Improvement of Project Management in an SME - A Six Sigma Approach

Master's thesis in Quality and Operations Management

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Summary

Enterprises all throughout the world, especially small and medium-sized businesses (SMEs), are essential to economies because they create jobs, innovate, and contribute value. However, in project based SMEs, because of their different structures, dispersed locations, and cultural barriers, SMEs especially those operating globally present distinct project management challenges because of their dynamic nature. This paper examines the project management difficulties that a developing medium-sized global organization has and suggests solutions to meet goals in the face of changing circumstances. Examining the existing information available on project oriented SMEs that work with project management and continuous improvement methodologies like Kaizen and Hoshin Kanri, this research investigates structural issues arising from growth and increasing targets. The methodology employed aligns with the Six Sigma DMAIC method, addressing research questions centered on project management challenges and pathways to achieving organizational objectives.
The research finds out a few challenges affecting the Project Management such as lack of Standard Operating Procedures (SOPs) and other un sustainable growth plans causing stress to the employees. The study later on moves forward in bringing out the causes of these challenges and finally marks out the areas of improvement with some recommendations. Important findings point to organizational structural challenges that are in need for focused adjustments. The fundamental objective of the recommendations is to match short-term improvements with long-term objectives by using continuous improvement approaches and improving organizational control while preserving project flexibility. This study adds to our understanding of project management in SMEs, especially when it comes to international expansion, and offers practical advice for businesses trying to successfully manage growth-related obstacles.

Key words: Small to Medium sized Enterprises, Project management, Underlying causes, Affinity interrelationship matrix, Effective scoping, Fishbone-diagram, Multivariate analysis,

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List of Acronyms and abbreviations

Below is the list of acronyms that have been used throughout this thesis listed in alphabetical order:

PM	Project Management
CRM	Customer Relationship Management
SMEs	Small to Medium sized Enterprises
CI	Continuous Improvement
AIM	Affinity Interrelationship Matrix
DMAIC	Define Measure Analyze Improve Control
QM	Quality Management
KPI	Key Performance Indicator
SOP	Standard Operating Procedure
PMBOK	Project Management Body Of Knowledge
VSM	Value Stream Mapping
PMI	Project Management Index
IPMA	International Project Management Association
CQI	Continuous Quality Improvement
TQM	Total Quality Management
ROI	Return On Investment
SPC	Statistical Process Control
FMEA	Failure Mode Risk Analysis
DFSS	Design For Six Sigma
MNC	Multinational Company
NIST	National Institute of Standards and technology
IPEC	Initiate, Plan, Execute, Control
C&E	Cause & Effect
SIPOC	Suppliers, Inputs, Processes, Outputs and Customers
LSS	Lean Six Sigma

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1. Introduction

This chapter offers the reader the relevant background information to establish a brief description of the study. It elucidates the study's aim and scope while acknowledging the inherent limitations. Additionally the chapter provides a comprehensive understanding of the case in interest and the problem being investigated through the duration of the study.

1.1. Background

Enterprises across the world exhibit diverse scales and structures, with one notable category being the small to medium enterprise (SMEs). SMEs play a pivotal role in the national economic landscapes globally fostering employment, adding value and catalyzing innovation. There is no single universally accepted definition of what constitutes a small and medium sized enterprise as it changes from country to country and between segments of statistics as described by Anderson (2011).The study focuses on project based SMEs that develop ad hoc mechanisms to carry out their tasks and complete the undertaken projects for business that demand and anticipate rapid innovation (Rvj, 2023) Some small to medium sized project based global companies with multiple locations that are conducting multiple projects simultaneously serve a wide range of customers. These types of organizations are a source of innovation and entrepreneurial spirit; they create competition and are vitally important for a healthy dynamic market economy (Hillary, 2000). A significant growth objective in such organizations could lead to increased complexity in managing projects effectively. The substantial physical distance serves as both a geographical and cultural barrier for the companies when trying to coordinate and align resources to reach strategic objectives. Such global firms are defined as firms that participate in the international economy along multiple margins and account for substantial shares of aggregate trade (Bernard et al, 2018). Different locations and departments usually work differently making it a challenge to utilize all the resources effectively across the company. This could mean when moving a team or individual to another location they have to relearn a new way of conducting work putting extra constraints on a company's ability to move resources around. Even Though many of the global firms are either product based or service based, most of them tend to have a project management approach. Looking in the product based firms dealing with research and development projects or just development the project management approach plays a pivotal role. In the case where most companies use different strategies for different project domains, the move of teams or individuals to other departments can be problematic. This is confirmed by Aaron & Shenhar (2020) who mention that the reason companies struggle with project management is the usage of different strategies for different projects. The flexibility of using different strategies for projects is something a company needs in order to adapt to the market. However, having control of the project management organization might be needed in order to better utilize the resources within a global company. This is why Olausson et al. (2010) mention that companies must find a balance between formal organizational control and project flexibility.

Kaizen (Kai - do, change, Zen- well) is a philosophy meaning gradual and continuous progress with increase in value, intensification and improvement (Karkoszka and Szewieczet, 2007). It is translated in the west as continuous improvements which are associated with a variety of organizational developments like lean, total quality management, six sigma and other waste reduction methods (Singh & Singh, 2015). Adoption of these developmental methods plays a crucial role for achieving organizational objectives in the small to medium sized global organizations. Since many of these organizations are focused on ambitious growth, it is vital to remember to make improvements along every step of the way in order to adapt to the changing dynamics of the organization. Japanese firms evolved a management process to coordinate the methods across departments, involve everyone and connect shop-floor improvements to company goals or strategically aligning the short-term improvements to the long term goals which came to be called hoisin kanri (HK) (Nicholas, 2014). Although continuous improvements harness the participation of all the employees to improve performance, quality and reliability every step of the way, it is a necessary step in order to avoid the pitfalls (Singh & Singh, 2015).

There is very little research that focuses on project-based SMEs, especially those operating on a global scale and working in different sectors. Given their critical role in driving economic growth, understanding how these firms manage and continuously improve their project management processes is essential. Acknowledging the importance of continuous improvement methodologies in achieving organizational objectives where adapting to changing dynamics is paramount, this thesis intends to study a particular department in a medium sized global organization for uncovering areas of improvement. By doing so, the study seeks to contribute valuable insights on these enterprises in achieving their ambitious growth objectives while maintaining alignment across diverse operations.

1.1.1. Purpose

Having diverse approaches across different sectors within the same division hinders the smooth collaboration between the personnel. The purpose of this thesis is to investigate the current challenges and look into how a project based global SME can focus on developing improvement strategies catering to the functionality and complexity of the Project Management division at the organization. Standardized project management practices are essential for organizations to improve efficiency and leverage collective knowledge. The goal of this research is to improve these techniques in project based industries, guaranteeing broad application. An organization without standard operating project management procedures, for example, would find it difficult to collaborate across projects, which is why this endeavor is so important. The aim of this thesis is to address the current situation of the organization by discovering the challenges faced in project management. Then analyzing the same through literature and other proven methods for finding a way for small to medium sized global companies to endure transformation by dealing with short and long term challenges in project management.

The first research question focuses on the common struggles or pitfalls faced by medium sized global companies when trying to meet their ambitious growth plan.

RQ1:What are the major challenges in Project Management in a growing medium sized global company?

While the first research question was on understanding the challenges and identifying the potential root causes of the same, the authors had to leverage scientific tools in order to analyze its severity and effects. The results derived from the first research question will be used to answer the second research question. The second research question talks about what necessary steps to be taken from organizations to eliminate these challenges and achieve their objectives. This question will also involve looking into the various proven improvement methodologies suitable for medium sized global companies analyzing the existing literature.

RQ2: How can SMEs working on a global scale overcome the identified challenges in Project Management?

1.2. Scope

When bringing about an organizational change, inherent challenges are expected. It is critical to acknowledge that the focus of this thesis is exclusively directed towards a single organization and digging deeper into the various nuances and disparities within the organization itself. Specifically the scope of the Thesis is focused on observation and analysis on a particular department of a growing small to medium sized global company. The intent is to delve deep into the analysis of the distinctive features, practices and challenges within the specific department and uncover the pitfalls faced by organizations in similar situations. The department of Project Management in particular is chosen in this case, as it involves processes that have a number of important characteristics, such as resources, work and outputs which significantly impacts the overall business operations of an organization (Zwikael & Smyrk, 2011).

The scope of this thesis extends to both short-term and long-term improvements for the organization chosen for the study, with distinct objectives for each. In the short term, the focus is on detailed analysis and optimization of the processes under the Project Management division. This involves identifying the inefficiencies, bottlenecks and areas for improvement in the overall project management workflow. The short term modifications will be carefully aligned with the objective of laying the groundwork for sustained long term transformation.

The long term scope of this thesis will be oriented towards establishing a structured and standardized framework for operations of various Project Management departments, within the organization. The overall aim is to develop a cohesive and consistent approach to project management, ensuring uniformity in the processes. By striving for long-term improvements,

the thesis will seek to create a lasting sustainable impact on the organization's project management practices, promoting collaborative and adaptive environments over time.

The suggested improvements put forth within this thesis are conceptual in nature. This makes it important to note that the practical implementation of these suggestions are beyond the defined boundaries of this thesis. The thesis is intended to serve as a guide, offering recommendations into potential improvement areas for standardization with the project management domain.

1.2.1. Organization for the study

Consilium Safety Group AB is a company that develops fire, flame and gas safety solutions and was founded 1912. Their journey started with selling speed logs for the marine sector, but from the late 1950s onwards they began to also develop gas, fire detection systems through acquisitions . The acquisitions of other companies enabled the development of integrated detection systems for both fire plus gas while entering new sectors to serve in safety solutions. Today, Consilium is a global company for safety solutions serving many sectors. Their main target sectors are: Marine, Transport, Energy, Building and industrial sectors. Their commitment is to ensure the protection of people's lives and ensure their safety with their products and services. They are located in 27 countries and 55 office locations with over 900 employees. Consilium has installed around 75,000 fire and gas detection systems so far and had a turn over of 1,9 billion sek in 2022. Consilium is a growing company that aims at being a world leader in safety solutions by continuously innovating their existing products, way of working and acquiring companies with products/services that complement their business for example their acquisitions of Salwico, Nittan Marine and Servoteknikk. In 2020 Consilium got new owners, Nordic Capital which have made them "stronger than ever, always looking forward" (Consilium Safety Group AB) Our history – where we come from | Consilium Safety

2. Theory

This chapter includes the necessary theoretical description of relevant topics for the thesis project presented. In this study we delve into the theoretical framework surrounding Quality Management shedding light into the key concepts and providing insights. By synthesizing existing literature and introducing innovative perspectives, we aim to contribute throughout the duration of this thesis.

2.1. Project based SMEs

According to Madani (2018) the currently used definition by the EU of an SME is an entity engaged in economic activity with a number of employees numbering no more than 250, turnover of 50 million £ or less and a balance sheet of 43 million £ or less. When it comes to PM in SMEs the literature suggests that it requires less structure compared with large organizations PM (Aquil, 2013). This is because SMEs compared to large organizations are more constrained in their finances and overall resources which require a higher degree of flexibility. Aquil (2013) mentions four major parameters to compare differences between large organizations and SMEs in relation to PM: Processes, Procedures, Structure and People. When it comes to the processes, SMEs require simple planning while large organizations apply formal processes that are bureaucratic in nature. The procedures in the SMEs have a low degree standardization and in large organizations have a high degree of standardization. Looking at the structure, SMEs have little specialization with a lot of multitasking, large organizations have well defined roles and designated tasks. Lastly, in the people parameters in an SMEs people are more likely to use tested techniques when doing assignments while in large organizations people are put in existing systems where the focus is to maintain the system and not the people. According to Dasari, et.al. (2015) most assignments in SMEs are conducted as a project. This could be a tiny modification in an existing product or the development of a new product from scratch which supports the gradual implementation of PM methodologies, tools and techniques (Dasari, et.al., 2015). This is supported by Turner et al., (2009) who mention the need of a light version of Project Management with a simple set of tools adapted for each enterprise. This project focus will be SMEs in a production based setting, because of the case-company in study.

2.2. Project management

In the past project management was primarily focused on providing schedule and resource data to top management in just a few industries, but in recent times it involves much more, and people in every industry and every country manage projects (Schwalbe, 2009). According to the Project Management Body of Knowledge (PMBoK) a project is a temporary

endeavor undertaken to create a unique product, service or result which is different from operations as projects are terminated once they reach their objectives. Projects are crucial in helping an organization achieve its strategic goals like venturing into global markets, shortening product life cycle or narrow product launch windows (Pinto, 2019).

In order for the project activities to meet the project requirements, it is essential to apply specific knowledge, skills, tools and techniques in the form of Project Management. The framework of project management process groups include initiating, planning, executing, monitoring/controlling and finally closing the activities (Schwalbe, 2009). Project management serves as an excellent training ground for future senior executives in organizations as it provides the true test of an individual's ability to master both the technical and human challenges in the business (Pinto, 2019).

The project management methodology represents a set of methods, techniques, procedures, best practices used in a project, which is based on a specific project management approach, that defines the manner in which the project is approached (Špundak, 2014). The best known PM methodologies are mainly process methodologies which include certain subprocesses or phases, namely PMI, IPMA, Agile and various others according to Jovanovic, & Beric (2018). All projects have three main components which are cost, time and quality; where the project methodologies are the means of organizing and directing projects. While methodologies help organizations to achieve outcomes that are aligned with strategic objectives, choosing the right methodology plays a pivotal role (Rasch, 2019). Although there exist several PM methodologies, they were developed with a focus on large companies and little has been written about the project management in small to medium sized enterprises (Turner et al, 2009). Turner et al. (2010) research into the PM in SMEs uncovered some interesting findings where; in one example, i.e., the Swedish companies that were interviewed for the article showcased a similar trend where the project teams wanted to be involved in developing the plans but adhere to them and the project manager providing laissez-free guidance. In this type of setting methodologies such as agile PM, which provides the individuals with more autonomy would be most suitable. Finally the end decision of choosing the right methodology in an SME would depend on; their strategic objective, key performance indicator and appropriate PM tools and technique. In the other three examples discussed in Turner et al. (2010), three other types of projects were conducted: i.e, change project: in which change/customer projects were used to help companies implement the right type of PM. *"Research projects:"* to develop research and innovation. Product development projects in which new products are developed (Turner et al, 2010). The previous article describes the three out of four types of projects mentioned by Koch and Friis (2015) which are: Change projects, production projects, product development projects and innovation projects.

The final project type looked into is called Project or Job Based Production (PBP/JBP) which is to produce small/limited batches of product output that is high quality and highly customized (Celano et al., 2016; Koch & Friis, 2015). It is considered to be a mix of production projects and product development projects. This is because it has a production setting where it is customer driven with a product focus, but without a stable repetitive

process (Koch & Friis, 2015). PBP is considered to be a production characterized by high complexity, high value, many stakeholders and unique production examples are construction projects and offshore (Thuesen, 2012). PBP is Project Based Organization/Enterprise (PBO/PBE) in a complex products setting (Oerlemans & Pretorius, 2014). PBO has been discussed more in the literature for example the literature has discussed PBO compared with a functional organization (Hobday, 2000). According to Hobday (2000) PBO is more innovative and is more adaptable to emerging properties and customer needs compared with functional organizations. This was seen in the case of a company used by Hobday (2000) which had both a functional division and a project based division for projects to make the comparison. In the coming section short descriptions on the challenges faced by PM managing in the different project types will be presented.

2.2.1. Challenges faced in PM

The project types discussed were production projects, Change projects, product development projects, innovation projects, PBP and PBO. This is to understand that there are different project types that are used in different settings which mean that they face different challenges. Therefore the project type that the authors will focus on is the project type in the case-company (PBP/PBO) where the challenges and ways to overcome them will be identified in order to answer RQ1 and RQ2.

When it comes to PM dealing with production projects one of the challenges is the need to have a highly capable project team, accurate planning, control process and quality measures as these factors highly influence the outcome of those projects (Ishtiaq et al., 2023). It is especially important for the PM to choose the right project team as it influences both the success of the Production project as well as financial performance.

One of the challenges faced by a project based companies according to the literature is a managerial inefficiency due to the temporariness of each project and because each project has its own unique demands regarding resources making project planning and allocation of human resources crucial (Ogrezeanu et al, 2019). Ogrezeanu et al. (2019) also mentions although resource planning is important, it is under prioritized due to overworked managers running multiple projects simultaneously while at the same time underplaying the resource demands of a project. The underplay of resources is done due to on the one hand lack of resources and on the other a desire for increased efficiency. In addition to this is the negligence in bringing in technical leaders and senior analysts early on in the project in order to make the resource planning realistic. The consequence of which usually leads to delays, insufficient quality which could negatively affect customer relationships and in many cases projects could be redone leading to higher costs (Ogrezeanu et al, 2019). Another challenge project based companies face is the ineffective knowledge sharing between project teams due to the “fragmentation and lack of uniformity of organizational structures, processes, practices,

and technologies (Almeida & Soares, 2014). The reason knowledge sharing is important is because it enables an organization to prepare for uncertainties in the organizational environments and enable continuous improvement of organizational performance. Almeida and Soares (2014) mentions that sharing problems of PBO is due to projects being structured in a way where it can't be utilized by other projects so called “informational limbo”.
Overcoming the challenges for PM in the project based companies will be the focus for the case-study.

2.3. Quality management

The Project Management Institute (PMI) acknowledges that project quality management must address both the management of the project and the product of the project, the quality tools and techniques identified in the PMBOK are explicitly described in terms of their application to project deliverables and not the management process (Orwig & Brennan, 2000). Quality has always been the important outcome of the project and the quality philosophy suggests that a good management will continually improve processes focusing on customer needs which can be achieved through feedback loops throughout the organization (Orwig & Brennan, 2000). Quality management (QM) is one of the most widespread and popular operations management practices to improve organizational effectiveness in the world with origin from Japan in the 1950s (Ebrahimi & Mehran, 2013). The meaning of quality according to Ebrahimi & Mehran. (2013) is multi dimensional, depending on the situation for example, in design it’s “Fitness for use”. Ebrahmi and Mehran. (2013) also mention that Garvin (1984, 1987) proposed eight dimensions for product quality (performance, features, reliability, conformance, durability, serviceability, aesthetics and perceived quality). This is also added with Demings proposed “14 principles to improve quality in organizations” (Ebrahimi & Mehran, 2013). This shows that quality is an operations management practice that focuses on optimizing any process, product and service that it’s incorporated in. This is done through continuous improvement of processes, products and services to achieve and even surpass customer needs & expectation (Prajogo & McDermott, 2005). QM is in short based on principles, practises and techniques. The principles offer a framework for practitioners of it with general guidelines, which are followed through with practices. QM practises are in turn supported with the techniques, but there are multiple frameworks for practises. According to Ebrahimi & Mehran (2013) there are two ways of choosing framework for practises: the first one is using a quality award as proxy such as Malcolm Baldrige National Quality Award (MBNQA) and the second one is to conduct surveys and interviews to identify most relevant practise. Since QM is as previously mentioned one of the most popular management practices in the world it has factual data on large, medium and small seized enterprises in different contexts regarding performance.

Customer focus, continuous improvement, strategically based and total employee involvement are key elements in QM which affect organizational performance (Pambreni et al., 2019). This makes QM an appropriate operations management for any organization that seeks to improve its performance by satisfying its external and internal stakeholders. Since it has customer focus it is assumed it will focus on external stakeholders, but also the continuous improvement could lead to organizations continually satisfying stakeholders (both internal and external) and surpass expectations. Likewise, since it is strategy based and total employee involvement one can assume it will engage both top management, lower management and workshop in the operations practices encompassing the entire organization that implements it. There is not much empirical research that demonstrates a link between quality management practice and better project management performance. However the study conducted by Barad and Raz (2000) regarding the same showed some link such as the improvement of process control is likely to improve process stability and improvement of training is likely to improve all outcome oriented variables. Either way QM will aid the PM directly or indirectly by improving the overall efficiency of the organization.

2.4. Continuous improvement

Quality management and continuous improvement have a shared goal of achieving excellence and driving organizational success. Quality management frameworks such as Six Sigma or Total Quality management emphasize the importance of continuously monitoring and improving processes to enhance quality and efficiency. The concept of continuous improvement (CI) and/or continuous quality improvement (CQI) is a concept taken from the Japanese word “Kaizen” and used in operational management practices like for example Lean and Total quality management (TQM) (Doshi & Desai, 2014; Singh & Singh, 2015). Singh and Singh (2015) mention that CI has three main notions:

- Firstly, Kaizen is continuous – which is used to signify both the embedded nature of the practice and also its place in a never-ending journey towards quality and efficiency.
- Secondly it is usually incremental in nature, in contrast to major management initiated technological innovation..
- Lastly it is participative, entailing the involvement and intelligence of the workforce, generative intrinsic psychological quality and quality of work-life benefits for employees.

CI has been a topic in the industrial world since the increased global competition intensified with rapidly changing customer needs, but how to achieve this has been a matter of debate. This is because there is one size fits all as there have been companies that have been investing CI approaches in terms of money and resources, but have not received a satisfying return on investment (ROI) (Singh & Singh, 2015). According to Doshi and Desai (2014) the benefits of CQI is that it will help to improve processes, activities, employees, products and management performance in the whole production cycle. CQI can be implemented using

many different types of tools for example Failure Mode & Effect Analysis (FMEA), Statistical Process Control (SPC). The challenges with CQI is that there are no clear frameworks or models for companies to choose from so every organization can take one best suited (Doshi & Desai, 2014).

A growing number of organizations are adopting project management as part of their management practices and a typical goal of project management is to execute the project within a targeted budget, schedule and performance. As organizations gain more project management maturity, Jung and Wang (2006) emphasize on making continuous improvement to project management as a new avenue towards achieving improved results. Meredith and Mantel (2010) also discuss how implementing continuous improvement in project management is essential for the success of international organizations. Since international business tends to have a higher number of dynamic variables influencing the business operations compared to a locally operating organization. The CI could aid in keeping up with the changing variables and adapt to the requirements as the organization grows. Since CI is primarily suited for repetitive processes and PM can be seen as an on-going repetitive process aiming for CI by PBO as it has a lot of on going projects due to it producing most of its products in projects (Backlund & Sundqvist, 2018).

In conclusion CI/CQI is a concept that offers increased organizational performance through the entire organization if implemented in a way that is suited for the organization, but if it's not then it can be a costly endeavor without benefits. This makes it necessary that organizations do their due diligence in how, where and when to apply CI/CQI.

2.5. Improvement of project management

Initially there is a lot of effort and knowledge put into developing a process. Nevertheless the amount of effort put into design and implementation of a process does not really matter; there is always room for improvement (Wysocki, 2004). Looking into growing multinational companies, it is essential to adapt to changing environments by using a holistic framework to take control of the growth crisis in order to be successful (Wood-Kline & Evans, 2003). For example the continuously changing power balance between nations, the increases in terrorist threats and cybercrime and the ongoing technological advancements can perhaps be considered as interdisciplinary issues (Konstantinou & Müller, 2016). In many cases these challenges are time critical and reflect the context in which all projects will need to be inspired, designed, executed and delivered. This exploration delves into the strategies and methodologies needed for large companies to optimize project management processes and ultimately achieve sustained success in the face of evolving business landscapes. Additionally this section will elaborate on a variety of approaches and methods that support change and continuous improvement, including Six Sigma and Lean, to effectively address the dynamic challenges posed by shifting global environments and interdisciplinary issues.

Identifying and actively monitoring the key performance indicators for the project management is vital for tracking the progress of projects. KPI can be either financial or non-financial measures that organizations use to reveal how successful they were in accomplishing long lasting goals (Velimirović et al., 2011). It is essential to have defined and standardized processes in the organization to constitute an effective system of performance measurement. Continual measuring of performances is significant and acts as a base for continual improvements of organization performances which is one of the most important management principles (Besic & Djordjevic, 2007). In most of the cases, the reason behind low performance is waste in different forms. By identifying the waste and implementing actions that reduce these waste in turn improves the performance which can be measured using KPIs (Lindberg et al., 2015)

2.5.1. Six Sigma

Six Sigma is a business philosophy, an improvement methodology and a performance metric. The aim of the business philosophy is to achieve top level customer satisfaction through quality and continuous improvement. The methodology aims to improve process performance by utilization of data and statistical tools in a phase wise manner Define, Measure, analyze, improve and Control (DMAIC). The aim is to achieve 3.4 faults per million opportunities in processes as well as aligning customer needs and expectations with the organization's strategic objectives (The Black Belt Memory Jogger). In a study by Bañuelas and Antony (2004) comparing Six Sigma and Design for Six Sigma (DFSS), it was noted that Six Sigma is mainly used in improving existing processes through incremental improvements of existing processes while DFSS is for creating a new process from scratch. In the case of Six Sigma application it is assumed that the products/ services generated from a process satisfies customer needs and functional requirements and are the most economical (Nave, 2002). Based on this one can assume Six Sigma (DMAIC) is a methodology that should be used on a system that is working and just needs some tweaking to get the most out of it.

2.5.1.1. Six Sigma in process improvements

Six Sigma as mentioned is mainly applied on existing processes, products and services Bañuelas and Antony (2004). For example, in a subsidiary of a British multinational company (MNC) that produces many types of abrasives Six Sigma DMAIC was used to reduce waste in an already existing non-stop continuous process line that produces rolls (Bañuelas and Antony, 2004 & Sheparhard, 1995). Six Sigma DMAIC showed a positive connection in improving process capability when the root causes of variation in British MNC were understood it was possible to eliminate them. This was also the case when six sigma was applied on a semiconductor manufacturer that specializes in producing circuit cartridges that was suffering from high rate of test failures. The semiconductor manufacturer was able to reduce the test failures by half once the root causes were identified (Valles *et.al*, 2009).

In conclusion it is observed that Six Sigma methodology is well versed when it comes to existing processes. This was observed in the two mentioned examples of two companies with different processes and products benefiting from the implementation of Six Sigma on their processes. Six Sigma methodology is not confined to any specific type or size of industry and SMEs with focus on Project Management can also reap the same benefits by the application of this methodology.

2.5.2. Lean methodology

Lean is defined as" a systematic approach to identifying and eliminating waste through continuous improvement, flowing the product at the pull of the customer in pursuit of perfection" by National Institute of Standards and technology (NIST). The waste mentioned above, is commonly referred to as non-value-added-activities by Lean practitioners, which are categorized into eight types of waste (Kilpatrick, 2003).
(1) Overproduction
(2) Waiting
(3) Transportation
(4) No-Value-Added-Processing
(5) Excess Inventory
(6) Defects
(7) Excess Motion
(8) Underutilized people (Kilpatrick, 2003).

The innovations achieved at the shop floors of Toyota Motor Corporation is where the origins of lean thinking can be traced back to (Ohno, 1988). Lean thinking is a management philosophy and a set of principles that originated from the Japanese manufacturing practices in the 1950s (Liker, 2008). The practices of lean have since been widely adopted across various industries ranging from healthcare, software development and services.

Over the years Lean has introduced many tools or building blocks to reduce or eliminate the wastes. The most common methods are the Pull system for understanding customer needs, Total Quality Management used for continuously improving all areas of the company's operation,visual controls which give immediate apparent understanding of a condition and Kanban used for maintaining orderly flow of material (Kilpatrick, 2003) . Lean methodology provides a systematic approach to improving efficiency, reducing waste and to foster a culture of continuous improvement. Lean is applied to PM to deliver the products while maximizing value and minimizing waste which is different from the traditional PM not only in the goals it pursues but also in the structure of its phases (Ballard et al., 2003).

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2.5.3. Lean Six Sigma

Lean Six Sigma (LSS) is a method aimed at understanding root cause through data collection, process improvement and cost reduction (Knapp. 2015; Voehl *et al.,* 2013). There are three main components to Lean Six Sigma implementation: Top management involvement, Statistical/graphical analysis and project champions. According to Beer (2003) the involvement of the higher management by taking action can influence success or failure of the Lean Six Sigma initiative. The analysis of the statistics and graphs are usually done with Value stream maps (VMS), Pareto charts, histograms, box plots and control charts (Trusko *et al.,* 2003). The project's champions are usually black or green belts in Six Sigma that oversee the initiative and drive the implementation of it (Knapp, 2015). The current literature shows the spread of Lean Six Sigma implementation in four industrial sectors: healthcare, human resources, finance and education (Singh *et al.,* 2018). It also shows that it is usually implemented in sequential manner going in between Lean and Six Sigma, but information regarding the complete integration of these two is miniscule (Singh *et al.,* 2018).

In Conclusion Lean Six Sigma is methodology that is a synergy of both Lean & Six Sigma. Where the aim is to reduce variation in processes and reduce waste. This is usually done through sequential implementation of Six Sigma & Lean. Tenera and Pinto (2014) discuss the attempts to enlarge the DMAIC cycle to project management as DMAIC will focus on finding solutions to problems and PM standards will provide the formal procedure for the implementations of these solutions. The results obtained from this study shows that process improvement on project management stable practices can be reached through continuous identification and evaluation of improvement opportunities in PM.

2.5.4. Agile

Agile methodologies represent a paradigm shift in the way software development and project management are approached. Agile methods are a reaction to traditional ways of developing software and acknowledge the need for an alternative to documentation driven, heavyweight software development processes (Cohen et al., 2004). The Agile manifesto emphasizes on the individuals and interactions , customer collaboration and responding to change which has made the agile framework usage across various industries due to its flexibility and focus on delivering value. Although the birth of agile can be traced back to the software industries, the agile manufacturing concept has started to emerge in SMEs but due to the depth in the available literature and lack of emphasis within the industries, the advantages of such philosophies are not fully appreciated (Moradlou & Asadi, 2015).

Agile is not a single methodology but an umbrella term consisting of different frameworks and practices , each with its own theoretical nuances such as Scrum and Kanban. The rewards of using this framework can be increased flexibility and improveroved team collaboration,

however it also comes with certain challenges while implementing as it requires cultural change and buy-in from all stakeholders which can be difficult to scale in large organizations. The Agile project management strategies which are iterative and adaptive in nature were developed to counter the traditional PM approaches which are linear and incremental strategies (Fernandez & Fernandez, 2016). Agile in PM represents a transformative approach where the projects are broken down into small manageable units called sprints which typically last from one to four weeks, during which a cross-functional teams work on specific deliverables.

3. Methodology

The methodology chapter of this thesis serves as a comprehensive guide to the different processes undertaken to accomplish the research objectives. It explains the research approaches chosen by talking about how data was collected and analyzed, furthermore discusses any concerns or criticism about the methods used. This chapter attempts to give transparency and reliability to the research approach used in this thesis by carefully explaining these features.

3.1. Research approach

According to Bell et.al. (2022) “Business research” refers to the academic study of topics related to questions relevant to business, including management and organizations. Business research conducted where research thinks there is an aspect of business management that is poorly understood . When conducting “Business research” there are three main types of approaches: abductive, deductive and inductive. A research approach is the way researchers are going to do their research in order to understand the aspect that is poorly understood. The first mentioned approach abductive is the way where the researchers begin with objective observation of a phenomena and try to bring forth explanations for them. This is done by regularly working with both existing theory and empirical data in parallel, which helps find gaps in the theoretical knowledge by exposing current frameworks inability to explain empirical findings. After exposing the gaps in the theory it is advised to creatively make new theories that can explain the researched phenomena by using the existing empirical data which will need further research (Tavory & Timmermans, 2014), which is incorporated in this study to analyze the empirical data.

The two other approaches mentioned work with the relationship between theory and research, but in two opposing ways. The deductive conducts research using the theory as a reference regarding hypothesis and ideas and then examines them with the empirical findings. This is executed by using the existing framework to then observe what the result was of the implementation. The inductive approach conducts research to make empirical findings which generates new theories with new hypotheses and ideas (Bell et al., 2022). The research approach for this case study is a abductive approach utilizing a mixed method in which the authors combine both quantitative and qualitative data to reach research conclusions.

3.1.1. Mixed method approach

The reason the authors chose a abductive approach with a mixed method of both qualitative and quantitative was because according to Thompson (2022) that abductive approach is a mix of data and hypothesis driven research. The abductive approach enables the authors to conduct the project using existing theories and complement them with new theories as

mentioned earlier which makes it a more comprehensive research approach. Since the research for this project is about improving project management in SME which is a wide topic since there are all kinds of SME in all different types of industry with different needs being reliant on only the theory is assumed to not be sufficient. Using the abductive approach will enable the authors to see in the case company which models/frameworks could improve PM according to the literature and see if there are challenges that need more investigation to overcome if it's missing in the literature. The mixed method for this research approach is to rely on both quantitative and qualitative data to complement each other for increased validity. The quantitative data will be extracted from the organization's existing database, but the qualitative data will be collected for the study to enforce quantitative data or generate new theories as mentioned by Bell et al., (2022). This will enable the authors to generate improvement suggestions for PM in SME that are enforced by more reliable data and potentially generate new theories for further investigation.

3.2. Research Design

A research design provides a framework for the collection and analysis of data and the choice of research design reflects decisions about the priority being given to a range of dimensions of the research process (Bell et al., 2022). As mentioned earlier this study uses the case study design due to the practical nature of the topic for the thesis. The case study approach is a popular and widely used research design in business research and some of the best known studies in business and management research are based on it (Bell et al., 2022). This study was carried out on behalf of Consilium Safety Group under the consultation of the supervisor from the organization. Based on the supervisor's area of expertise and the organization's emphasis on continuous improvement, a six sigma methodology was chosen for this study which is widely practiced in the same organization. The Six Sigma methodology follows a DMAIC cycle which consists of scientific flow of information. While the methodology consists of five stages, the scope of the study includes onlys the first four, as the practical application of the results is in the hands of the organization rather than the authors.

3.2.1. Define

The Define phase is started off by understanding the voice of the customer and by assessing the business benefits. In the initial stages, the objective is to find out what the problem is/what to improve which is referred to as the big Y in the effective scoping framework made by Peter Hammersberg. Secondly, to know the jurisdiction of influence for the research in the process. Lastly, identifying all the little y's which are used as key performance indicators to measure the progress of the big Y. The authors have carefully selected the tools required for the particular purpose from all the recommended Six sigma tools like Affinity interrelationship matrix (AIM), Effective scoping and Value stream mapping (VSM).

3.2.2. Measure

The Measure is the second phase in the DMAIC methodology, where the objective is to measure the identified problem in the Define phase by mapping out all the processes inputs, outputs, current baseline and target involved. The process map should represent the “as is” process and be detailed enough to represent improvement opportunities. Once this is achieved the measurement system is analyzed followed by reconfirming project charter and risk management plan. This is achieved usually by the recommended Six Sigma tools VSM, Data collection template, Processes capability studies and others.

3.2.3. Analyze

The purpose of the Analyze phase is to analyze information about the process and prove the root causes of the problem documented in the Measure Phase. The deliverables in this phase include making a list of potential root causes, on which graphical and statistical analysis is conducted to determine a list of proven root causes with an assessment of their effects. Upon completion of this phase, the team is expected to have enough understanding to start identifying solutions.

3.2.4. Improve

The impactful phase in DMAIC is the Improve phase where the main purpose is to improve the process by implementing solutions that address the root causes that were confirmed in the Analyze phase. This is the phase where the objective is to identify a portfolio of potential improvements for the process and then conclude with a final improvement. This is mainly done with these recommended Six Sigma tools: Brainstorming, Idea generation, Solution selection, Prioritization Matrix, Process Mapping, Failure Mode and Effects Analysis (FMEA), Implementation plan, Piloting Solutions and others.

3.2.5. Control

The final part is the Control phase where the task at hand is to maintain the gains there verified on the pilot basis in the Improve phase. This is achieved by assigning accountability regarding documentation, monitoring of the improvements implementation to ensure its long term sustainability. When the Control phase is complete, measures are in place to maintain the gains for the long term and the project is closed out. In the case of this project the control phase is outside the scope as mentioned earlier.

3.3. Research Methods

This section outlines the different data collection methods used in this particular thesis. This involves the interviews conducted which serve as the primary method for gathering qualitative data directly from the participants. It also includes the empirical data from the surveys and internal resources of the case company containing the information relevant to the research objectives.

3.4. Interviews

In this study, qualitative data collection was chosen due to the nature of the problem, which doesn't lend itself to specific quantitative metrics in PM. To explore inefficiencies or potential improvements in PM processes, semi structured interviews were conducted. Qualitative interviews in semi-structured format follow a structure where the researcher has a list of questions on fairly specific topics to be covered (Bryman & Bell, 2022). The interviews were between one to two hours each and were transcribed either manually or by audio recording. During the data collection the authors conducted the semi- structured interviews in three different stages which is explained below. The three stages of interviews enabled the author to have a robust understanding of what are the input fueling PM processes as well how it functions at large and in detail. The data collected during the interviews would later be used as primary input during various stages in the study which the authors discuss in the results section. In total four interviews were conducted using the case-companies own project management structure known as “Initiate, Plan, Execute, Control” (IPEC) phases in addition to their position in PM as guide for making the questions. The question focused on their position were as follow:
What do you do in the PM department? What challenges are you facing in PM? What is/is not working in PM? Have you worked in other positions in the PM? Have you worked in other departments? What would make PM easier/effective for you if changed?
The questions regarding the PM overall were as follows:
What is done in each IPEC phase? What is the usual duration of each IPEC phase? What are the challenges in each IPEC phase? What is not challenging in each IPEC phase? What is the skill set required to fulfill each step in each IPEC phase? What skill if absent will cause issues in PM? What would make PM easier/effective for the department if changed?

In total four semi-structured were conducted and four informal interviews were conducted. The semi-structured are spread across three stages of interviews conducted during working hours in a formal setting and were structured by going from the macro level in the first stage to the micro level and cross departmental in the second and third stages. The informal interviews were conducted outside business hours, usually around breaks and free time, in a casual manner to uncover insights for the same problems from potentially a different perspective.

Since many of the interviews were semi-structured it enabled each interviewee to speak freely after receiving a question leading to different spontaneous follow up questions from the authors which are not listed in text. This is because the authors were focusing on collecting the data in the form of answers for these questions which will then be used as input for the AIM.

3.4.1. First stage interviews

The interviews were classified into three different stages based on the when and who were the participants. In the first stage interviews, the authors interviewed one senior manager responsible for multiple market segments. The interview with the senior manager was conducted in order for the authors to understand how the PM process looks overall across the department and general issues affecting the entire department regardless of segment.

3.4.2. Second stage interviews

In the second stage of interviews the authors interviewed two managers, the first is responsible for the Marine/Navy segments and the second is responsible for the Transport segment. The interview with the manager for the Marine/Navy segments was to enable the authors to understand specifically these segments in PM regarding processes and issues faced in detail. The interview with the manager for the Transport segment was to enable the authors to understand the transport segment in the same amount of detail as the Marine/Navy segment. It was also conducted inorder to make a comparison between the segments to find out commonalities and differences in the processes and challenges faced. In addition to this, informal interviews were conducted continuously with both the project leader and manager for the Marine/Navy segments as well as the senior manager in order to assist the authors in the processes of extracting relevant data and interpreting them.

3.4.3. Third stage interviews

The final stage was to interview the sales department since the output from this department was the input of the PM. The authors conducted an interview with the bid team manager in order to understand what the sales handover to the PM and why. This was conducted to also know how the external factors could affect or potentially affect the PM. The data collected through the interviews were also later used in the define phase of the thesis to gain deeper insights and conclusions on the underlying causes of the problem. The authors also conducted an informal interview with the case company expert regarding data interpretation methodologies in order to support the authors in finding potential ways in analyzing data.

3.4.4. Quantitative data

The quantitative data collection was conducted through the primary means of surveys and data extracted from the Customer Relationship Management (CRM) system in place at the organization acted as the secondary data. The survey involved a self-administered questionnaire through online forms where the respondents answer the questions by completing the questionnaire themselves (Bryman & Bell, 2022). The questionnaire included the ordinal scale of measurement level to capture the perspective of the respondents. The ordinal scale reports the ranking of the data without determining the degree of variance among them capturing the quantitative information with naturally existing orders and how they vary is uncertain (Akman, 2023). The questionnaire also included a series of questions for which the respondents had a chance to give examples of certain situations or circumstances in order for a deeper understanding. The design of the questions in the questionnaire was two types of multiple choice questions with a "other" option that allows respondents to explain their choice that is not in the list in text. In the first type; respondents are only allowed to pick one choice, in the second type respondents could choose the options they think apply.

The questionnaire allows the respondents to consult with peers and note down the answer without the interviewer control which ensures the correctness of the answers is controlled by the respondent (Aini et al., 2018). The questions were designed to capture the perspectives of the respondents regarding the challenges that were uncovered in the initial stage of the study. The questionnaire consisted of nine multiple choice questions and two additional questions regarding the respondents position and experience. The survey was sent out to the division of Project Management in the marine segment which consisted of 12 members out of which 10 responses from varying roles were recorded.

Additional quantitative data was collected from the case company CRM system where the motive is to analyze the cost, time efficiency and other related factors of the selected sample. The sample chosen for the study was a particular department in the organization which was involved in the majority of the business. The survey conducted was in focus of all the personnel in the chosen department. The data extracted consisted of all the projects that were worked on by the same personnel which accounted for about 71 projects in the year 2023.The challenge with this is that there is no control over the quality of data which will affect the conclusion (Bell et al., 2022).

3.2.3 Data analysis

The data analysis is indeed something that occurs typically at the late stage in the overall process; however this does not mean one can postpone the methods to analyze the data till then (Bryman & Bell, 2022). The primary method for analysis involved leveraging the data analyzing software JMP to conduct multivariate analysis in order to understand how the different variables affect data (if they do) and also observe the relationship between them

(variables) visually. The second analysis is fishbone-diagram (C&E), based on empirical data, as well as input from the interviews in order to further expose what affects the main problem in question. The analysis conducted to identify the main problem in question was the AIM which was used to organize the input of the semi-structured interviews into problem statements. These statements were then clustered into main problem themes for the authors to focus on. The analysis conducted to identify the scope of the main problem was effective scoping in order to identify what processes to improve (identify input, output and how to improve). Some of the identified processes did not have sufficient quantitative/qualitative data so a survey was conducted in order to confirm the validity of quantitative/qualitative data when analyzing.

3.5. Ethical considerations

This section sheds light on the ethical initiatives undertaken by the authors to ensure integrity of the research process and credibility of the findings. The main ethical principles have been broken down into four main areas: avoidance of harm, informed consent, privacy and preventing deception (Bryman & Bell, 2022). The authors managed the data with utmost discretion and informed the participants how their data will be used to avoid any kind of harm for all the involved parties. The authors have supplied sufficient information about the study and observation techniques used, to ensure that the participants are willingly engaging in the research knowing all the risks and benefits. The third ethical criterion is the obligation to respect the privacy of the participants which was assured by providing an alternative of refusing to answer some questions for whatever reason they believe are legitimate. The authors have aimed to avoid any kind of deception by making study procedures completely transparent to earn the participants trust and faith.

3.6. Data trustworthiness

This study incorporates the concept of data triangulation and audit trails which involves employing multiple data sources which can enhance the credibility of the findings and by maintaining detailed record data interpretations along with analytical decisions allowing the transparency and accountability of the findings. This study also incorporates the concept of reciprocity where the idea is that the research should be of mutual benefit to the researchers and participants enhancing the trustworthiness of the data (Bryman & Bell, 2022).

The authors incur credibility of the study by incorporating the processes of triangulation. Triangulating means using several sources of information or procedure from the field of study to repeatedly establish identifiable patterns (Fossey et al., 2002). The methodology provides a thick description by which a rich enough portrayal of circumstance for application to others' situations in order to ensure transferability of the study conducted. The authors have relied on constructs like precision and accuracy in this research practice and also the study was constantly inspected by the peers by which researchers had to be careful with what was

recorded as fact and what was recorded as researcher's interpretive comments about the data. Through these measures taken by the authors, the study fulfills the different perspectives of the trustworthiness of the study such as dependability and confirmability as described by Fossey et al. (2002).

3.7. Discussion of Methods chosen

The chosen methods were suitable for efficiently gathering and analyzing data within the constraints such as availability of time and resources which allowed the authors to draw conclusions within the boundaries of the study. The semi-structured interviews that were conducted during this study were an effective data collection method which enabled the accumulation of information under the specific area of interest for the study. Its qualitative nature which offered flexibility allowed the interviewees to speak freely and delve deeper into the topic of interest. Although it had several advantages, the semi-structured interviews were dependent on the interviewee's ability and willingness to articulate their thoughts and experiences. Hence the data gathered through other empirical means such as surveys aided in this regard complementing the mixed method approach inculcated in this study.

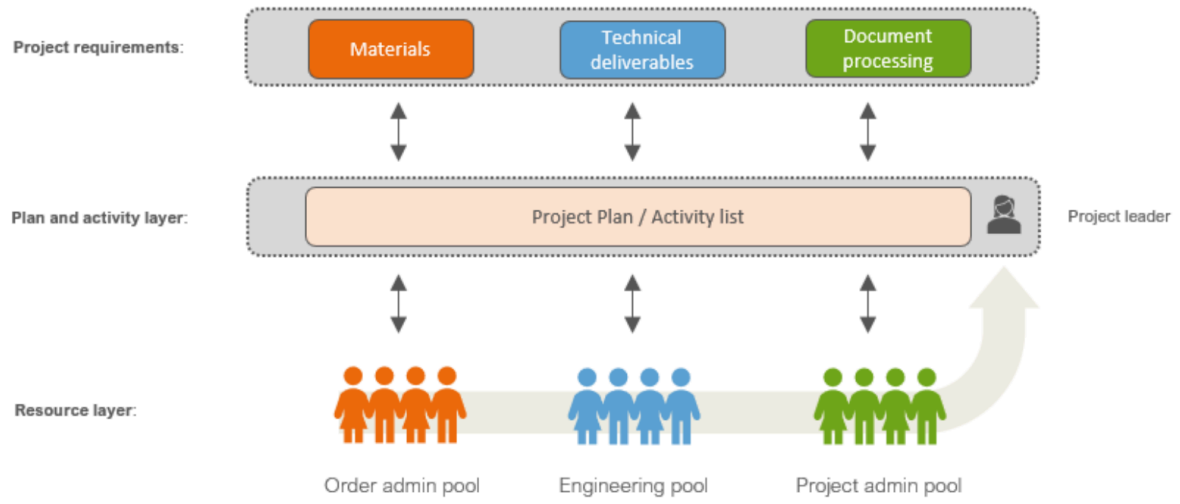
The DMAIC research design was adopted for this study for its effective problem solving capability with the structured five step approach. DMAIC is applicable to empirical problems running from well-structured to semi-structured, but not to ill-structured problems (De Mast & Lokkerbol, 2012). Taking into account the scope of the study, DMAIC is well suited for extensive problem solving tasks, requiring comprehensive components of problem definition. However, it is less effective for tasks with a smaller scope. Due to the nature of the study which starts with a broad perspective and eventually narrowed down over the duration of the study, the research questions evolved and adapted effectively. As a consequence the data collection was getting specific and deeper, seeing that the authors gained extensive information of the necessary areas.

4. Results

The main purpose of the Define phase in the Six Sigma Project was to gain a comprehensive understanding of the key problem description by utilizing a variety of tools and techniques to give an outline to it. By achieving a deeper comprehension, the analysis can be performed more effectively by identifying the root cause of the issue. A broader perspective of the Project Management department was gained through a series of interviews and observations. The initial interview with the managers from the Project Management division acted as the base for getting a clear insight into the day-to-day working of the division. This aided in differentiating the market segments within the division and also the different roles and their working procedure.

4.1. Project management at Case Company

The Project Management department at Consilium is divided into different divisions based on market segments and regions. The headquarters at Gothenburg contains the marine and transport division working closely with the administrative office offshore in India. Every division of the department is supposed to follow a structure working between roles of project engineer, project administrator and project leaders managed by project manager.



[Fig 1] Project Management structure at Case Company

The project layer model [fig 1] depicts how the requirements of the project are supposed to match with the existing resources based on effective planning by the project leaders. Elaborating on this, the requirements layer is the translation of the customers expectations for deliverables within the project which is typically identified in the initial phase. These specifications are subjected to change during the execution from a project change request which can be generated by either the customer or Consilium. The plan layer is the list of

activities broken down from the project requirements where the project leader is responsible for ensuring the activities are executed in accordance with the plan. Finally the resource layer is a specific or a group of resources that are assigned to carry out certain activities in the project.

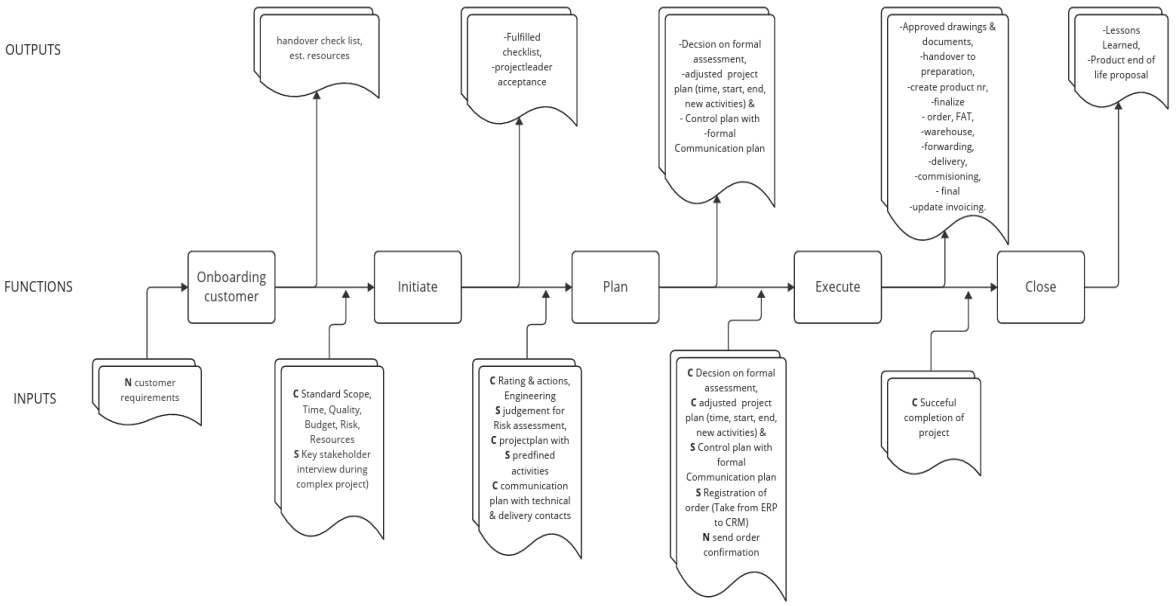
During the data collection the authors found varying ratios of different roles and competence subjected to specific market segments. The primary focus will be on the Marine division, where the current structure consists of one manager, nine project leaders and two project engineers, where the part admin work will be assisted by the Kochi office staff. Upon individually assessing the different divisions inside the Project Management, various patterns can be interpreted. A few divisions consist of a pattern where they function as an independent entity and in other divisions which consist of multiple segments collaborating with each other or some divisions where collaboration is completely restricted. The reasons why this can be observed may range from restrictions from the customer, specialized competence to high turnover rate in the department.

4.2. Process map

After completing the initial stage of defining the problem, authors developed a process map which acted as a visual aid for picturing work processes and helping align system elements in the same direction to allow process improvements (Curtis et al., 1992). The process map of PM was developed based on the information gathered by the authors from available documents on the flow of value chain in the organization's system [Fig 2]. The adopted structure in the (mentioned)shows a process map that identifies the flow of events in a process as well as the inputs (x's) and outputs (y's) in each step of the process. The process functions are the tasks that transform the inputs of the process into the outputs of the process. The inputs were classified into three groups based on its influence to alter the output, which are:

- Controllable (C): Inputs that can be changed to affect the output.
- Standard operating procedures (S): Standard methods or procedures for running the process.
- Noise (N): Things that cannot or that have been chosen not to be controlled due to cost or difficulty.

These classifications were defined based on the interviews in order to understand what factors could be influenced to bring about a change for improvement in PM.
The purpose of the process map with the mentioned structure was to identify the opportunities to improve the original process (Klotz et al., 2008).
The basis of the process map is adopted from the standard framework set by the Organisation's management for how a project shall be managed, regardless of segment or type of system, and covers the general activities that shall take place from the sales handover to aftermarket handover.

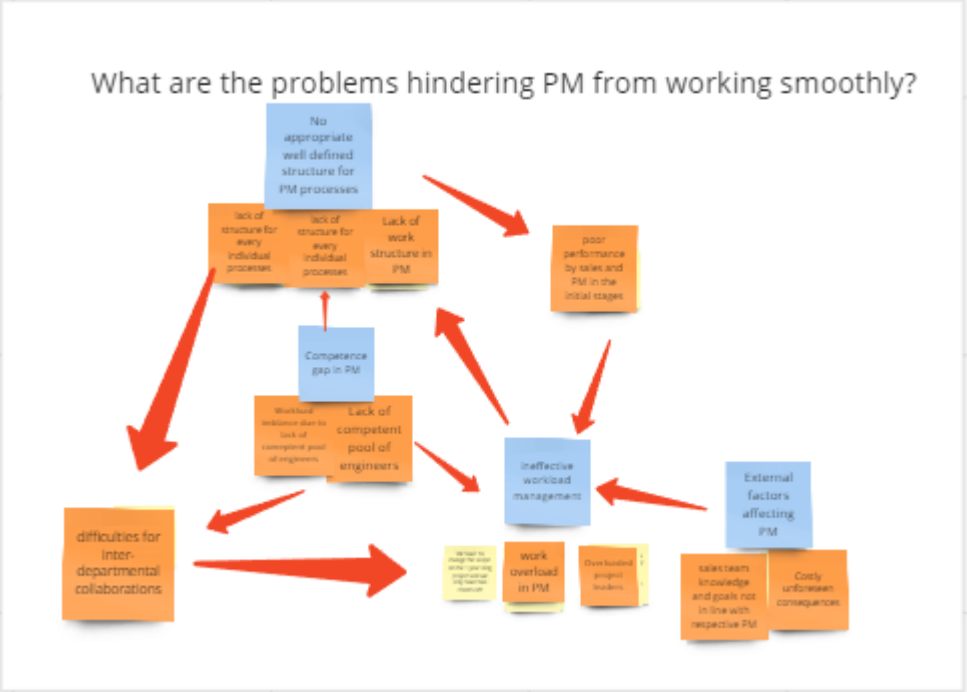


[Fig 2] Process Map of PM processes

The sales team starts off the process by onboarding the customer by making the list of all the requirements and resources, which is then handed over to the Project Management team. The manager of the particular market segment will appoint the project leader and engineer incharge of the project. Following this, the standard Initiate, Plan, Execute and Close framework is followed where the various steps in each stage differ based on the market segment, duration, complexity and requirements of the specific project. While all the market segments have the same standard operating procedures, the method in which it is carried out is specific to the individual in charge of the project. The inputs and the outputs mentioned are general in nature and are required by all the projects irrespective of the segment, which are essential in proceeding to the next stage. Every activity describes what the organization shall do to assure that the customer gets the value expected.

4.3. Affinity Interrelationship Matrix

AIM is a tool that is being used to find the underlying causes of a problem. It helps the researchers to have a pull thinking frame of mind and avoid falling into a push thinking frame of mind. In other words, keep pulling data to deeply understand what is happening and avoid falling too quickly into conclusion. This is crucial in order to avoid problem solving before the problem is properly understood.



[Fig 3] Affinity Interrelationship Matrix

During the Define phase in this case an AIM workshop (Alänge, 2009) was conducted inorder to expose what are the problems hindering PM from working smoothly at Consilium. An AIM is usually conducted with four to six people plus one or two AIM team leaders which in this case were the two authors of this report. These people are often picked from the targeted areas of a company, for example the PM department. In this case the people that were supposed to be part of the AIM workshop did not have the time to join in a lengthy workshop. This prompted the authors to interview all the stakeholders and conduct the AIM themselves using it as a data analysis tool to analyze the interview material. The authors read through the notes taken from the interviews as well as listening to the recorded audio of the interviews to extract valuable insights to form concrete meaning on yellow post-its during the AIM workshop. The authors then proceeded with clarifying the meaning of all the yellow post-it notes with a stakeholder in Consilium. Once all the post-it had a clear concrete meaning the authors started with the first level grouping which is grouping the yellow post-it notes in groups of two & three or lone wolves. The authors then added post-its in orange which they wrote titles on that were less concrete for the grouping of yellow post-its.

After that the Authors conducted a second grouping of two & three orange post-its or lone wolf and then added blue post-its and wrote on them titles that were abstract in nature. The authors got four major groups with blue titles and two orange lone wolves as the underlying problems hindering PM from working smoothly which can be seen at [Fig 3]. The underlying problems are as follows: 1. No appropriate well defined structure for PM processes (Blue), 2. Competence gap in PM (Blue), 3. Ineffective workload management (Blue), 4. External factors affecting PM (Blue), 5. Difficulties for inter-departmental collaborations (Orange) and 6. Poor performance by Sales and PM in the initial stages (Orange). Once the underlying problems were presented the authors proceeded with making arrows of cause & effect (C &

E) or contradiction. This was done in order to know the connection between the groups as seen in [Fig 3]. Once the connections were known the authors in collaboration with a stakeholder from the case company then voted on which of the orange post-its that were the most critical, second most critical and third most critical. The authors and the stakeholders each had three votes, a three point vote, a two point vote and a one point vote. The result of the voting can be seen in [Appendix A] which was that the most critical problem hindering PM from working smoothly at six points is the "lack of structure for every individual processes".Second most critical is shared at three points each between the "Workload imbalance due to lack of competent pool of engineers", "Work Overload in PM" and "Poor performance by sales and PM in the initial stages". The third spot had two points which is "Difficulties for inter-departmental collaborations". Since the voting was conducted with only one stakeholder and the authors there is a chance of missing out the perspectives of the other stakeholders. The Authors then concluded the AIM workshop with these final statements which can be seen at [Appendix A]

" The project management lacks a well defined structure and a required number of competent engineers. This causes poor performance in the initial stages, also influenced by sales leading to work overload. This also leads to the difficulty for inter-departmental collaborations, which prevents PM from working smoothly".

4.4. Effective scoping

Effective scoping is an essential tool that is used to make sure that project teams transition from traditional push oriented thinking for solutions to pull oriented thinking for more input before considering solutions (Carleton, 2016). This is because effective scoping helps in identifying the relevant inputs, outputs and all the relevant stakeholder for example who puts the input and who takes it for these two as well as identifying the small ys'. The small ys are measurable factors that influence the big Y (problem statement) that was identified in the AIM. Effective scoping achieves this by using the framework called "Suppliers, Inputs, Processes, Outputs and Customers (SIPOC)" which are the parts the framework is divided in. The SIPOC framework review on the processes on a deeper level, were it precise the scope of what the project will focus on regarding a through out a specific processes. This will help the project team develop a more complete process map in the measure phase of the project as well as identifying what small ys to measure. The effective scoping was executed by the authors alone, but has been reviewed by the case company supervisor. The objective for this effective scoping is to find the scope on what to improve in PM in the case company. The SIPOC framework for the effective scoping can be seen in this [Appendix C,D,E,F].

4.4.1. Procedure

The first part of effective scoping is to identify the output, customers, measures to be improved, baseline for improvement and constraints of improvements that cannot change, all of which can be seen in the following [Appendixes C,D,E,F]. The authors identified that the output of the process is “completed projects with no hiccups” and it is shipped from the warehouse[Appendix C,D,E,F]. The customers were identified as the case companies' end customers (external) as well as the case companies' production (internal) and also the eight improvement proposals for the big Y were identified [Appendix C]. The big Y is the main output of the PM, this output is affected by multiple variables/inputs known as small “ys' '. The small “ys” are usually measurable processes parameters that can be controlled or manipulated in order to improve the Big Y (Bañuelas et al., 2005). The small ys were identified & confirmed by the authors after brainstorming based on the data collected from the semi-structured interviews and AIM result. Four small ys were identified : “y1=the time difference between agreed delivery time by sales and the actual delivery by PM” , “y2=the difference between the planned work boundaries for each PM position”, “y3= the difference between available work potential and the executed work” and “y4= Amount of changes made in execution phase”. After this step all the other steps are repeated four times for every small y which will be described in the coming sections.
When dealing with broad problems with multiple factors (ys’), as in our case the problem statement (Y) derived from AIM, it is necessary to identify small measurable factors so a deeper investigation can be conducted on them. This enables the practitioners to get a thorough understanding of the factors and their behavior which will later on aid in uncovering the causes of their behavior.

4.4.2. y1: agreed delivery time vs actual delivery

It was identified by the authors that the baseline for y1 is that there is data regarding the agreed delivery time by sales and the actual delivery time by PM and that any improvements for this cannot cause loss of business. The jurisdiction for the project is that the solution is a recommendation, but the project team is not responsible for the application of the solution to the PM. This is because any changes to the PM in the case company will require more time and resources then what is set on for the project. The competences that will be needed based on the data from the semi-structured interviews and the results of the AIM-workshop are the “technical expertise for the sales”, “the awareness of the case company regarding the capabilities and potential regarding product design & delivery” and “ project engineers should be capable of taking any project”. This is because firstly when sales has the technical expertise it is assumed that they are less likely going to agree on a delivery date that is unsustainable for the PM to uphold. Secondly, when there's awareness throughout the company regarding the capabilities for product design and delivery it is assumed that the case company will be able to seek to take orders they are capable of and avoid those outside of it.

Lastly the engineers should be able to take on any order from the sales since it is their job and anything compromising that should be minimized. When it comes to the input it has been identified that it is “number of projects” and “list of technical specifications” both inputs have one supplier respectively. Supplier for the “number of projects” is the sales team who bring new projects to reach their sales goals and the supplier for the “technical specification requirement” for a project is the end customer who dictates what specification they want for their product. The inputs should be calculated with consideration to the workload capacity of the PM as well as their technical competence so they don’t work more than expected and with products outside their scope of expertise [Appendix A & C].

4.4.3. y2: Difference between planned work boundaries in PM

It was evident based on interviews that managers are taking on the role of an engineer and administration more than they are actually supposed to by calculating approximately (in%) the time managers allocate for non-managerial work. The solution that comes from this should not cause the loss of business, no outsourcing of work, no further delays in delivery and lastly it should not go against the wishes of the customers regarding product specification. The jurisdiction for this solution is that they are presented as recommendations and any implementation of them is in the hands of the case company. In order to solve this there must be universal competence across the case company regarding the jurisdiction of each role so that every employee knows what's their work and what's not based on the semi-structured interviews and the AIM-workshop. This is to reduce the difference between planned and actual work boundaries. The inputs for this process is the “working structure within PM” and ”availability of resources' ' both of which are supplied by the upper management. The inputs should consider the capacity and competence requirement for the work structure so managers don’t have to work as engineers or admin according to the semi-structured interviews and the AIM-workshop [Appendix A & D].

4.4.4. y3 : available work potential vs executed work

Based on the interviews with employees, they thought that they worked too much and that any solution for this problem cannot cause loss of business, outsourcing, delivery delays and can’t go against customer specifications. This solution is also a recommendation and any form of implementation is within the jurisdiction of the case company and for this solution to work the competence regarding work management needs to be better based on the semi-structured interviews and the AIM-workshop. The inputs for this process are “Projects” supplied by the sales team and “Availability of competent engineers” supplied by HR. The input should involve and consider all the stakeholders affected by the project in the decision

making. This is to prevent compromising the interest of any stakeholder according to the semi-structured interviews and the AIM-workshop [Appendix A & E].

4.4.5. y4 : Amount of changes made in execution phase

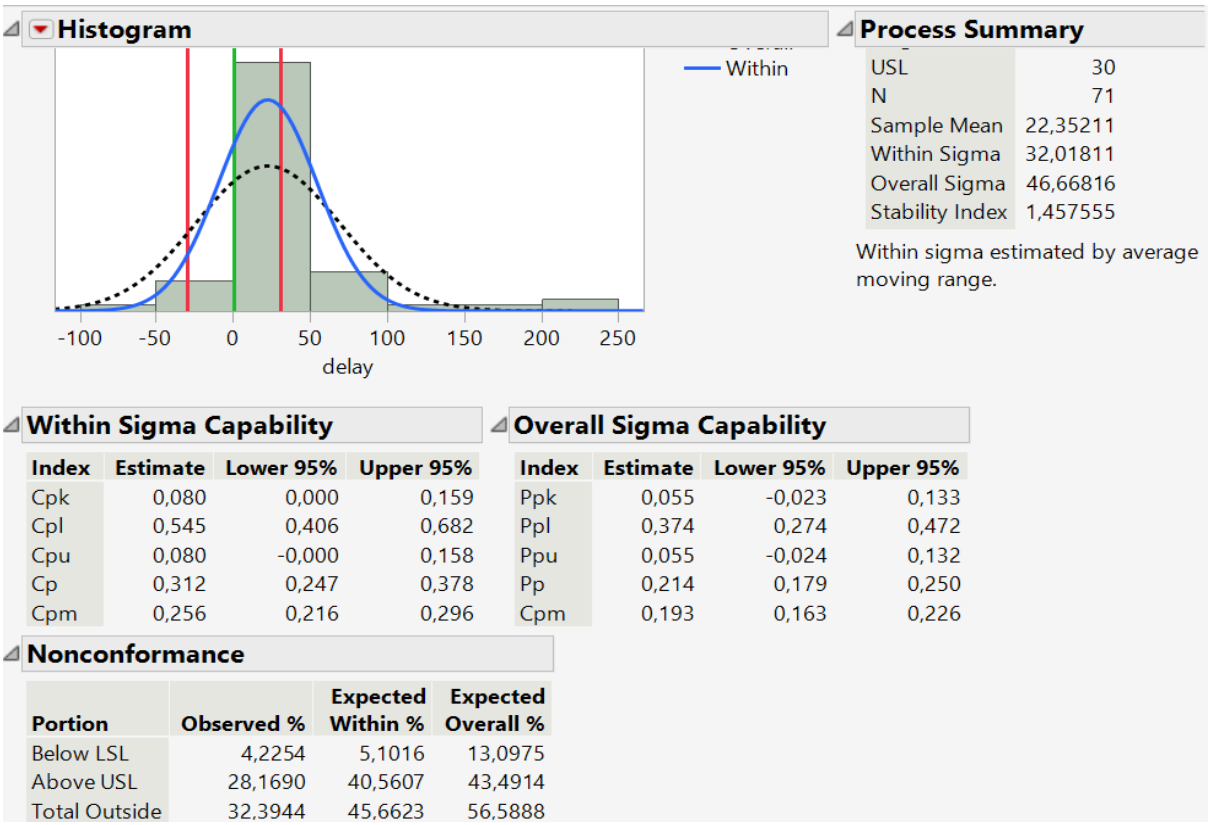
According to the semi-structured interviews, there are a lot of undocumented changes during the execution phase conducted on emails internally. The few documented in the case company lime database shows one or two changes, but the interviewees says it's an underestimated number [Appendix B]. These changes according to the semi-structured interviews cause extra costs and delays on the case company, but since it does not want to lose customers it does not transfer the costs to customers. The Case company requires that any solution presented cannot cause loss of business, outsourcing, delivery delays and can't go against customer specifications. The solution is a recommendation and any form of implementation is within the jurisdiction of the case company. The solution is a recommendation and any form of implementation is within the jurisdiction of the case company itself. The competence that will be needed to manage this problem is better communication between sales and PM according to the semi-structured interviews. The main inputs regarding changes for the execution phase are the "changes in technical specification for making product", "number of units (product)" and " less units (product)". The first input is supplied by the PM and the other two is supplied by the end customers. The input should have better handovers from sales and this is done by having better communication between sales, PM and end customer [Appendix F].

4.5. Analysis of the small ys'

As a result of the effective scoping the authors uncovered the four measurable ys' which were leading to the problem or big Y. In this section of the report, each individual y has been measured and analyzed further to get more insight in the problem and finally map out the potential root causes of the Y.

4.6. y1

The first y1 affecting the big Y is " The time difference between agreed delivery time and the actual delivery". This y explains when a project is supposed to be delivered to customers and when it actually is, after measuring the 71 projects in the [Appendix B] there was a significant gap between them as can be seen in the image below.



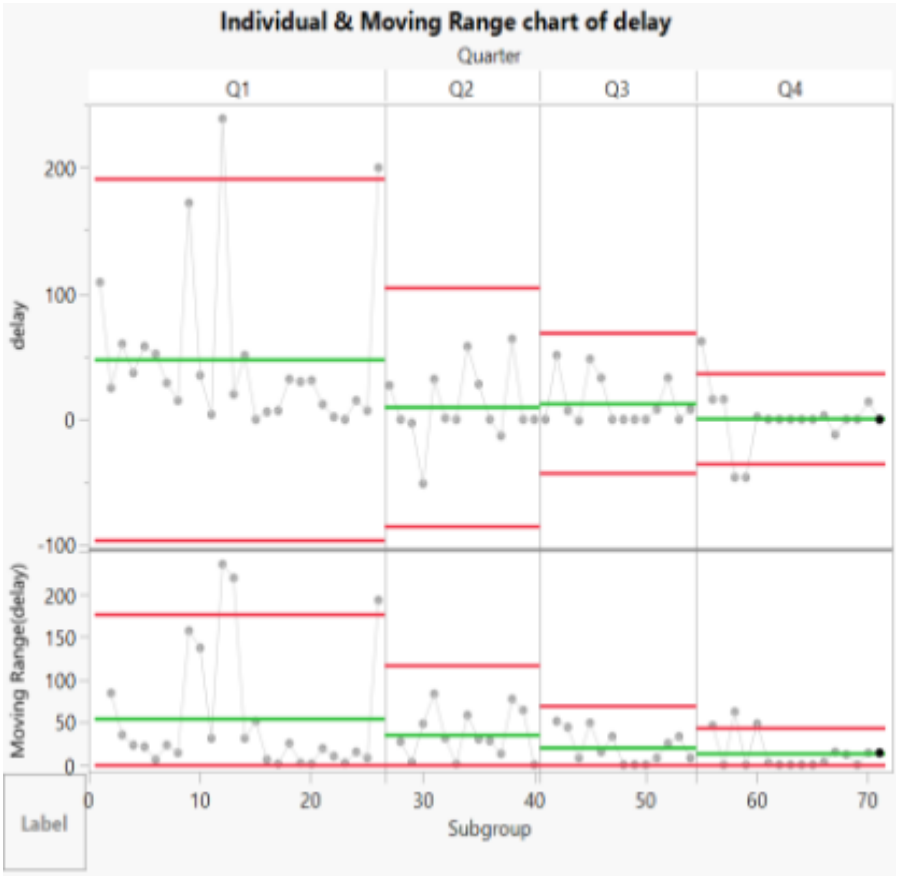
[Fig 4] **Graphical Analysis of y1**

The [Fig 4] depicts the process capability analysis, which has five windows that explains the CRM, the first window is a histogram that shows the distribution of the CRM data points

regarding delays. The 0 stands for a project being delivered as promised, anything to the right of the 0 is delayed and anything before is earlier than planned**.** The second is a summary of the data point values in terms of Upper specification limit (USL) (estimated limit of acceptable delivery postpone) which is set for 30 days, Lower specification limit (LSL) (estimated limit of acceptable delivery prepone) also set for 30 days. The reason 30 days was chosen was because usually the project duration lasts for years and the customers require the product delivered within the promised month irrespective of the day. The data points (N) for this sample is 71, Sample mean is the average value of this sample. The value within sigma is the short term estimate of sigma which is around 32, Overall sigma is the long term estimate of sigma which is around 46,7 (Walsh & Lancaster, 2015). The Stability index divides "overall sigma" with "within sigma" (Overall sigma/value within sigma) (*Stability Index*, 2023). The third and fourth windows respectively focus on "Within Sigma Capability" shows the short term capability of a process Cpk (Cpk = Process capability) and "Overall Sigma Capability" which shows the long term performance of the process Ppk (Ppk = Process performance) (Hessing, 2024), (Admin, 2022)(Carleton, S.A, 2016). The last window "Nonconformance" shows the percentage of data points that are above/ below the specification limit in separate and combined values (*Calculating Capability Indices Using the Distribution Platform*, 2021).

The image shows the low capability and performance of the PM processes when conducting projects at the case company according to the analysis of sampled data. Since most data points tilt to the right of the green line as well as the red upper specification limit (USL) with an average delay of more than three weeks. According to the Carleton, S. A. (2016) for a process to be considered good in the short term and long term it needs to have both an Cpk and Ppk of around 1,5 , but in this case it's 0.08 and 0,055 respectively [Fig 4] (Mapue, 2018) . This means that the delivery of the PM is subpar to customer expectations when it comes to delivering according to schedule.

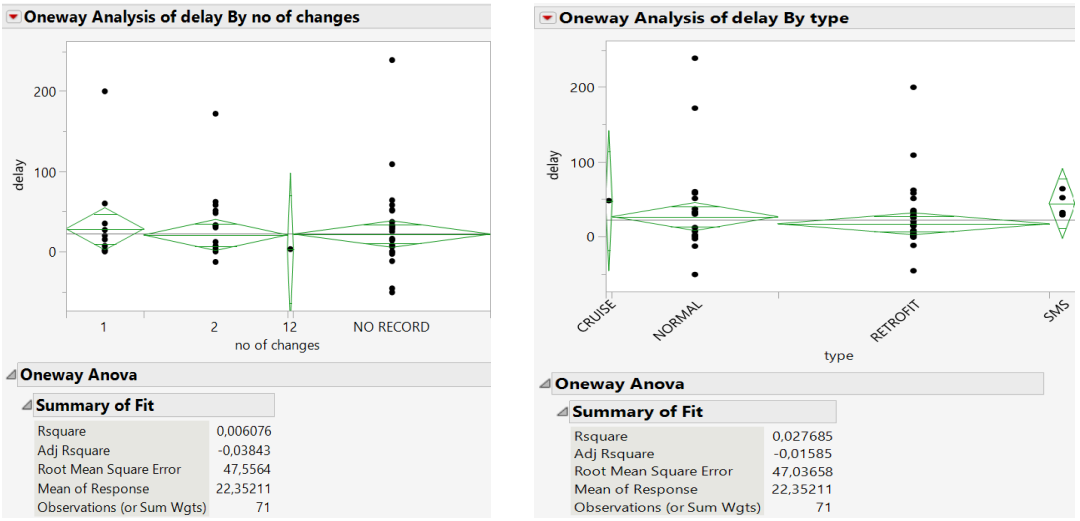
The delays could have been caused by one or multiple causes, therefore the authors made a multivariate analysis on JMP with these factors: delays, shipping date (planned), delivery date (Actual), number of changes, type, status, delay and Time of the year. Out of all these factors analyzed, the time of the year showed a prominent effect compared to others on the delays. The analysis [Fig 5] shows that most delays and the longest delays were in the first quarter of the year with improvements in the time delivery for every quarter. The volatility in the beginning of the year and successive stabilization at the end of the year as can be seen in the image below, could potentially mean that the PM pushes projects until next year which causes the extreme delays in the first quarters of years.



[Fig 5] Time factor influencing y1

These delays in the early part of the year could also potentially be caused by processes changes in PM which usually means a slower execution of work. Another cause could be the restructuring of teams in PM, because of new employees joining and old/experienced employees leaving the job which causes change in team dynamics, competence level and work redistribution.

Apart from the extreme delays in the first quarter of a year the analysis showed that different "project types" and "number of changes done to a project" have differences in the average delays as can be seen in the images below.



[Fig 6 & 7] No of changing and project type influencing y1

The analysis [Fig 6 & 7] shows that the two project types with greater number of data points "Normal" and "Retrofit" had a slightly lower average of delay in project delivery. The number of changes done to a project did seem to affect the average delay. However the category of "No record" has the greatest amount of data points which also lacked information regarding changes done to the project. This could mean a lot of undocumented changes have been done or none. The authors observed in both "2 changes" and "No record" that some projects were delivered before their shipping date as well that the project with 12 changes was only delayed with three days which could give a small indicator that more changes increases likelihood of less delays. This can be seen in the image above about both aforementioned categories having lower average delay time than the category of "1 change". However since the "No record" is an unknown variable no clear conclusion can be taken it's more of an indication of a potential source of the delay.

In conclusion the potential causes identified by the authors of the delays are primarily the extreme delays in the first quarters of a year, secondary the project type and number of changes done in the project.

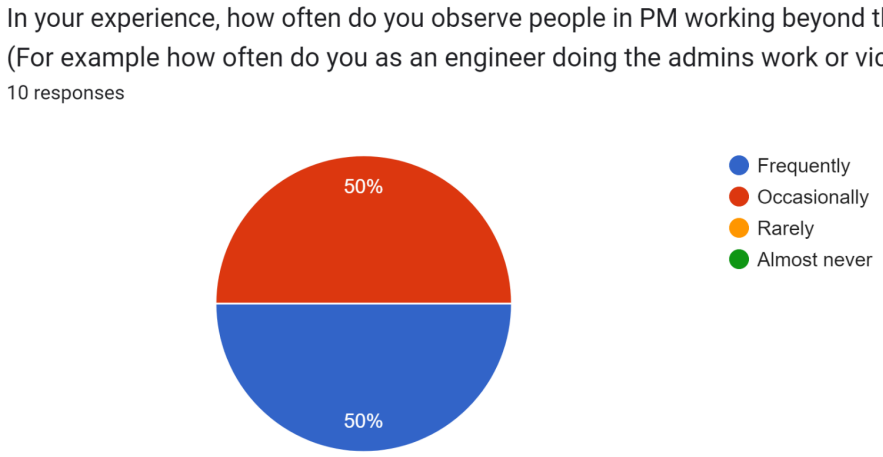
4.7. y2

The second small y impacting the big Y is "The difference between the planned work boundaries and the actual work boundaries". The difference in focus is how the work involved in an individual project is divided between the different roles in the department. Currently there are four different roles in the department which are the manager, leader, engineer and administrator. Upon investigation, there was no clear description found on who the process owners were for all the tasks involved in completing a project. Although it was evident that, the lack of these boundaries was creating a state of confusion and frustration in the employees as expressed in the interviews conducted by the authors. One of the possible

ways in which the authors could have measured this was through tracking down the individual process owners of all the tasks completed in the project and comparing it to the expected boundaries. This method was not possible with the current data recording system present at the organization in interest. The observations also uncovered that the major tasks of a role were clear to every individual but many of the tasks overlapped between different competencies.

To gather further evidence, the authors conducted a survey focusing on the larger growing department based in Sweden of the organization in interest. The survey was designed based on ordinal scale which is the second level of measurement for research purposes to understand the higher or lower value of the data set (Chaudhari, 2021). The first question was focused on the frequency of the existence of the problem in question.

The respondents were asked to choose the frequency of the employees working beyond their work boundaries, which they had observed in their experience working in the department. As observed from the results obtained in [fig 8] it is evident that all of the respondents, which makes up the majority of the people in the department, have observed employees doing tasks outside their boundary more often. Since the value is in the higher data set, providing clear evidence into the existence of the problem.



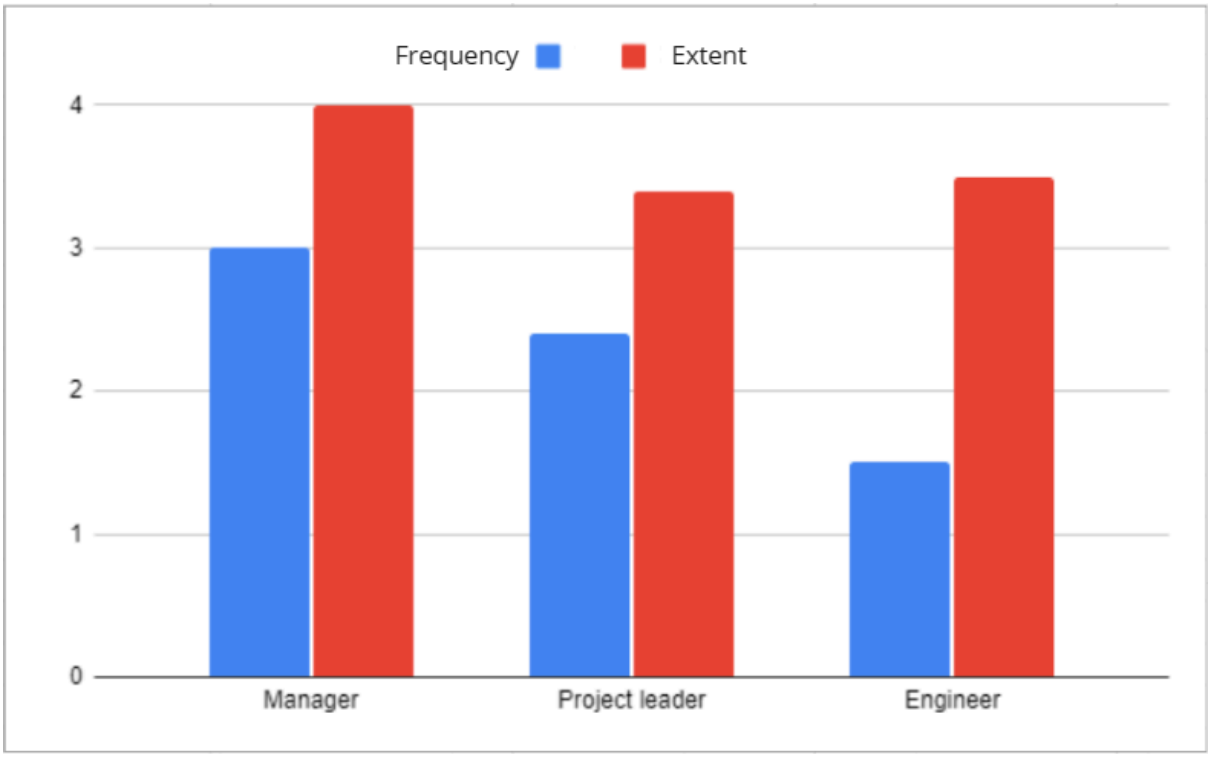
[Fig 8] Survey results of y2

The second question [Appendix I] was framed in order to understand the deviation of the problem from the expected setting. The respondents were now asked to estimate the extent of the difference between the expected work boundaries and the actual work boundaries that exist in the department.

As observed from the results obtained [Appendix I] which shows a spread of the value in the data. Curious of the results, the authors decided to take a look deeper into the results and found out that all the engineers responded chose the option minimal or moderate. Whereas all the managers responded with significant difference indicating noticeable deviations while the

project leaders vote was split between the higher and lower value in the data set. Analyzing this variation the authors made a possible assumption for this effect would be that, as the experience in the department along with the title grows the work boundaries gets more blurred as depicted in fig. The results taken from the second question which is regarding the extent of how far the additional work is beyond their own role, we see consistency in the responses; meaning people working in every role feel they are working far beyond their own role related tasks [Fig 8].

Summarizing the results from the survey, it is evident that there is a higher frequency of employees working out of their scope and extent of the scope of work increases with growth in the department as depicted in [Fig 9].



[Fig 9] Analysis of Fig 8 and appendix I

The evidence regarding the particular y is subjective in nature and can vary with perspectives based on different titles and authors had to find another means of proving the existence of the problem. In order to achieve this the authors decided to collect an estimation of the tasks available in a project for different roles in the department. Since there were no clear process owners for each task this way of estimation was adopted.

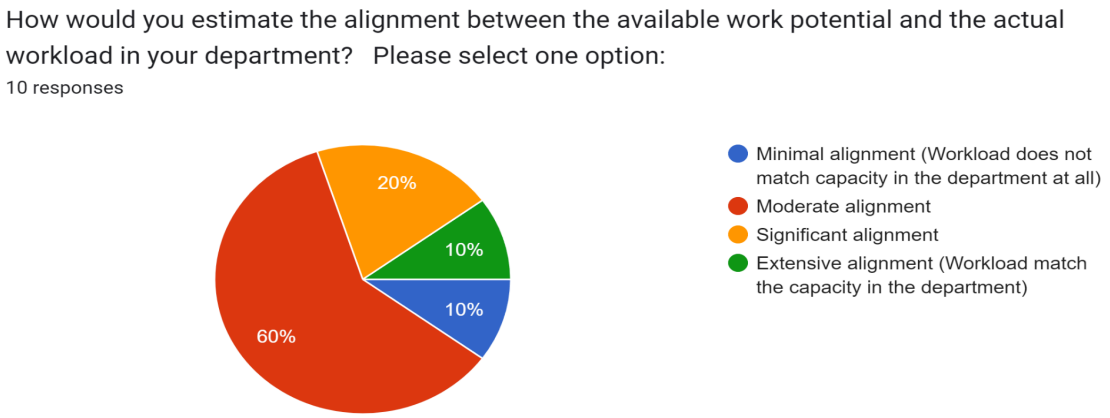
To continue with this calculation the authors chose one particular department within the Project management division which consisted of ten project leaders and two engineers where one of the project leaders was also the manager of the division. When asked about the rough estimation of the percentage of tasks available particular to the leader and engineer role in a single project the respondents from different roles gave the same estimation of 30% to 40% being the project leaders work while the rest is engineering work. While comparing this to the existing personnel count in that department it was found out that there is 83% of project

leading potential from the 10 project leaders and 2 engineers accounting for the 17% of engineering work potential. The effect of discrepancies proven from the surveys conducted can be confirmed with this imbalance ratio of personnel in the department. The imbalance of having a higher number of project leaders where an individual project consists of a higher number of tasks to be achieved by the engineers is causing the project leaders to conduct the engineers' work which is out of the scope of the position.

4.8. y3

The third measure or the third small y which scope the project and drive further exploration for improving the big Y which is the overwhelmed state of the PM department is being discussed in this section. Recollecting the measure which was mentioned earlier at the end of Effective scoping was the difference between available work potential and the executed work. This particular measure is very subjective in nature as it talks about how many projects can be worked by a certain number of people in the department without overworking them and causing them stress or frustration. It is a very prominent measure as it was raised numerous times as the cause of the overwhelmed state of the department, hence it is vital to prove its existence through substantial evidence.

The authors had framed a question regarding the available work potential and executed work where the respondents had to pick an option on a four point scale based on their perspective on the alignment of work potential to workload. This refers to the amount of work that can be produced by the employees in the department without overwhelming them and the amount of work that is in the department to be executed. The results of the survey can be observed in [Fig10].



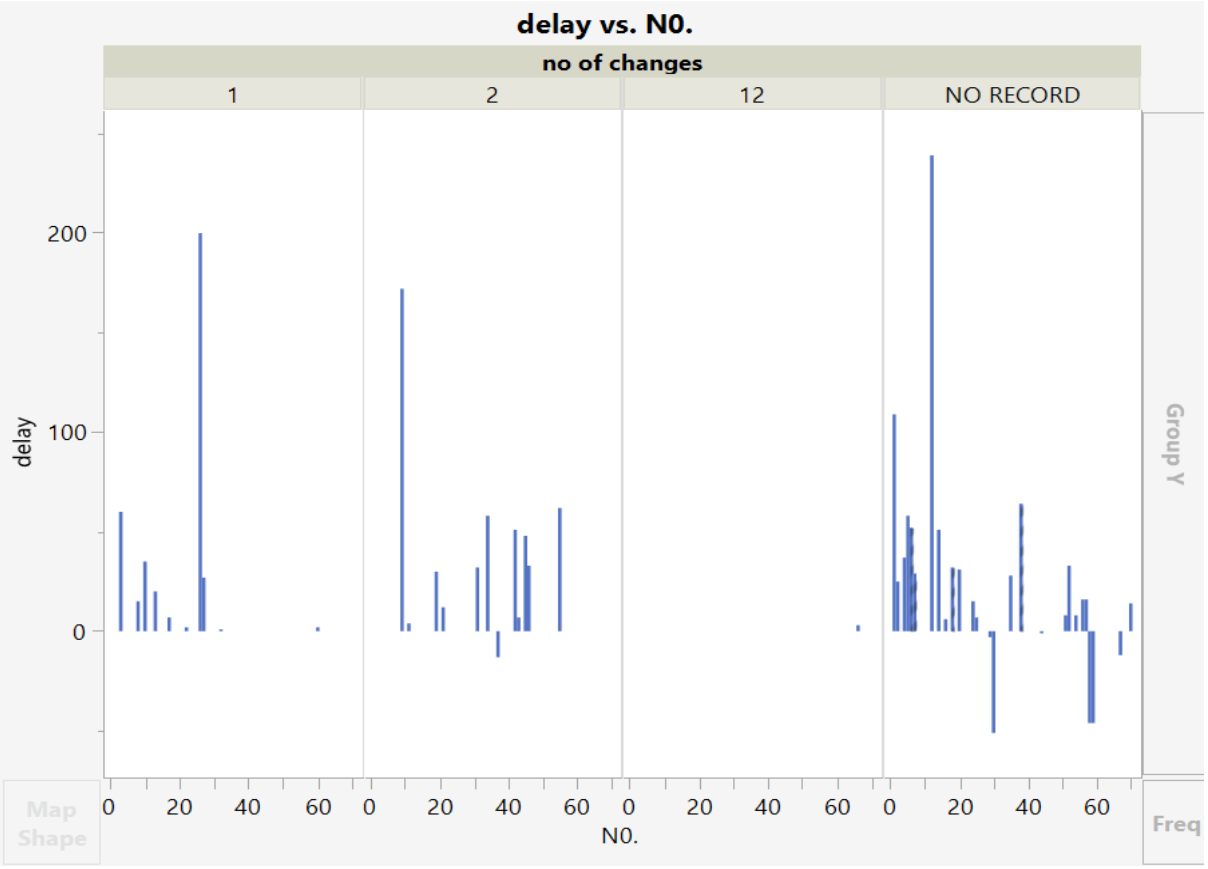
[Fig 10] Survey results of y3

Analyzing the results from the survey which clearly shows a seventy percent of the responses have higher value in the data indicating the majority of the respondents estimate there is minimal to moderate alignment workload. While this higher value was chosen by all the project leaders who took up the survey and the lower value where thirty percent of respondents chose significant to extensive alignment consisted of managers and engineers working less than an year. This is a very interesting trend because every PM department consists of project leaders as majority in number who are in a position between an engineering and manager on the growth scale. It can be presumed that the possible reason for this trend would be because, as proven earlier in y2 where the work boundary is blurred is prominently affecting the project leaders due to the work leakage from both the sides.

To further explore the measure the authors tried to conduct a quantitative analysis. This started off by calculating the total available working hours of a particular PM division which was 19200 hr/yr. The authors started to look for specific project dates to estimate the total number of time spent by the department working on projects. Although the project completion date was found on all the delivered projects there was inconsistency in recording the initiation date of the project. However, a few projects did have an initiation date, so now the authors had the exact time spent on five projects whose average time was 710.8 hrs.Using this to estimating the total time spent on all the completed in 2023, where 71 projects completed and average the 5 random projects from this is 710.8. Total estimation of time spent on 71 projects is 71*710.8= 50470 hrs. Comparing the available work hours which is 19200 hrs and accomplished work of 50470 hrs, it was evident that data recording method had numerous noise factors and it would be not possible to quantify this measure with the current data recording method in use at the organization. The current system does not segregate the time spent by the project in idle state while waiting on external factors and also does not differentiate the time spent by different departments. Due to the mentioned reasons the analysis obtained from this particular measure will not serve as hard evidence rather it intends to shed light into the problem.

4.9. y4

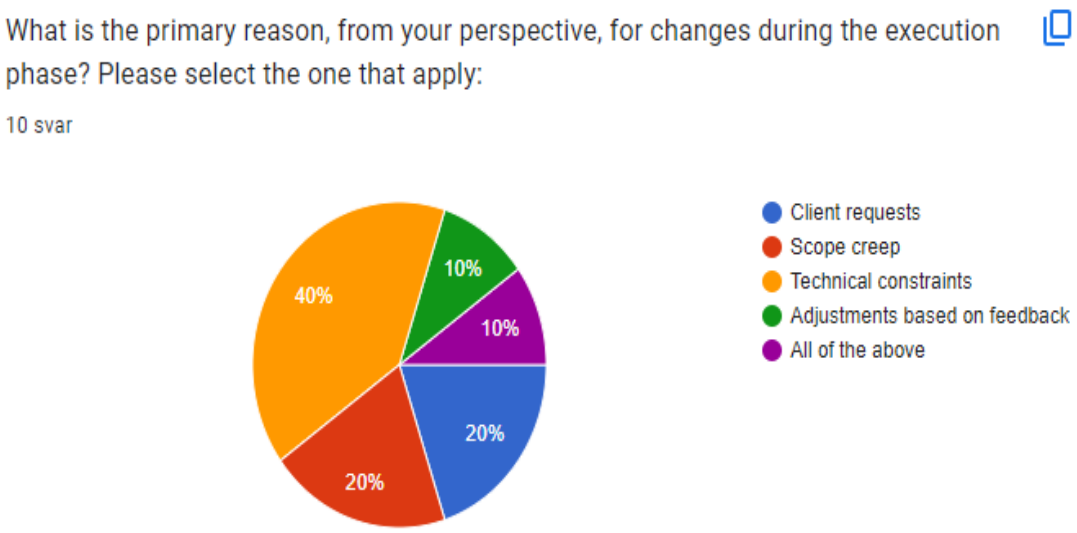
The last little y affecting the big Y is the “Amount changes made in the execute phase”. Although the amount of changes done to the project was mentioned in how it affects the shipping date compared with the actual delivery date. That was done in conjunction with other factors and it gave a macro view on how it affects the delivery time, but here the “number of changes” will only be analyzed with the “delay” as well as being complemented with the results from the questionnaire.



[Fig 11] Graphical Analysis of changes affecting delays

When the authors were analyzing [Fig 11] they observed a large disparity between individual projects in every category of "Number of changes". This was an indication that although the categories of "2 changes" and "No record" had a lower average delay than "1 change" the micro level focus shows it depends largely on every unique project rather than the number of changes. This was based on the quantitative data collected which the authors did not consider sufficient since 33/71 collected data points as can be seen in the table at [Appendix G] belonged to the "No record" category of changes which as previously mentioned was an unknown variable.

Therefore the authors decided that the input from the questionnaire will complement the quantitative data as can be seen in [Appendix H]. Where 9 out 10 respondents experienced frequent or very frequent changes in the project which potentially indicate that many of the "1 change" and "2 changes" categories have changes not registered in the case company database. This could mean that the data regarding the number of changes done in a project is wrong and can not be trusted. This also means most likely that the "No record" category also has many changes that are not registered in the case companies database as well. This will make it challenging for the case company to identify improvements opportunities regarding "Number of project changes" since a lot of the data is not in the database, it was also mentioned by case company representatives that many of the changes are mentioned in emails and not collected making it difficult to trust data. But in the questionnaire the main cause for change is technical restraints which was the answer of half the respondents (40+10)% as can be seen in [Fig 12] below.



[Fig 12] Survey results of y4

The other two equally sized causes for change are the Scope creep and Client requests (20+20)% respectively. Since the changes are usually requested by either internal stakeholder or external customer. One could speculate that changes done to the project which affects only internal stakeholders might not get registered for example the technical constraints. While changes requested by the customer (external stakeholder) might be registered since it affects the agreements. This is just speculation since there is no data on proving or disproving it.

Concluding, the number of changes in the quantitative data misses a lot of data points, but is complemented with qualitative data which indicate that the company needs to reassess how it collects data regarding project changes.

4.10. Fishbone-diagram

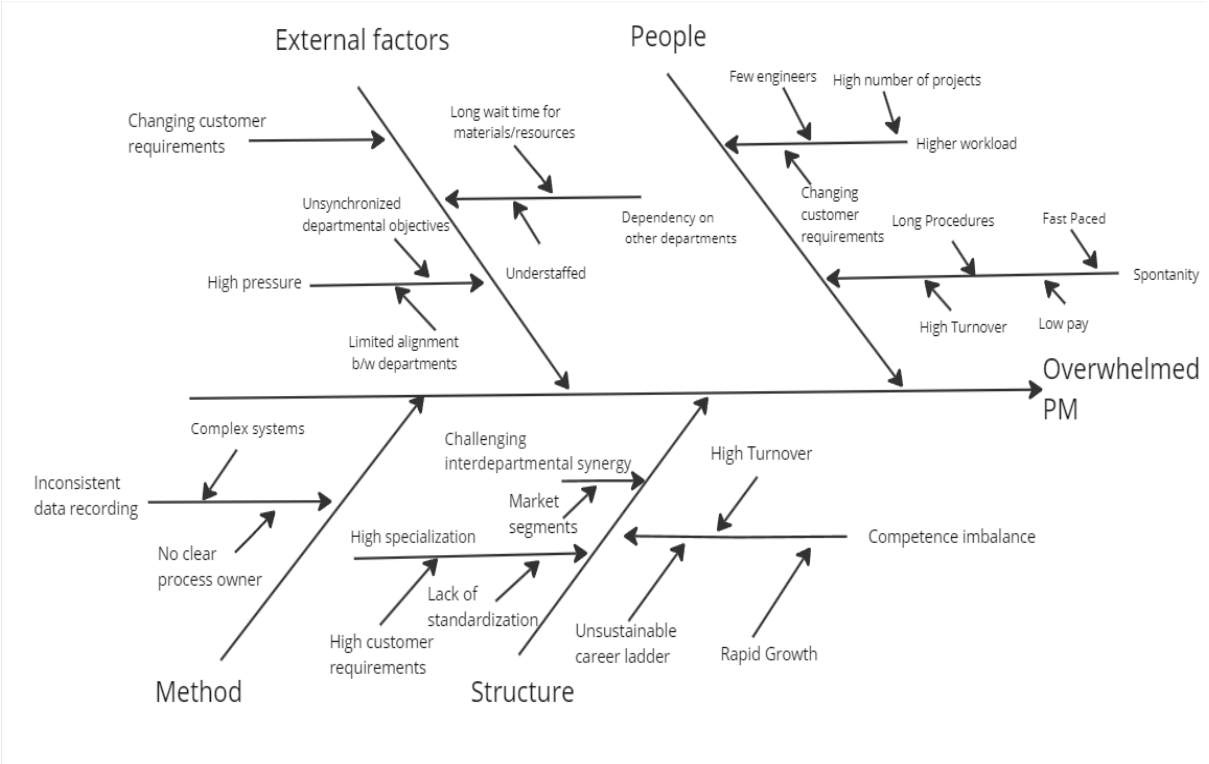
Heading towards the final stage of analyzing the data the authors now had to identify the potential root causes and assess the effect of them with the data. One of the possible ways in which this can be carried out was through mapping the cause and effect. The cause-effect chart (Fishbone diagram) is a method for the analysis of complex problems that present several interrelated causes. The data to perform this analysis was the insights the authors had gained throughout the duration of research till date through interviews, surveys and data measurements which was translated into the cause-effect [Fig 13]. The method uses a combination of visual representation (branches) and brainstorming techniques for obtaining the causes (Loredana, E. M. 2017).

The structure of a fishbone chart makes use of arrows or branches where:

-Primary branch represents the effect

-Major branch corresponds the major cause

-Minor branch corresponds to the causative and more detailed factors.



[Fig 13] Fishbone diagram of potential root causes

The main effect was chosen to be the overwhelmed state of the Project Management department as it was wide enough to include all the variety of problems in the department. The investigation into the overwhelmed state of the Project Management department exposes a complex web of interconnected issues. The main four categories of causes were chosen to be People, Structure, Method and the External factors. At its core, the primary cause appears to be the strain on personnel resources. This strain manifests in various ways, including a

higher workload stemming from a shortage of engineers, an abundance of projects and the continuous flux of changing customer requirements. Furthermore, the work environment's spontaneity exacerbates the situation, characterized by its fast pace, lengthy procedures, insufficient compensation and high turnover rates which collectively disrupt team cohesion and productivity. External factors compound these challenges with dependencies on other departments often leading to delays due to understaffing and prolonged wait times for necessary materials and resources. Moreover, The high-pressure environment, driven by unsynchronized departmental objectives and limited alignment between departments which further intensifies the branch. Looking into the methodological issue, such as inconsistent data recording, attributed to lack of clear process ownership and complex systems which in turn contribute to the department's overwhelmed state.

Analyzing the environmental aspect where the structural deficiencies, including competence imbalance caused by rapid growth, high turnover and an unsustainable career ladder. Alongside with the challenging interdepartmental synergy influenced by market segmentation and high specialization causing the lack of standardization in the way of working which further compounds the problem. In conclusion, addressing these multifaceted root causes is critical to alleviating the overwhelmed state of the Project Management department and enhancing overall efficiency and project outcomes.

5. Recommendations

Upon the completion of the analysis of data leveraging the use of fish bone diagrams and other analysis techniques, several potential root causes were identified. Based on the comprehensive analysis of the challenges faced by the PM department within the growing SME, some strategic recommendations emerge to address the identified issues effectively. Primarily, the strain on the personnel resources and structural deficiencies stands out as the central issues, necessitating initiatives to be taken. The primary improvement initiatives recommended by the authors is to start by categorizing the different tasks in the project process based on the sequence and competence along with resources required for the tasks. The next step would be to assign specific designation intended to accomplish the categorized group of tasks. By establishing this, there will be a clear and transparent division of the work which in turn will reduce the work leakage. By estimating the duration of each categorized task from past data, the required number of personnel in each designation of a department, based on the overall number of projects, can be calculated. This enables them to develop a structured and sustainable career ladder with room for adaptations to different stages while SMEs are in the process of continuous growth.

Furthermore, addressing methodological issues, including inconsistent data recording which also made it difficult for the authors to extract the required data, can be resolved by developing standard data recording procedures. One of which can be categorizing the tasks and assigning process owners for each category identified, as mentioned earlier. By segregating as mentioned, and assigning process owners who ensure all the relevant information along with documents and time taken to accomplish the tasks; traceability and retractability can be achieved. The record of time taken to accomplish each category of tasks can be useful in analyzing the bottle necks and the overall performance of the project. Once there is enough data, it can be further used to predict the estimated duration of the future projects containing similar factors.

Product oriented SMEs can be of either standardized products or customizable products based on customer demands (Allen et al., 2008). When looking into the customized product oriented SMEs, the questions are raised regarding how do you collect customer requirements, how involved is the customer in the design process, and others. In this particular case company the customer was involved throughout the design process with continual change requirements on several occasions. While this may provide a satisfactory product, Allen et al. (2008) states that “as the number of meetings increases, the quality and value of meetings can have a direct impact on an organization's bottom line in the form of wasted time and effort”; which could be seen in the form of irregular documentation of changes or delays in the product delivery and other such effects. To tackle this issue the authors recommend a structured way of meetings in different stages of the project ensuring the fulfillment of both

the customer and organizations' requirements. The authors propose a three meetings approach where the first one is a more elaborate one involving all the stakeholders such as the sales, project management and the customer. The second one will be held right before the execution phase between the PM personnel and customer where the initial specifications are reviewed and changed if necessary. The third and the final one will be held during the design phase where the PM and customer review the proposed design and the list of specifications before proceeding to the production.

including, the proposed recommendations offer a strategic approach to address the various challenges encountered by the Project Management department. The recommendations aim to enhance overall operational efficiency, streamline processes and foster collaborations between the stakeholders. By strategically implementing these recommendations to ensure continuous improvement, the organization can effectively navigate the complexities of project management within the rapidly growing environment. In the long run these improvements will ultimately aid in facilitating the achievement of ambitious organizational objectives.

6. Discussion

In the case report the authors have conducted a literature study regarding PM in product based SMEs and what challenges it faces, as well as searching through the literature regarding ways to overcome and improve it. The authors then went ahead to define, measure and analyze the challenges that exist in the PM of the case-company to answer the RQ1. This was preceded with the development of general recommendations that the case-company and other SME could use to overcome the challenges in PM in line with RQ2. In this chapter of the report, the authors discuss how the results and challenges found in PM for the case company relate to the literature.

When looking at the first RQ1 that talks about major challenges for PM in SMEs it was important to understand how PM is structured in the case-company.
The PM in the case-company as mentioned in the results was based on 4 main groups working in a project: The project leader, engineers, resource administrators and documentation administrators. After receiving an accepted project from sales through the bid team the project is initiated with a formal agreement and the project directly enters the planning phase. In the planning phase the resource administrators plan for the resources for the project, the document administrators prepare all necessary documentation and the engineers prepare all the technical requirements. This was done in order to enable the authors to see who the stakeholders are and what they do in PM in the Case-company, because Beringer et.al. (2013) suggest that both research and practice agree that stakeholders play a crucial role in PM. Yang et al. (2011) also suggest that stakeholder involvement is important to project outcomes. In order to understand where in the PM structure the challenges exist the authors identified the inputs and the outputs of all the stakeholders in PM by making a process map. This is because a process map as mentioned earlier exposing the inputs will expose all the influencing factors in the PM. The inputs influencing the PM are the three types N,S and C which existed in all PM phases. It was only C that could be changed easily, but one of the customer requirements which was a noise factor (N) can't be changed, but the authors realized it could be contained. This led to suggesting the recommendation of putting raistrains on it since that N was constantly changing throughout a project which is not in line with the mapped out process map. Although customer requirements are set from the beginning of a project the reality in the case-company the customer influencing was constant throughout the project since the case-company had extensive contact with the PM changing their requirements which meant too much noise influencing the project. Beringer et al. (2013) further mentions that the stakeholder effect in a project is phase-specific which means it increases or decreases depending on which phase in the project, but in the case-company the noise from customer requirements did not decrease regardless of phase. This meant that the noise factor influencing the PM would be too considerable which potentially would make it challenging to introduce any improvement. It indicated that limiting the influence of noise

factors in the PM was a way to overcome some of the challenges which partly answers the RQ2. Since the case-company is an SME, it could be added one way of overcoming the challenge of N is by limited jurisdiction as in this case where the recommendations limit the meetings regarding customer requirements. However (Beringer et al., 2013) talks about organizations in general which could indicate that SMEs are not much different from larger organizations regarding influences from stakeholders. However, since the approach to improve PM is about Pull thinking an AIM was conducted the results of which showcased the underlying causes of these challenges which showed four blue themed titles and two orange [Appendix A]. Two seemed a bit connected with the process map: the “External factors affecting PM” and the “ Poor performance by sales and PM in the initial stages” . The former in its sub-sections talks about the unforeseen consequences where it mentioned that the PM can not turn down any offers from the customers out of the risks of losing the customer. This could indicate that the reason customers can change their requirements freely throughout projects could be because the PM does not want to upset customers hence preventing them from canceling the offer. However in the latter it is mentioned that the poor performance is due to misunderstanding of customer requirements which could indicate that the changed customer requirements are due to the PM not understanding the initial requirements hence the back and forth communication. This should not necessarily mean that it is one or the other both could be valid. However, the former in the cause and effect arrows shows that it is the underlying issue of another theme “ineffective workload management” while the latter is caused by the “No appropriate well defined structure for PM processes” [Appendix A]. When looking into the “ineffective workload management” the authors saw that the challenges facing PM were “overloaded project leaders” , "Work overload in PM” and late changed customer requirements. The “overloaded project leaders” is because of the long term contact with the customers even after product delivery and lack of proactivity from project leaders. Having to keep in contact with the customer even conducting new projects could potentially consume valuable time preventing the project leader from being more proactive. Add to that the late changes required from the customer in a one year long project and it becomes quite reasonable that both PM and project leaders are overloaded with work and have “ineffective workload management”. The “ ineffective workload management” in the case-company has some alignment with what Ogrezeanu et al. (2019) mentioned regarding the managerial inefficiencies in PBO. Ogrezeanu et al. (2019) mentions the inefficiencies are in the form of project leaders failing at prioritizing human resource planning due to overworked project managers who are managing multiple projects at the same time and have to manage current issues instead of future planning. The “ineffective workload management” in the case-company was in-part contributing to “No appropriate well defined structure for PM processes” which in turn is the sole cause for “ poor performance by sales and PM in the initial stages” [Appendix A]. This shows that going back to the process map that the N factor changed customer requirements is the “External factor” that causes the chain reaction of “ineffective workload management” in-part causing “No appropriate well defined structure for PM processes” causing “poor performance by sales and the PM in the initial stages” [Appendix]. The “ineffective workload management” in the Case-company is also caused by the “Competence gap in PM” this is due to “Workload imbalance due to lack of competent pool of engineers” and “Lack of competent pool of engineers” [Appendix A]. The

“Competence gap in PM” is primarily caused by “Lack of competent pool of engineers” due to it also causing the former. This is because too few engineers and that all experienced engineers leave so only new engineers are left which lead to a gap between the existing competence and the competence needed. The reason the competent leave could be because of retirement, new with better salaries or better career prospects, during one of the interviews it was once mentioned by a manager that they thought their engineers were underpaid.

The problem with the “Competence gap in PM” is that it causes “ineffective workload management” as mentioned earlier, but also “No appropriate well defined structure for PM processes” and “difficulties for inter-departmental collaborations”. This is because the lack of competence forces the project leader to help the engineers in their work which causes workload imbalance for the project leader. Add to that the project leader does some engineering work it becomes difficult to structure the PM processes as each task could be done by different positions from project to project. For example finalize CAD drawings are done in one project by the engineers and in the next project it’s done by the project leader. Lastly, the competence gap causes the difficulty to collaborate with other departments because there is not enough competence to bridge the differences between departments.When it comes to the challenges faced by PM in RQ1 it shows to main factors causing the rest the “External factors affecting PM” mainly through changed customer requirements N input in the process map and the “Competence gap in PM” mainly through lack of competent engineers due to high overturn. When it comes to changed customer requirements the literature mentions that SMEs in big size product manufacturing that are characterised with the systems “Make to order” (MTO) which mean manufacturing only done after customer order and “Engineer to order” (ETO) which mean engineering and design of products is conducted with customers (Zennaro et al., 2019). These SMEs are known to produce low-volume, highly customized products. These types of SMEs have limited financial resources and need “well-fitted and robust production planning and control systems as they are deeply influenced by uncertainty (customers’ orders, product specification, order process, etc.)” and they also need to be very flexible inorder to keep their competitiveness hence the ETO. In order for these types of SMEs to succeed in their industry they need to offer attractive prices and delivery times which are deeply affected due to ongoing changed customer requirements due to ETO. Zennaro et al. (2019) further mentions that SMEs with ETO that product specifications become more clear as the project proceeds. The results of the study in the Case-company which is also an SME in a project production based setting producing highly customized products confirms the literature. This means that the N factor factor of ongoing changed customer requirements according to the literature is what makes it competitive. However the Case-company is a rapidly growing SMEs which could indicate it’s in a transitioning phase to potentially become a large organization, but there is a gap in the literature regarding how growing SMEs should manage ETO as production volumes increase. Looking at the Competence gap in literature Horvat et al. (2019) is in line with Zennaro et al. (2019) in that SMEs in manufacturing need to be highly flexible and offer a high quality/price ratio without the mentioning delivery times. Horvat et al. (2019) also mentions that in order to achieve that, SMEs need to adopt the usage of advanced technologies in manufacturing processes specifically “competence management” which refers to a “company's capability to adjust organizational and employees’ competencies to new

requirements". Currently there is a process-based "strategic competence management approach (SCMA) developed by (Horvat et al., 2019) which develops strategic and operational required competencies based on market and technological trends it then identifies competency gaps among employees, then selects and implements competence development measures to close them for example company-internal or external courses, coaching, mentoring and practical training etc. Looking at the case-company the main reason for the competency gap as mentioned was losing all the experienced engineers to other positions furthermore it was also mentioned in interviews that it takes six to twelve month to train a new engineer in one segment, but also moving and retraining an experienced engineer to a new segment takes just as long hence the "difficulties for inter-departmental collaborations. This could mean although the SCMA could be implemented to potentially improve the competence management within the case-company it would still not resolve the six to twelve month training period. However the idea of adjusting employees competencies to new requirements is still valid as in the interviews it was mentioned that there is a desire to not just employ new engineers, but to utilize the existing competences, by effectively moving around the engineers across segments (departments) in PM. Perhaps an SCMA that considers time efficient ways of closing the competence gap would be relevant in the Case-company which is something that could be added for future research. The results of the AIM which summarized all the challenges faced by PM answering RQ1 in one statement ***" The project management lacks a well defined structure and a required number of competent engineers. This causes poor performance in the initial stages, also influenced by sales leading to work overload. This also leads to the difficulty for inter-departmental collaborations, which prevents PM from working smoothly"*** which is the big **Y.** This was the foundation for the effective scoping where the authors identified measurable factors that influence the big **Y** which are called small **ys** using the SIPOC framework. In this Case the results identified four small **ys** which influences the big **Y** i.e. improvements in these measures is an indication of overcoming the identified challenges in PM in SMEs which would answer RQ2.

When looking at the first y1 "The time difference between agreed delivery time by sales and the actual delivery by PM" an improvement in this y i.e reducing the difference between agreed and actual delivery time would mean a reduction in "Costly unforeseen consequences" [Appendix A]. One of the main causes for the "Costly unforeseen consequences" is that the Sales team is not able to deliver the projects in the agreed time because of PM, which means any reduction in y1 would mean reduced "External factors affecting PM" i.e overcoming some of the challenges faced by PM giving an answer to RQ2. This reduces the negative effect on the cascading challenges [Appendix A]. When the CRM data was analyzed the main sources of delays occurred were the extreme delays in the first quarter of the year, followed by project type and number of changes done to a project. During the analysis the authors could not determine why these were the main sources due to a lot of unrecorded changes making the CRM data insufficient in explaining the causes. Looking at the literature Abdellatif and Alshibani (2019) mention that the main causes of delays in industrial/manufacturing projects in Saudi Arabia are: difficulties in financing projects by manufacturer, late procurement of materials, late delivery of materials, delay in progress payments and delay in approving design documents. Although this paper focuses on projects

in Saudi Arabia it's finding could still be relevant as one the main causes of the delay was delay in approving design documents which was similarly mentioned in the interviews that they usually are negotiating with customer for a few weeks to agree on project documents, but that some projects are negotiated for up to 6 month in the initiate phase. In addition to the information in the process map where project drawings have to be redrawn until customer approval of drawings which could be considered as delay in approving design documents. Zennaro et al. (2019) mentions similarly to Abdellatif & Alshibani (2019) that execution time of a project depends on the material procurement in SMEs conducting big size manufacturing using ETO. During the interviews there was no mention regarding the delayed material procurement, however this does not necessarily mean it does not occur as the material procurement could be connected with registration and confirmation of order which is the start of the execute phase [Fig 2]. Lastly Zennaro et al. (2019) also mentions that the distance and lack of coordination between marketing, sales, production and control is the cause of orders being delivered later than promised by sales which is one of the challenges defined in the AIM "difficulties for inter-departmental collaborations" answering RQ1.

When looking at the second y2 "the difference between the planned work boundaries and the actual work boundaries for each PM position" an improvement in y i.e reducing the difference between planned and actual work boundaries would will enable PM in the case-company to overcome the challenge "No appropriate well defined structure for PM processes" [Appendix A]. This is because in the interviews it was mentioned that there is no clear division of work and everybody uses their own ways of collecting data making it hard to track the process owner. Thus reducing the difference between planned and actual work boundaries would lead to improved work structure in the individual process and PM overall overcoming the challenge of "No appropriate well defined structure for PM processes" and the cascading challenges which would give us an additional answer to RQ2 [Appendix A]. The main findings after analyzing shows a discrepancy between expected work boundaries and actual work at the case-company. However this discrepancy varied as managers reported highest frequency and extent of working outside their work boundaries, followed by project leaders and engineers indicating career progress increases ambiguity regarding work boundaries. The calculation of potential leading and engineering work compared to actual work showed a shortage of engineers compared to project leaders which could be a potential cause for the imbalance. Which brings us back to the interviews and the AIM where it was mentioned that there is a lack of competent engineers due them climbing to new positions or moving to another organization. The interviewees mention that in order to prevent engineers from moving to another organization they promote them to project leader, but the problem is after that there are not many new positions in the department except for manager causing them to stagnate in the project leader because the case-company does not make difference between a 1 year experienced project leader and a 5 years experienced position or get a new position in another department or leave the organization. This brought the question: why are the engineers so keen on promotions? The Assumption by the authors is that engineers, after developing experience, want to get promoted for multiple reasons: one is increased salary, second would be to keep growing and learn in their field, because it was mentioned in the interviews that found the engineers to be underpaid. This challenge could perhaps be

overcome by a more comprehensive career ladder with continuous salary increases and new positions with clear work boundaries and tasks, giving a sense of growth which would add another answer to RQ2. Looking at the literature regarding work boundaries Smit et al. (2014) talks about interdisciplinary cooperation with co-creative trading zones between different positions. There are two types of trading zones: external and internal, the external when there is cooperation between a customer and someone within an organization for example engineer, the internal is cooperation within the organization for example engineers and administrators. Another article (Turner & Ledwith, 2016) talks about that SMEs need to adopt more informal, less bureaucratic and more people focused project management practices than what is implemented in large organizations. Turner and Ledwith (2016) further mentions when a small company transitions to a medium sized company the organizational structural changes were so significant that the growth became a crisis of growth. Since the case-company is a rapidly growing SME the existing PM practices where project leader does a lot of engineering might become less effective and that more formal work boundaries that are less people focused as it transitions into a larger organization. So perhaps to overcome the challenge of "No appropriate well defined structure for PM processes" in the long run looking into large organization strategies might be more useful.

Looking at the third y3 "the difference between available work potential and the executed work" the improvement i.e the reduced difference between the executed work and potential work. This means PM are not working less or more than planned which would indicate that the challenge "ineffective workload management" is overcomed including the cascading challenges which would give additional answer to RQ2 [Appendix A]. When analyzing the questionnaire the main findings were there is limited alignment between the potential and actual workload, with project leaders perceiving lower level of alignment compared to engineers and managers despite the noise factors. This is due to the fact that project leaders can't reject projects and that there is potential work leakage from both engineers and managers which makes them feel overwhelmed. One can conclude that the "Competence gap in PM" and the "External factors affecting PM" both cascade to "ineffective workload management" which further confirms the challenges identified in RQ1. In order to potentially answer RQ2 a solution bridging the competence gap and enabling the PM to delay projects could be suggested. Looking at the literature it mentions the concept Workload Control (WLC) is relevant to MTO SMEs, because it can improve Production Planning and Control (PPC) in organizations as there are examples of successful implementation in few SMEs , but most research have been based on large organizations (Stevenson et al., 2011; Land & Gaalman, 2009). WLC is used for input control of: Due Date quotation, job acceptance, when to start a job, and order progress control on the shopfloor as well as output control of: capacity adjustments. Stevenson et al. (2011) mentions that the fundamental principle of WLC is to "control the total input rate of work in accordance with the output rate; restrict and control the amount of work on the shop floor, and, stabilise throughput times as customers value reliability". This could be relevant to look into for the case-company in the long run as it's rapidly growing and could potentially transition into a large organization which would help structure the workload in the PM and other departments. Another article (Ma, 2023)

mentions the development of discrete regression particle swarm algorithm that uses three indicators (time, cost and stability) and constraints (Prevent overworking) which helps managers to make informed decisions on work schedules. The development of such algorithms in case-company using customized indicators and constraints could potentially be used to manage workload in order to minimize the difference between executed work and potential work. Lastly the difference between executed work and potential work as mentioned earlier is connected to the "ineffective workload management" which in the AIM was partly caused by the "Competence gap in PM" due to the loss of experienced engineers to other work positions within the organization or to other organizations. The article of Morales-Rojas et al. (2021) mentions that SMEs have high turnover rates due to two main predictors of staff turnover: organizational commitment and enterprise-employees relationship quality. Therefore the development of a system to tackle these two factors is composed of three processes: Workload distribution, professional growth and development, Compensation and Rewards. These three factors are meant to positively impact these factors i.e improve the predictors to reduce turnover rates (Morales-Rojas et al., 2021). Implementing a similar system in the case-company could potentially keep more engineers thus reducing the competence gap which would cascade to improved workload management for example in this case reduced difference between potential work and executed work. This means that some of the challenges in RQ1 could be overcomed thus answering RQ2.

Looking at the last y4 "Amount of changes made in execute phase" an improvement in this y i.e is a reduction in the number of changes made in a project. The main findings of the analysis of y4 is that changes were done due to technical constraints connected with the "Competence gap", client requests connected with "External factors affecting PM" and scope creep. There was no direct correlation between delays and the number of changes, which indicate that the individual project differences probably have a more significant role. In addition to that the limited data collection of project changes in the CRM due to many of them occurring in email and are not recorded which indicates the need of better data collection. This indicates that the challenges in the AIM need to be overcome to respond to RQ2. When looking at the literature as mentioned earlier many SMEs in manufacturing conduct ETO where they conduct engineering with the customer in order to distinguish themselves from the competition, which lead to a competitive edge, but also uncertainties regarding project delivery due to changed customer requirements (Zennaro et al., 2019). This is part of the challenges that answered RQ1 more specifically the "External factors affecting PM" like the changed customer requirements which as mentioned is one of the major challenges that is also partly causing the other challenges. Willner et al. (2016) propose four distinct archetypes of ETO: complex, basic, repeatable and non-competitive with varying degrees of standardization and automation strategies hence require different competitive strategies. Organization should pick what is most suitable to its organizational structure,processes and products in order to maximize organizational effectiveness. For example, for the complex ETO archetype the market is usually limited hindering volume increases while at the same time both internal (Technical restrictions) and external customer (Changed customer requirements) keeps the complexity high. The recommendations for such

ETO is to have low standardization and automation as a competitive strategy (Willner et al., 2016). The analyzed reasons for changes in a project for y4 as mentioned where the technical constraints, client request and scope creep which are very similar to the Complex ETO. However since the case-company is rapidly growing and wants to grow for the years to come this could indicate that the case-company market is not limited or not as limited in terms of volume. This could mean that although a low complex ETO competitive strategy might be practical now, the growth of case-company will require it to either stop aiming for greater volume or overcome the challenges technical restriction usually due to competence gap and changed customer requirements due to high customization. The latter challenges are more aligned with the results from the AIM when answering RQ1 and overcoming them would answer RQ2.

After analyzing the small ys the fishbone-diagram was conducted to identify root causes. The main findings showed that the main effect is the overwhelmed PM, branched out into four major causes (people, structure, method and external factors) which are further branched out to more detailed factors (root causes). Any improvement for the overwhelmed state of PM was going to come from solutions developed to resolve the detailed factors. Looking at the literature Shinde et al. (2018) mentions that using fishbone-diagram is a structured way of brainstorming root causes and that they were able to present solutions to their problem. They further mention that the implementations of solutions for the root causes have improved the situation in the case of their study (Shinde et al., 2018).

After using the fishbone-diagram three proposed solutions were presented: task categorization,standardized data recording and limiting the times customers change requirements. These solutions address “External factors affecting PM”, “No appropriate well defined structure for PM processes” and the “ Competence gap” which would address RQ2 with a definite answer. Looking at the literature Aalst et al. (2005) presents a “bottom-up approach for evolving a company’s business process management based on the execution experience of their knowledge workers while ensuring the required flexibility as well as providing assistance for knowledge workers to stay productive, creative, and motivated” which aims at resolving the dilemma between Process-aware information systems (PAIS) rigidness and knowledge workers flexibility. On one hand the PAIS provides a top-down approach that provides standardization and transparency for ease of traceability, control and monitoring which increases better synchronization of interdependent activities within an organization but less flexibility (Aalst et al., 2005). On the other hand knowledge workers who focus on their complex situation which demands flexibility, negotiation and collaboration, but forget the organizational need for streamlining processes and avoid using the PAIS. These conditions can be found in SMEs where on the one hand they must allow for flexible execution for individual tasks assigned, but on the other hand the execution needs to be within an inter-organizational business process (Aalst et al., 2005). The case-company is an SME which makes it require flexibility, but on the other hand it is quickly growing making it increasingly complex and costly to keep such flexibility and that’s why most identified

challenges were connected with the uncertain flexibility of the SMEs which could be a sign that the company is in a transitioning phase to a large organization. This prompted the authors to develop solutions that aim at increasing the structure and standardization to the process of PM in order to potentially serve the case-company in their potential transition in the long run which would make the process more efficient and less flexible, but it will overcome the challenges in RQ1 hence answering RQ2. This could potentially increase profits by reducing costs of inefficiencies that come with uncertainties, it will put the case-company in a new position with new opportunities to take on new challenges to tackle. The project answered the research questions, however it still left us with new questions which will be further discussed in future work.

7. Conclusion and future work

Project based SMEs which are on the constant path of growth tend to face many challenges along the way. The major impact will usually fall on the PM division who then have to adapt effectively in every step of the way to keep up with the dynamic changes and customer requirements. With the mixed method approach, data was collected through semi-structured interviews, surveys and other empirical data was recorded. The study identified key issues affecting PM in the case company. This included a significant gap between agreed and actual delivery times where the average of delays was higher in the first quarter in this particular case. The lack of clear work boundaries between roles led to confusion and frustration, with employees frequently working outside their designated tasks. Additionally there was an imbalance between available work potential and workload, particularly affecting project leaders who were burdened. Finally the number of changes in the project was not accurately recorded, complicating analysis. Following up with the results, potential areas for improvement were identified through a fishbone diagram which was later on used to provide suitable recommendations.

Concluding, the challenges found from the case company are in line with challenges discussed in the literature concerning project-based SMEs, but the case data gave more empirical insight in why these challenges occur. The Six Sigma was the methodology chosen by the authors to bring suggested solutions for SMEs to overcome these challenges. The recommendations were task categorization with specific processes owner, improved data collection and “structured meeting approach”. These recommendations will potentially help organize the career ladders, improve time estimation and planning for projects which will make managers less overwhelmed. This could potentially enable the PM in SMEs to take on more projects which would increase their revenue, but since the project was based on comparing one company with the literature, future work is recommended. For future work one could do a similar study, but with more case-companies involved from multiple industries to see if this applies to all SMEs across all industries and also try different methodologies when conducting the project for example Lean or Lean Six Sigma. The authors also recommend a further project using the PDCA cycle to be conducted regarding the results of implementing the improvement suggestions in order to see their effect on PM in SMEs and how they can be improved. This will further add to the literature, the usefulness of the recommendations if the effects are positive or to not use them otherwise. Lastly the authors recommend conducting two projects regarding two frameworks found in the literature. The first one is the bottom-up approach for evolving a company’s business process management which could potentially keep the balance between the management will for structure and knowledge workers need for flexibility hence improve the ambidexterity for the SME. The second project is about implementing a process-based approach for competence management which could help the case-company close the competence gap without constantly employing new people, but instead utilizing the existing one by developing appropriate competence development measures to close the competence gap. The authors hope implementing the

recommendations and later the suggested future work will help project based production SMEs PM to better navigate through their challenges and overcome them.

8. Bibliography/References

Admin. (2022, December 27). Six sigma Terminology | Dictionary | Glossary. Six Sigma Daily. https://www.sixsigmadaily.com/six-sigma-terms/

Aini, Q., Zaharuddin, Z., & Yuliana, Y. (2018). Compilation of criteria for types of data collection in management of research methods. Aptisi Transactions on Management, 2(2), 97-103.

Allen, J. A., Rogelberg, S. G., & Scott, J. C. (2008). Mind your meetings: Improve your organization's effectiveness one meeting at a time. Quality Progress, 41, 48.

Alänge, S. (2009). The affinity-interrelationship method aim. A Problem Solving Tool for Analysing Qualitative Data Inspired by the Shiba "Step by Step" Approach. Chalmers university of technology, Technology Management and Economics.

Andersen, E. S., Grude, K. V., & Haug, T. (2009). Goal directed project management: Effective Techniques and Strategies. Kogan Page Publishers.

Aquil, M. A. (2013). Project Management in SMEs - ProQuest. https://www.proquest.com/openview/ee5f5ee5921ba84355219c01c656f1aa/1?pq-origsite=gscholar&cbl=2035009

Ballard, G., & Howell, G. (2003). Lean project management. Building Research & Information, 31(2), 119–133. https://doi.org/10.1080/09613210301997

Bañuelas, R., & Antony, J. (2004). Six sigma or design for six sigma? TQM Magazine/˜the œTQM Magazine, 16(4), 250–263. https://doi.org/10.1108/09544780410541909

Banuelas, R., Antony, J., & Brace, M. (2005). An application of Six Sigma to reduce waste. Quality and Reliability Engineering International, 21(6), 553-570.

Barad, M., & Raz, T. (2000). Contribution of quality management tools and practices to project management performance. International Journal of Quality and Reliability Management/International Journal of Quality & Reliability Management, 17(4/5), 571–583. https://doi.org/10.1108/02656710010298607

Beer, M. (2003). Why total quality management programs do not persist: the role of management quality and implications for leading a TQM transformation. Decision Sciences, 34(4), 623-642.

Bell, E., Bryman, A., & Harley, B. (2022). Business research methods. Oxford university press.

Bernard, A. B., Jensen, J. B., Redding, S. J., & Schott, P. K. (2018). Global firms. Journal of Economic Literature, 56(2), 565-619.

Besic, C., & Djordjevic, D. (2007). Benchmarking, Technical Faculty-Cacak. Cacak. Helet.

Carleton, S. A. (2016). The Lean Six Sigma Tools Memory Jogger: The Concise Reference Guide for LLS Success.

Celano, G., Castagliola, P., Chakraborti, S., & Nenes, G. (2016). On the implementation of the Shewhart sign control chart for low-volume production. International Journal of Production Research, 54(19), 5886–5900. https://doi.org/10.1080/00207543.2016.1186297

Chaudhari, A. (2021, August 19). Definition and examples of ordinal scale for better surveys. Voxco. Retrieved from https://www.voxco.com/blog/ordinal-scale/

Cohen, D., Lindvall, M., & Costa, P. (2004). An introduction to agile methods. Adv. Comput., 62(03), 1-66.

Consilium Safety Group. (2024, April 17). Our history – where we come from | ConsiliumSafety.Consilium Safety. https://www.consiliumsafety.com/en/about/history/

Curtis, B., Kellner, M. I., & Over, J. (1992). Process modeling. Communications of the ACM, 35(9), 75-90.

Dasari, S., Jigeesh, N., & Prabhukumar, A. (2015). Analysis of Project Success Issues: The Case of a Manufacturing SME. IUP Journal of Operations Management, 14(1).
De Mast, J., & Lokkerbol, J. (2012). An analysis of the Six Sigma DMAIC method from the perspective of problem solving. International Journal of Production Economics, 139(2), 604–614. https://doi.org/10.1016/j.ijpe.2012.05.035
Doshi, J. A., & Desai, D. A. (2014). Review of continuous quality improvement methodology - enablers, exertion, benefits for SMEs. International Journal of Quality and Innovation, 2(3/4), 245. https://doi.org/10.1504/ijqi.2014.066357
Ebrahimi, M., & Mehran, S. (2013). Quality management and performance: An annotated review. International Journal of Production Research, 51(18), 5625–5643. https://doi.org/10.1080/00207543.2013.793426
Editor, C., Foreword by Chris Fay, R. H., Chair, Committee on Business, A., & Environment (ACBE), UK. (2000). Small and Medium‐sized Enterprises and the Environment: Business Imperatives. International Journal of Sustainability in Higher Education, 1(2), 208-211.
Editor, C., Foreword by Chris Fay, R. H., Chair, Committee on Business, A., & Environment (ACBE), UK. (2000). Small and Medium‐sized Enterprises and the Environment: Business Imperatives. International Journal of Sustainability in Higher Education, 1(2), 208-211.
Fernandez, D. J., & Fernandez, J. D. (2016). Agile Project Management —Agilism versus Traditional Approaches. JournalofComputerInformationSystemsWinter2008-2009, 49(2), 10–17. https://doi.org/10.1080/08874417.2009.11646044
Fossey, E., Harvey, C., McDermott, F., & Davidson, L. (2002). Understanding and evaluating qualitative research. Australian & New Zealand journal of psychiatry, 36(6), 717-732.
Hessing, T. (2024, February 4). Process Capability & Performance (PP, PPK, CP, CPK). Six Sigma Study Guide. https://sixsigmastudyguide.com/process-capability-pp-ppk-cp-cpk/
Hillary, R. (2000). Small and Medium‐sized Enterprises and the Environment: Business Imperatives20002Small and Medium‐sized Enterprises and the Environment: Business Imperatives. The Network for Environmental Management and Auditing, UK, 400 pp., ISBN: ISBN 1 874719 22 5 £35.00/US$65.00, hardback. International Journal of Sustainability in Higher Education, 1(2), 208–211. https://doi.org/10.1108/ijshe.2000.1.2.208.2
Hobday, M. (2000). The project-based organisation: an ideal form for managing complex products and systems? Research Policy, 29(7–8), 871–893. https://doi.org/10.1016/s0048-7333(00)00110-4
Ishtiaq, F., Ali, M. A., Ahmed, N., Raza, M. H., Jahanzaib, M., & Zahoor, S. (2023). A Structural Equation Modeling-Based Project Management Framework: A way forward to Oil and Gas Exploration and Production project success. Arabian Journal for Science and Engineering, 48(12), 17067–17087. https://doi.org/10.1007/s13369-023-08364-w
Calculating capability indices using the distribution platform. (2021, December 3).JMP-User-Community.https://community.jmp.com/t5/Statistical-Thinking-for/Calculating-Capability-Indices-Using-the-Distribution-Platform/ta-p/271887
Jovanović, P., & Berić, I. (2018). Analysis of the available project management methodologies. Management, 23(3), 1. https://doi.org/10.7595/management.fon.2018.0027
Jung, J. Y., & Wang, Y. J. (2006). Relationship between total quality management (TQM) and continuous improvement of international project management (CIIPM). Technovation, 26(5–6), 716–722. https://doi.org/10.1016/j.technovation.2006.01.003
Karkoszka, T., & Szewieczek, D. (2007). Risk of the processes in the aspect of quality, natural environment and occupational safety. Journal of Achievements in Materials and Manufacturing Engineering, 20(1-2), 539-542.
Kilpatrick, J. (2003). Lean principles. Utah manufacturing extension partnership, 68(1), 1-5.

Klotz, L., Horman, M., Bi, H. H., & Bechtel, J. (2008). The impact of process mapping on transparency. International Journal of Productivity and Performance Management, 57(8), 623-636.
Knapp, S. (2015). Lean Six Sigma implementation and organizational culture. International journal of health care quality assurance, 28(8), 855-863.
Koch, C., & Friis, O. (2015). Operations strategy development in project based production – a political process perspective. Journal of Manufacturing Technology Management, 26(4), 501–514. https://doi.org/10.1108/jmtm-03-2013-0017
Konstantinou, E., & Müller, R. (2016). The role of philosophy in project management. Project Management Journal, 47(3), 3–11. https://doi.org/10.1177/875697281604700301
Lanning, H. (2001, November 16). Planning and implementing change in organisations : a construct for managing change projects. https://aaltodoc.aalto.fi/items/b96ed8a3-bb33-4f37-b7ac-7bd58b589d81
Liker, J. K., & Hoseus, M. (2008). Culture—the heart and soul of the toyota way.
Lindberg, C., Tan, S., Yan, J., & Starfelt, F. (2015). Key performance indicators improve industrial performance. Energy Procedia, 75, 1785–1790. https://doi.org/10.1016/j.egypro.2015.07.474
Loredana, E. M. (2017). The analysis of causes and effects of a phenomenon by means of the "fishbone" diagram. Ann Econ Ser, 5, 97-103.
Madani, A. E. (2018). SME Policy: Comparative Analysis of SME Definitions. https://www.semanticscholar.org/paper/SME-Policy%3A-Comparative-Analysis-of-SME-Definitions-Madani/104af4efbefa0cb3c9999ef1f761edc7ddf8872d?p2df
Meredith, J. R., & Mantel, S. J. (2010). PROJECT MANAGEMENT: A MANAGERIAL APPROACH, 7TH ED.
Milewski, D., & Milewska, B. (2024). Effective concepts of management against the challenges of the modern world: Lean and Agile: competition or cooperation? Ekonomia I Prawo, 23(1), 137–161. https://doi.org/10.12775/eip.2024.007
Moradlou, H., & Asadi, M. (2015). Implementation of agile manufacturing principles in small and medium Enterprises (SMES). Deleted Journal, 4(3), 31–44. http://mpmpjournal.iaun.ac.ir/article_558276_2d34dcce9def67b951c87ee7ce10573e.pdf
Nave, D. (2002). How to compare six sigma, lean and the theory of constraints. Quality progress, 35(3), 73-80.
Nicholas, J. (2014). Hoshin kanri and critical success factors in quality management and lean production. Total Quality Management & Business Excellence, 27(3-4), 250-264.
Ogrezeanu, A., & Scarlat, C. (2019). Managerial challenges and limitations to innovation and growth in romanian project based companies in the ICT sector. Calitatea, 20(S3), 31-36.
Ohno, T. (1988). Toyota production system: beyond large-scale production. Productivity press.
Olausson, D., & Berggren, C. (2010). Managing uncertain, complex product development in high-tech firms: in search of controlled flexibility. Department of Management and Engineering, Linköping University, SE-58183 Linköping, Sweden.
Orwig, R. A., & Brennan, L. L. (2000). An integrated view of project and quality management for project‐based organizations. International Journal of Quality & Reliability Management, 17(4/5), 351-363.
Pambreni, Y., Khatibi, A., Azam, S., & Tham, J. (2019). The influence of total quality management toward organization performance. https://m.growingscience.com/beta/msl/3218-the-influence-of-total-quality-management-toward-organization-performance.html
Pinto, J. K. (2019). Project management: Achieving Competitive Advantage.

Prajogo, D., & McDermott, C. (2005). The relationship between total quality management practices and organizational culture. International Journal of Operations & Production Management, 25(11), 1101–1122. https://doi.org/10.1108/01443570510626916
Rasch, F. A. (2019). Methodologies in project management. IJBMR.
Schwalbe, K. (2009). Introduction to Project Management, second edition. Cengage Learning.
Shenhar, A. J. (2020). One Size Does Not Fit All Projects: Exploring Classical Contingency Domains. Institute for Operations Research and the Management Sciences, 21. https://doi.org/10.1287/mnsc.47.3.394.9772
Singh, J., & Singh, H. (2015). Continuous improvement philosophy – literature review and directions. Benchmarking, 22(1), 75–119. https://doi.org/10.1108/bij-06-2012-0038
Singh, M., & Rathi, R. (2018). A structured review of Lean Six Sigma in various industrial sectors. International Journal of Lean Six Sigma, 10(2), 622-664.
Špundak, M. (2014). Mixed Agile/Traditional Project Management Methodology – reality or illusion? Procedia: Social & Behavioral Sciences, 119, 939–948. https://doi.org/10.1016/j.sbspro.2014.03.105
Stability Index. (2023, June 10). JMP User Community. https://community.jmp.com/t5/Discussions/Stability-Index/td-p/420258
Tavory, I., & Timmermans, S. (2014). Abductive analysis: Theorizing qualitative research. University of Chicago Press.
Thompson, J. (2022). A guide to Abductive thematic analysis.
Thuesen, C. L. (2012). Understanding Project Based Production through Socio-technical Modularity. Welcome to DTU Research Database. https://orbit.dtu.dk/en/publications/understanding-project-based-production-through-socio-technical-mo
Trusko, B., Pexton, C., Gupta, P. K., & Harrington, J. (2003). Improving healthcare quality and cost with six sigma. Pearson Education.
Turner, J. R., Ledwith, A., & Kelly, J. (2009). Project management in small to medium‐sized enterprises. International Journal of Managing Projects in Business, 2(2), 282–296. https://doi.org/10.1108/17538370910949301
Turner, J. R., Ledwith, A., & Kelly, J. (2010). Project management in small to medium-sized enterprises: Matching processes to the nature of the firm. International Journal of Project Management, 28(8), 744–755. https://doi.org/10.1016/j.ijproman.2010.06.005
Valles, A., Sanchez, J., Noriega, S., & Nuñez, B. G. (2009). Implementation of Six Sigma in a manufacturing process: A case study. International Journal of Industrial Engineering, 16(3), 171-181.
Velimirović, D., Velimirović, M., & Stanković, R. (2011). Role and importance of key performance indicators measurement. Serbian Journal of Management, 6(1), 63–72. https://doi.org/10.5937/sjm1101063v
Voehl, F., Harrington, H. J., Mignosa, C., & Charron, R. (2013). The lean six sigma black belt handbook: tools and methods for process acceleration. CRC Press.
Wood-Kline, A. H., & Evans, J. P. (2002, August). Improving development performance in growing companies. In IEEE International Engineering Management Conference (Vol. 1, pp. 310-315). IEEE.
Wysocki, R. K. (2004). *Project Management Process improvement*. Artech House.
Zwikael, O., Smyrk, J., Zwikael, O., & Smyrk, J. (2011). Projects: An Executive Context. Project Management for the Creation of Organisational Value, 1-9.
Rvj. (2023, July 27). ERP for Project-based Industries – A Complete Guide. Deskera Blog. https://www.deskera.com/blog/erp-for-project-based-industries/#:~:text=Project-
Beringer, C., Jonas, D., & Kock, A. (2013). Behavior of internal stakeholders in project portfolio management and its impact on success. International Journal of Project Management, 31(6), 830–846. https://doi.org/10.1016/j.ijproman.2012.11.006

Yang, J., Shen, G. Q., Ho, M., Drew, D. S., & Xue, X. (2011). Stakeholder management in construction: An empirical study to address research gaps in previous studies. International Journal of Project Management, 29(7), 900–910. https://doi.org/10.1016/j.ijproman.2010.07.013
Zennaro, I., Finco, S., Battini, D., & Persona, A. (2019). Big size highly customised product manufacturing systems: a literature review and future research agenda. International Journal of Production Research, 57(15–16), 5362–5385. https://doi.org/10.1080/00207543.2019.1582819
Horvat, D., Moll, C., & Weidner, N. (2019). Why and How to Implement Strategic Competence Management in Manufacturing SMEs? Procedia Manufacturing, 39, 824–832. https://doi.org/10.1016/j.promfg.2020.01.422
Abdellatif, H., & Alshibani, A. (2019). Major factors causing delay in the delivery of manufacturing and building projects in Saudi Arabia. Buildings, 9(4), 93. https://doi.org/10.3390/buildings9040093
Smit, G., De Haan, Y., & Buijs, L. (2014). Working with or next to each other? Boundary crossing in the field of information visualisation. ˜the œJournal of Media Innovations, 1(2), 36–51. https://doi.org/10.5617/jmi.v1i2.875
Turner, R., & Ledwith, A. (2016). Project Management in Small to Medium-Sized Enterprises: fitting the practices to the needs of the firm to deliver benefit. Journal of Small Business Management, 56(3), 475–493. https://doi.org/10.1111/jsbm.12265
Stevenson, M., Huang, Y., Hendry, L. C., & Soepenberg, E. (2011). The theory and practice of workload control: A research agenda and implementation strategy. International Journal of Production Economics, 131(2), 689–700. https://doi.org/10.1016/j.ijpe.2011.02.018
Land, M. J., & Gaalman, G. J. (2009). Production planning and control in SMEs: time for change. Production Planning & Control, 20(7), 548–558. https://doi.org/10.1080/09537280903034230
Ma, H. (2023). Construction of a refined people management model for SMEs based on discrete regression algorithm. Applied Mathematics and Nonlinear Sciences, 9(1). https://doi.org/10.2478/amns.2023.1.00368
Morales-Rojas, G., Uchida-Ore, K., Sotelo, F., & Rojas, J. (2021). System of human Management processes to improve the predictors of staff turnover in SMEs dedicated to the service sector. In Lecture notes in networks and systems (pp. 1227–1234). https://doi.org/10.1007/978-3-030-85540-6_157
Willner, O., Powell, D., Gerschberger, M., & Schönsleben, P. (2016). Exploring the archetypes of engineer-to-order: an empirical analysis. International Journal of Operations & Production Management, 36(3), 242–264. https://doi.org/10.1108/ijopm-07-2014-0339
Shinde, D. D., Ahirrao, S., & Prasad, R. (2018). Fishbone Diagram: Application to identify the Root Causes of Student–Staff Problems in Technical Education. Wireless Personal Communications, 100(2), 653–664. https://doi.org/10.1007/s11277-018-5344-y
Sakdiyah, S. H., Eltivia, N., & Afandi, A. (2022). Root cause analysis using Fishbone Diagram: Company Management Decision making. Journal of Applied Business, Taxation and Economics Research, 1(6), 566–576. https://doi.org/10.54408/jabter.v1i6.103
Santanen, E. L., Briggs, R. O., & De Vreede, G. (2004). Causal relationships in creative Problem solving: Comparing Facilitation Interventions for Ideation. Journal of Management Information Systems, 20(4), 167–198. https://doi.org/10.1080/07421222.2004.11045783
Riss, U. V., Rickayzen, A., Maus, H., & van der Aalst, W. M. (2005). Challenges for business process and task management. Journal of Universal Knowledge Management, 2, 77-100.
Almeida, M. V., & Soares, A. L. (2014). Knowledge sharing in project-based organizations: Overcoming the informational limbo. International Journal of Information Management, 34(6), 770–779. https://doi.org/10.1016/j.ijinfomgt.2014.07.003
Oerlemans, L., & Pretorius, T. (2014). Linking project-based production and project management temporary systems in multiple contexts : an introduction to the special edition | South African Journal

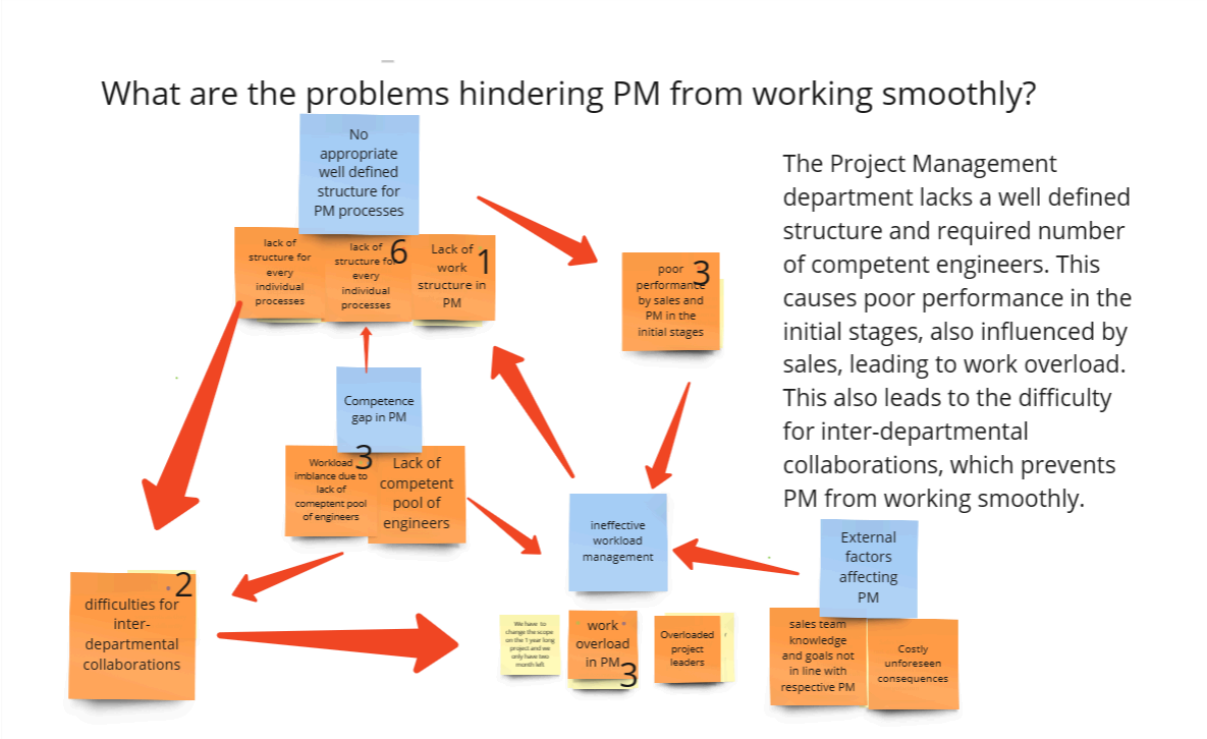
of Economic and Management Sciences. South African Journal of Economic and Management Sciences. https://journals.co.za/doi/abs/10.10520/EJC148772

Backlund, F., & Sundqvist, E. (2018). Continuous improvement: challenges for the project-based organization. *International Journal of Quality and Reliability Management/International Journal of Quality & Reliability Management*, *35*(7), 1306–1320. https://doi.org/10.1108/ijqrm-12-2016-0229

Walsh, S., & Lancaster, L. (2015). Process Capability in JMP® 12 – A New Look. In *https://www.google.se/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&ved=2ahUKEwjEyZuv6taGAxUMFBAIHbZSAC8QFnoECBMQAw&url=https%3A%2F%2Fcommunity.jmp.com%2Fkvoqx44227%2Fattachments%2Fkvoqx44227%2Fdiscovery-2015-content%2F18%2F2%2FProcess%2520Capability%2520in%2520JMP.pdf&usg=AOvVaw06qrxqGkirANQXW7zXAq2P&opi=89978449* (No. kvoqx44227). JMP User Community. Retrieved June 12, 2024, from https://www.google.se/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&ved=2ahUKEwjEyZuv6taGAxUMFBAIHbZSAC8QFnoECBMQAw&url=https%3A%2F%2Fcommunity.jmp.com%2Fkvoqx44227%2Fattachments%2Fkvoqx44227%2Fdiscovery-2015-content%2F18%2F2%2FProcess%2520Capability%2520in%2520JMP.pdf&usg=AOvVaw06qrxqGkirANQXW7zXAq2P&opi=89978449

Mapue, J. (2018, October 17). Lean Six Sigma Essential Glossary of Terms. GoSkills.com. https://www.goskills.com/Lean-Six-Sigma/Resources/Lean-six-sigma-glossary-terms

9. Appendix



Appendix A

NO.	project no	type	status	shipping dati	delivery date	delay	o of changes	system type	start date	project dura	Quarter
1	20939R1	RETROFIT	CLOSED	2023-01-02	2023-04-21	109	NO RECORD	Salwico CCP Larg...	2022-09-26	207	1
2	5702R1	RETROFIT	CLOSED	2023-01-05	2023-01-30	25	NO RECORD	CS3000 Retrofit-780			1
3	47834F1	NORMAL	PARKED	2023-01-09	2023-03-10	60	1	Salwico CCP Anal...			1
4	47344G1	NORMAL	PARKED	2023-01-11	2023-02-17	37	NO RECORD	CGD50/500-124			1
5	47344F1	NORMAL	PARKED	2023-01-11	2023-03-10	58	NO RECORD	Salwico CCP Anal...			1
6	3548R2	SMS	PARKED	2023-01-16	2023-03-09	52	NO RECORD	SMG full - 160			1
7	47892R2	SMS	CLOSED	2023-01-16	2023-02-14	29	NO RECORD	SMG full - 160			1
8	47892R1	RETROFIT	PARKED	2023-01-16	2023-01-31	15	1	Salwico CCP Larg...			1
9	47720F1	NORMAL	PARKED	2023-01-16	2023-07-07	172	2	Salwico CCP Anal...			1
10	42081G1	RETROFIT	CLOSED	2023-01-18	2023-02-22	35	1	CGD50/500-124	2022-11-23	91	1
11	3548R1	RETROFIT	PARKED	2023-01-23	2023-01-27	4	2	Salwico CCP Larg...			1
12	47188F1	NORMAL	PARKED	2023-01-23	2023-09-19	239	NO RECORD	Salwico CCP Anal...			1
13	48149R1	RETROFIT	PARKED	2023-02-02	2023-02-22	20	1	Salwico CCP Larg...			1
14	393R1	RETROFIT	CLOSED	2023-02-06	2023-03-29	51	NO RECORD	Salwico CCP Anal...	2023-01-17	71	1
15	47927F1	NORMAL	PARKED	2023-02-06	2023-02-06	0	2	Salwico CCP Anal...			1
16	9253R1	RETROFIT	PARKED	2023-02-16	2023-02-22	6	NO RECORD	Salwico CCP Con...			1
17	48679R1	RETROFIT	PARKED	2023-02-20	2023-02-27	7	1	Salwico ccp (Retr...			1
18	7724R1	SMS	CLOSED	2023-02-20	2023-03-24	32	NO RECORD	SMS retrofit - 760			1
19	48634F1	NORMAL	PARKED	2023-02-27	2023-03-29	30	2	Salwico CCP Anal...			1
20	5690R2	RETROFIT	PARKED	2023-02-28	2023-03-31	31	NO RECORD	Salwico ccp (Retr...			1
21	47837F1	NORMAL	PARKED	2023-03-01	2023-03-13	12	2	Salwico CCP Anal...			1
22	48593F1	NORMAL	PARKED	2023-03-06	2023-03-08	2	1	Salwico CCP Con...			1
23	48733R1	RETROFIT	PARKED	2023-03-16	2023-03-16	0	NO RECORD	Salwico ccp (Retr...			1
24	11931R1	RETROFIT	PARKED	2023-03-21	2023-04-05	15	NO RECORD	CGD50/500 (RET...			1
25	48614R1	RETROFIT	PARKED	2023-03-22	2023-03-29	7	NO RECORD	Salwico CCP Con...			1
26	13010R2	RETROFIT	PARKED	2023-03-30	2023-10-16	200	1	Salwico CCP Anal...			1
27	5083R1	RETROFIT	CLOSED	2023-04-01	2023-04-28	27	1	Salwico CCP Larg...	2022-09-26	214	2
28	48347F1	NORMAL	PARKED	2023-04-05	2023-04-05	0	NO RECORD	Salwico CCP Anal...			2
29	47345F1	NORMAL	PARKED	2023-04-19	2023-04-16	-3	NO RECORD	Salwico CCP Anal...			2
30	47345G1	NORMAL	PARKED	2023-04-19	2023-02-27	-51	NO RECORD	CGD50/500-124			2
31	48635F1	NORMAL	PARKED	2023-04-24	2023-05-26	32	2	Salwico CCP Anal...			2
32	4917R3	RETROFIT	PARKED	2023-05-01	2023-05-02	1	1	Salwico ccp (Retr...			2
33	5920R1	RETROFIT	PARKED	2023-05-02	2023-05-02	0	2	Salwico CCP Larg...			2
34	2150R1	RETROFIT	PARKED	2023-05-08	2023-07-05	58	2	Salwico CCP Larg...			2
35	6638R1	RETROFIT	PARKED	2023-05-10	2023-06-07	28	NO RECORD	SMS retrofit - 760			2
36	48794G1	NORMAL	PARKED	2023-05-22	2023-05-22	0	2	CGD50/500-124			2
37	48794F1	NORMAL	PARKED	2023-06-05	2023-05-23	-13	2	Salwico CCP Anal...			2
38	10243R1	SMS	PARKED	2023-06-26	2023-08-29	64	NO RECORD	SMS retrofit - 760			2
39	17702R1	NORMAL	PARKED	2023-06-26	2023-06-26	0	2	Salwico ccp (Retr...			2
40	348R1	RETROFIT	PARKED	2023-06-27	2023-06-27	0	2	Salwico ccp (Retr...			2
41	12936R1	RETROFIT	PARKED	2023-07-03	2023-07-03	0	NO RECORD	Salwico CCP Anal...			3
42	49152R1	NORMAL	PARKED	2023-07-17	2023-09-06	51	2	Salwico CCP Anal...			3
43	49194R1	NORMAL	PARKED	2023-07-24	2023-07-31	7	2	Salwico CCP Anal...			3
44	11475R2	RETROFIT	PARKED	2023-08-01	2023-07-31	-1	NO RECORD	SMS retrofit - 760			3
45	11475R1	CRUISE	PARKED	2023-08-01	2023-09-18	48	2	Salwico CCP Larg...			3
46	49158F1	NORMAL	PARKED	2023-08-02	2023-09-04	33	2	Salwico CCP Anal...			3
47	49155R1	NORMAL	PARKED	2023-08-02	2023-08-02	0	2	Salwico CCP Anal...			3
48	10888R1	RETROFIT	PARKED	2023-08-28	2023-08-28	0	2	Salwico ccp (Retr...			3
49	49213R1	NORMAL	PARKED	2023-08-28	2023-08-28	0	2	Salwico CCP Anal...			3
50	11214R1	RETROFIT	PARKED	2023-08-31	2023-08-31	0	1	Salwico ccp (Retr...			3
51	1986R1	RETROFIT	PARKED	2023-09-04	2023-09-12	8	NO RECORD	OEM- Salwico CC...			3
52	49764R1	RETROFIT	PARKED	2023-09-21	2023-10-24	33	NO RECORD	Salwico CCP Anal...			3
53	198R2	RETROFIT	PARKED	2023-09-21	2023-09-21	0	1	Salwico CCP Anal...			3
54	33831R1	RETROFIT	PARKED	2023-09-25	2023-10-03	8	NO RECORD	CGD50/500-124			3
55	9972R2	RETROFIT	PARKED	2023-10-10	2023-12-11	62	2	Salwico ccp (Retr...			4
56	12416R2	RETROFIT	CLOSED	2023-10-16	2023-11-01	16	NO RECORD	SMS retrofit - 760			4
57	12416R1	RETROFIT	CLOSED	2023-10-16	2023-11-01	16	NO RECORD	Salwico CCP Larg...			4
58	4973R2	RETROFIT	PARKED	2023-10-20	2023-09-04	-46	NO RECORD	Salwico CCP Anal...			4
59	49473R1	RETROFIT	PARKED	2023-10-20	2023-09-04	-46	NO RECORD	Salwico CCP Anal...			4
60	13010R3	RETROFIT	PARKED	2023-10-23	2023-10-25	2	1	Salwico CCP Anal...			4
61	12397R2	RETROFIT	PARKED	2023-10-23	2023-10-23	0	no record	OEM- Salwico CC...			4
62	49805F1	NORMAL	PARKED	2023-10-24	2023-10-24	0	1	Salwico CCP Anal...			4
63	49525R1	RETROFIT	CLOSED	2023-10-27	2023-10-27	0	NO RECORD	Salwico CCP Anal...			4
64	49413R1	NORMAL	PARKED	2023-11-01	2023-11-01	0	2	Salwico CCP Anal...			4
65	49412R1	NORMAL	PARKED	2023-11-01	2023-11-01	0	2	Salwico CCP Anal...			4
66	43139F1	RETROFIT	PARKED	2023-11-28	2023-12-01	3	12	Salwico CCP Anal...			4
67	49807R1	RETROFIT	CLOSED	2023-11-29	2023-11-17	-12	NO RECORD	Salwico ccp (Retr...			4
68	49762F1	NORMAL	PARKED	2023-11-30	2023-11-30	0	NO RECORD	Salwico CCP Anal...			4
69	3548R4	RETROFIT	PARKED	2023-12-04	2023-12-04	0	2	Salwico ccp (Retr...			4
70	9798R2	RETROFIT	CLOSED	2023-12-07	2023-12-21	14	NO RECORD	SMS retrofit - 760			4
71	49978R1	RETROFIT	CLOSED	2023-12-11	2023-12-11	0	2	Salwico CCP Larg...	2023-11-02	39	4
					Mean:	22.352112				124.4	
					Median:	7					
					Standard deviati	46.668159					
					Mode:	0					

Appendix B

Process owner (org):	Project sponsor:	Six Sigma champion, MBB:

Effective Scoping of continuous improvement projects

The sequence in itself, of questions Q1-Q4, Q5-Q7 and Q8-Q9 below, is key to facilitate consensus in the shift of an organisation's mindsets from push to pull, in accordance with the principles of Lean Six Sigma

Supplier	Input		Process	Output		Customer
8b. Who supplies the inputs?	Q8a. What are the inputs to the system?	Q9. What does the system require of the inputs?	Q7a. Team/project jurisdiction of changes	Q1. What comes out (of the physical flow) - OUTPUT?	Q3. What is required of the output from this particular user (List of big Y's and improvement proposals)	Q2. Who uses the output?
1. By the sales team based on their sales targets. 2. By the customers based on their technical requirements.	1. Nr of projects 2. List of technical specifications.	1. It should be calculated considering the workload of PM 2. It should be negotiated based on the technical competence of Consilium	for PM, but we cannot determ 1. Technical expertise for the Q7b. What competences are needed in the team (WHO)? *Name of the underlying system that build up the y to be improved:* *The sales team lack of technical expertise and the lack of consideration of the rapid growth for* From where is the physical output shipped? Warehouse	Projects completed with no hiccups	Required output: Improvement of PM Improvement proposals: 1. Better methods to ensure delivery on time, 2. Better methods to ensure no technical hiccups after product delivery, 3. Better understanding of customer requirments initaly, 4. Better Quality for products, 5. shorter negotiation phase, 6. Shorter delivery time, 7. No misinterpretation of customer specification, 8. correct drawings with no change requests. **Q4. What ONE MEASURE (y) should be understood and improved? The y that scope the project and drive further exploration.** **Each small y has its own underlying system of influencing parameters, sometime overlapping. Use one template per y to reduce complexity** **Scope on y (not x - upstream) and don't proceed until Q1-Q4 is thoroughly understood!** y1: The time difference between agreed delivery time by sales and the actual delivery by PM Q5. What is the baseline of the y and can that precis y be measured today (and can old data be trusted)? In other words: What is the **facts** behind the problem that form the base for our improvement promise? Show the data/proof of a problem! The fact is that their is a clear miscomunication between sales and PM. Yes we have data from sales agreeed delivery time and PMs actual delivery time. Q6. What other Y can not be lost in the process (constraints)? 1. It can't lose offers (Because if they reject advanced or big	End customer (External), Production (Internal)

Appendix C

Process owner (org):	Project sponsor:	Six Sigma champion, MBB:

Effective Scoping of continuous improvement projects

The sequence in itself, of questions Q1-Q4, Q5-Q7 and Q8-Q9 below, is key to facilitate consensus in the shift of an organisation's mindsets from push to pull, in accordance with the principles of Lean Six Sigma

Supplier	Input		Process	Output		Customer
8b. Who supplies the inputs?	Q8a. What are the inputs to the system?	Q9. What does the system require of the inputs?	Q7a. Team/project jurisdiction of changes	Q1. What comes out (of the physical flow) - OUTPUT?	Q3. What is required of the output from this particular user (List of big Y's and improvement proposals)	Q2. Who uses the output?
1. The upper management. 2. Upper management	1. Working structure within the department. 2. Availability of recource.	1. Consider capacity and competences required for the workstructure.	for PM, but we cannot determ They should know the jurisdic Q7b. What competences are needed in the team (WHO)? *Name of the underlying system that build up the y to be improved:* *The underlying system is that they do not consider the rapid growth of the company when* From where is the physical output shipped? Warehouse	Projects completed, delivered on time, meeting all the customer specifications and with no hiccups	Required output, Improvement proposals: 1. Better methods to ensure delivery on time, 2. Better methods to ensure no technical hiccups after product delivery, 3. Better understanding of customer requirments initaly, 4. Better Quality for products, 5. shorter negotiation phase, 6. Shorter delivery time, 7. No misinterpretation of customer specification, 8. correct drawings with no change requests. **Q4. What ONE MEASURE (y) should be understood and improved? The y that scope the project and drive further exploration.** **Each small y has its own underlying system of influencing parameters, sometime overlapping. Use one template per y to reduce complexity** **Scope on y (not x - upstream) and don't proceed until Q1-Q4 is thoroughly understood!** y2: the diffrence between the planned work boundaries and the actual work boundaries for each PM position. Q5. What is the baseline of the y and can that precis y be measured today (and can old data be trusted)? In other words: What is the **facts** behind the problem that form the base for our improvement promise? Show the data/proof of a problem! It is clearly evident that managers are taking on the role of engineers and admin more than neccasary. We can approxiamtely calculate the amount of time (in %) project managers allocated work time for work outside their role. Q6. What other Y can not be lost in the process (constraints)? 1. It can't lose offers (Because if they reject advanced or big	End customer (External), Production (Internal)

Appendix D

Process owner (org):	Project sponsor:	Six Sigma champion, MBB:

Effective Scoping of continuous improvement projects

The sequence in itself, of questions Q1-Q4, Q5-Q7 and Q8-Q9 below, is key to facilitate consensus in the shift of an organisation's mindsets from push to pull, in accordance with the principles of Lean Six Sigma

Supplier	Input		Process	Output		Customer
8b. Who supplies the inputs?	Q8a. What are the inputs to the system?	Q9. What does the system require of the inputs?	Q7a. Team/project jurisdiction of changes	Q1. What comes out (of the physical flow) - OUTPUT?	Q3. What is required of the output from this particular user (List of big Y's and improvement proposals)	Q2. Who uses the output?
			for PM, but we cannot determ	Projects completed, delivered on time, meeting all the customer specifications and with no hiccups	Required output, Improvement proposals: 1. Better methods to ensure delivery on time, 2. Better methods to ensure no technical hiccups after product delivery, 3. Better understanding of customer requirments initaly, 4. Better Quality for products, 5. shorter negotiation phase, 6. Shorter delivery time, 7. No misinterpretation of customer specification, 8. correct drawings with no change requests.	End customer (External), Production (Internal)
			1. Better work management b		**Q4. What ONE MEASURE (y) should be understood and improved? The y that scope the project and drive further exploration.** **Each small y has its own underlying system of influencing parameters, sometime overlapping. Use one template per y to reduce complexity** **Scope on y (not x - upstream) and don't proceed until Q1-Q4 is thoroughly understood!**	
			Q7b. What competences are needed in the team (WHO)?		y3: the diffrence between available work potential and the executed work.	
1. Sales team. 2. High turn overrate by HR	1. Projects 2. Availability of competent engineers	Involve all stakeholders affected by the project processes in decision making.	*Name of the underlying system that build up the y to be improved:*		Q5. What is the baseline of the y and can that precis y be measured today (and can old data be trusted)? In other words: What is the **facts** behind the problem that form the base for our improvement promise? Show the data/proof of a problem!	
			In consideration of some of stakholders involved in the process.		Their is fact that employees say that they work too much.	
			From where is the physical output shipped?		Q6. What other Y can not be lost in the process (constraints)?	
			Warehouse		1. It can't lose offers (Because if they reject advanced or big	

Appendix E

Process owner (org):	Project sponsor:	Six Sigma champion, MBB:

Effective Scoping of continuous improvement projects

The sequence in itself, of questions Q1-Q4, Q5-Q7 and Q8-Q9 below, is key to facilitate consensus in the shift of an organisation's mindsets from push to pull, in accordance with the principles of Lean Six Sigma

Supplier	Input		Process	Output		Customer
8b. Who supplies the inputs?	Q8a. What are the inputs to the system?	Q9. What does the system require of the inputs?	Q7a. Team/project jurisdiction of changes	Q1. What comes out (of the physical flow) - OUTPUT?	Q3. What is required of the output from this particular user (List of big Y's and improvement proposals)	Q2. Who uses the output?
Customer (externally), PM themselves (internally)	Changes in technical specification for making product, more units, less units	Better handover of orders from sales, communication between sales, PM and end customer	for PM, but we cannot determ Better communication betwee Q7b. What competences are needed in the team (WHO)? *Name of the underlying system that build up the y to be improved:* From where is the physical output shipped? Warehouse	Projects completed, delivered on time, meeting all the customer specifications and with no hiccups	Required output, Improvement proposals: 1. Better methods to ensure delivery on time, 2. Better methods to ensure no technical hiccups after product delivery, 3. Better understanding of customer requirments initaly, 4. Better Quality for products, 5. shorter negotiation phase, 6. Shorter delivery time, 7. No misinterpretation of customer specification, 8. correct drawings with no change requests. **Q4. What ONE MEASURE (y) should be understood and improved? The y that scope the project and drive further exploration.** **Each small y has its own underlying system of influencing parameters, sometime overlapping. Use one template per y to reduce complexity** **Scope on y (not x - upstream) and don't proceed until Q1-Q4 is thoroughly understood!** y4: Amount of changes made in execute phase Q5. What is the baseline of the y and can that precis y be measured today (and can old data be trusted)? In other words: What is the **facts** behind the problem that form the base for our improvement promise? Show the data/proof of a problem! We have data on production time today, but it is necessary to clean it to make it accurate Q6. What other Y can not be lost in the process (constraints)? It cant led to the loss of bussines.	End customer (External), Production (Internal)

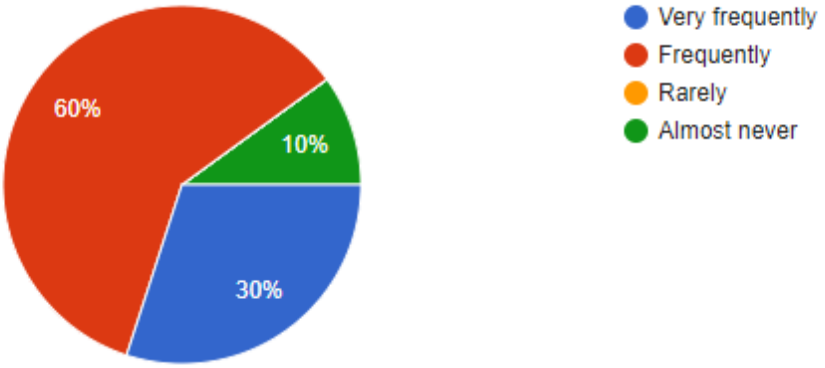
Appendix F

Title	Cruise	Normal	Retrofit	SMS	Total:
1 Change	0	3	10	0	13
2 Changes	1	15	8	0	24
3+ Changes	0	0	1	0	1
No record	0	7	22	4	33
Total:	1	25	41	4	71

Appendix G

In your experience, how often do changes occur during the execution phase of projects?

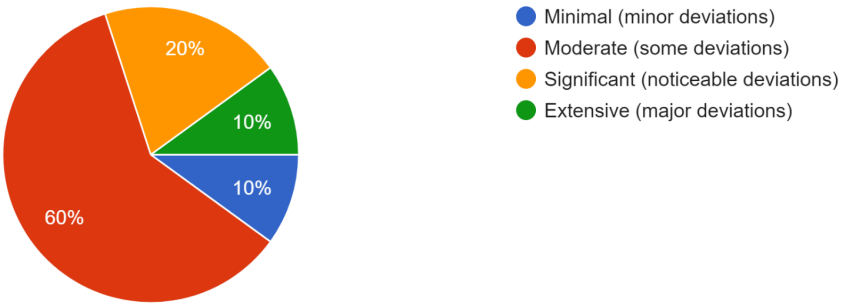
10 svar



Appendix H

How would you estimate the extent of the difference between the expected work boundaries and the actual work boundaries? Please select one option:

10 responses



Appendix I

DEPARTMENT OF TECHNOLOGY MANAGEMENT AND ECONOMICS
Division of Innovation and R&D Management
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