other company processes and with the company's IT systems in order to optimize the company's performance.	The process has been designed to fit with customer and supplier processes in order to optimize intercompany performance.	R	G	G	R
	Context	The process's inputs, outputs, suppliers, and customers have been identified.	The needs of the process's customers(end users) are known and agreed upon.	The process owner and the owners of the other processes with which the process interfaces have established mutual performance expectations.	The process owner and the owners of customer and supplier processes with which the process interfaces have established mutual performance expectations.	G	G	G	Y
	Documentation	The documentation of the process is primarily functional, but it identifies the interconnections among the organizations involved in executing the process.	There is end to end documentation of the process design.	The process documentation describes the process's interfaces with, and expectations of, other processes and links the process to the company's system and data architecture.	An electronic representation of the process design supports its performance and management and allows analysis of environmental changes and process reconfigurations.	Y	G	R	R
Performers	Knowledge	Performers can name the process they execute and identify the key metrics of its performance.	Performers can describe the process's overall flow, how their work affects customers, other employees in the process, and the process's performance, and the required and actual performance levels.	Performers are familiar both with fundamental business concepts and with the drivers of company performance and can describe how their work affects other processes and the company's performance.	Performers are familiar with the company's industry and its trends and can describe how their work affects intercompany performance.	R	G	G	G
	Skills	Performers are skilled in problem solving and process improvement techniques.	Performers are skilled in teamwork and self-management.	Performers are skilled at business decision making.	Performers are skilled at change management and change implementation.	G	G	G	G
	Behaviour	Performers have some loyalty to the process, but owe primary loyalty to their function.	Performers try to follow the process design, perform it correctly, and work in ways that will enable other people who execute the process to do their work effectively.	Performers strive to ensure that the process delivers the results needed to achieve the enterprise's goals.	Performers look for signs that the process should change, and they propose improvements to the process.	G	G	Y	G
Owner	Identity	The process owner is an individual or a group informally charged with improving the process's performance	Enterprise leadership has created an official process owner role and has filled the position with a senior manager who has authority and credibility.	The process comes first for the owner in terms of time allocation, mind share, and personal goals	The process owner is a member of the enterprise's most senior decision-making body.	Y	R	R	R
	Activities	The process owner identifies and documents the process, communicates it to all the performers, and sponsors smallscale change projects.	The process owner articulates the process's performance goals and a vision of its future; sponsors redesign and improvement efforts; plans their implementation; and ensures compliance with the process design.	The process owner works with other process owners to integrate processes to achieve the enterprise's goals.	The process owner develops a rolling strategic plan for the process, participates in enterprise-level strategic planning, and collaborates with his or her counterparts working for customers and suppliers to sponsor intercompany process redesign initiatives.	R	R	R	R
	Authority	The process owner lobbies for the process but can only encourage functional managers to make changes.	The process owner can convene a process redesign team and implement the new design and has some control over the technology budget for the process.	The process owner controls the IT systems that support the process and any projects that change the process and has some influence over personnel assignments and evaluations as well as the process's budget.	The process owner controls the process's budget and exerts strong influence over personnel assignments and evaluations.	R	G	Y	R
Infrastructure	Information system	Fragmented legacy IT systems support the process.	An IT system constructed from functional components supports the process.	An integrated IT system, designed with the process in mind and adhering to enterprise standards, supports the process.	An IT system with a modular architecture that adheres to industry standards for intercompany communication supports the process.	Y	G	G	Y
	Human Resource System	Functional managers reward the attainment of functional excellence and the resolution of functional problems in a process context	The process's design drives role definitions, job descriptions, and competency profiles. Job training is based on process documentation.	Hiring, development, reward, and recognition systems emphasize the process's needs and results and balance them against the enterprise's needs	Hiring, development, reward, and recognition systems reinforce the importance of intra- and intercompany collaboration, personal learning, and organizational change.	Y	Y	Y	Y
Metrics	Defintion	The process has some basic cost and quality metrics.	The process has end-to-end process metrics derived from customer requirements.	The process's metrics as well as cross-process metrics have been derived from the enterprise's strategic goals.	The process's metrics have been derived from intercompany goals.	R	R	G	G
	Uses	Managers use the process's metrics to track its performance, identify root causes of faulty performance, and drive functional improvements.	Managers use the process's metrics to compare its performance to benchmarks, best-in-class performance, and customer needs and to set performance targets.	Managers present the metrics to process performers for awareness and motivation. They use dashboards based on the metrics for day-to-day management of the process	Managers regularly review and refresh the process's metrics and targets and use them in strategic planning.	R	R	R	R

Figure A.2: Buyer 3 response for PEMM questionnaire- Process Maturity



## A.4 Interview Questions

*The interview questions that were used for the data collection will be presented here:*

1. In the RFQ process, there is a task called offer comparison. Are you following the offer comparisons for the cost breakdown structure?
2. In the RFQ process, does the supplier update the IMDS database with customer and environmental requirements?
3. In the RFQ process, do you consider the 'B and C' rated suppliers?
4. Do you select the suppliers based on total cost of ownership or just the face value price?
5. In the supplier selection process, how much of the predefined criteria are followed for choosing the supplier?
6. In the supplier selection process, who is sending the RFQ to the supplier? What are possible areas of improvement?
7. In the start up meeting with suppliers, who are the participants in the meeting? What are the deliverables? Who sends the meeting invitation?
8. In the supplier list process, who is responsible for audit results registration and performance registration?
9. In the supplier confidentiality agreement process, Are you working along with the PLM coordinator? How is the communication between the PLM coordinator and you?
10. In the CDM, do you refer to the checklist for customer designated suppliers?
11. In the approval of a new materials process, how is cooperation from the materials department and production? Do you approve the new materials from suppliers based on the supplier evaluation process? What are possible areas of improvement?
12. In the qualification of new components, how is the communication between you and SQA engineer in the process of PPAP? Are you aware of your tasks in this process? What are tasks you do in this process? What are possible areas of improvement?
13. In the frame agreement, Who sends the RFQ and contracts to the suppliers? How was the cooperation from the purchasing manager?
14. In the preferred terms and conditions of purchase, do you check the conformance to guidelines? Are the terms and conditions updated on time? Heard that the terms and conditions are going to be changed, what are the changes that are coming in addition to the existing one?
15. Are you updating the component list until the lifetime of the product in the database? Is SQA updating the quality assurance information?
16. In the APQP process, are the suppliers aware of GP 12 requirements? How is the teamwork between you and quality assurance function? What type of containment action plan is followed currently?
17. Do you need further clarification on the PPAP process from the quality assurance function?
18. Do you verify the mandatory data in the purchase orders before sending the order copies to suppliers?

19. How effective is the upstream and downstream communication, between the plant and the suppliers and the different functions involved in a product?
20. In the supplier rating process, do suppliers notify the changes in certifications from their side? Who sends a report to the supplier regarding their performance? Who rates the supplier and updates it in the supplier database?
21. In the quality and process audit, who performs the audit at the supplier site? Who will review the audit results and do approval?
22. In the supplier risk assessment process, how is the support from your colleagues and other departments? When do you perform supplier risk assessment? Is it before the supplier approval or during the quality issues?
23. In the register of supplier contact, who communicates with the supplier and register their contracts in Company's database? How often the database is updated?
24. In the qualification of new components, who is responsible for storing the sampling parts? Who conducts the trial production run and reviews the report?
25. In the controlled shipping procedure, who is responsible for the process from the purchase department? Who communicates with the supplier? How fast the supplier responds to the deviation in quality or delivery?
26. In the complaint handling procedure, who is responsible for the process from the purchase department? How was the cooperation from the plant for this process? Is the deviation updated on time in the database and informed to the purchase department? There are various stages of escalation (Stage 1 to stage 4), which is the most practiced escalation process among them?
27. In the supplier evaluation process, Are the suppliers answering the questionnaire without any errors? Who is responsible for this process? Is there any possibility of improvement in supplier evaluation form?
28. Are suppliers comfortable with digital systems? Are suppliers able to understand everything from the document? for example: filling out the forms digitally?
29. In the supplier rating process, who does classification of the suppliers? What are the criteria that you are following for the rating process?
30. In the supplier rating process, do you display the B and C suppliers at the board on the wall in the database? Who is responsible for that activity?
31. In the supplier continuous improvement process, what are the discussions you have with supplier development function in your department? Who is responsible for the decision process?
32. Does the present purchasing and supply strategy support the business strategy and does it meet the long term requirements ? are opportunities for the benefitting from synergies between divisions/business units fully exploited, for example by joint contracting for common materials and service requirements?
33. What percentage of our purchasing requirements is covered by long term contracts ? what percentage is covered by spot-market transactions or short-term contracts?
34. In addition to the above questions, do you have any additional responsibilities ? If yes, what are the responsibilities and what is the process?
35. How many approvals do we have in place? Why?

36. Can we eliminate any forms? Do we absolutely need them?
37. Can we eliminate or combine any steps in the process or standardize a step, a report or a form?
38. Is there any chance of error occurrence in the existing process?

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