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Optimizing Interdepartmental Communication and Information Flow: The Role of Process Control in Production and Management Accounting

Case Study

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ABSTRACT:
In the manufacturing of complex products, the seamless flow of information both within systems and in interdepartmental communication is essential. Gaps in information flow and delayed availability of information can cause challenges in the later stages of cross-functional processes and result in errors. This case study examines the role and importance of the Process Control department, established a few years ago in the case company. In addition to clarifying the role, the aim is to investigate and improve interdepartmental communication, while optimizing cost accuracy and the consistency of maintained data with the production environment. The data maintained by the Process Control interconnects the production process, product structure, and cost information, linking multiple departments. The role of the department is particularly examined between the finance and production functions within the organization, identifying the information needs of different departments and examining current communication practices.

The primary data consists of semi-structured interviews and observations, while internal reports and documents represent the secondary data. The data was analyzed with thematic analysis, which identified that the department's role and significance can be categorized into two main themes. The first theme addresses the creation and maintenance of standard process data, which connects product structure, the production process, and the needs of the finance function for cost management. In situations deviating from the standard process, a second role emerges, in which the department supports cost tracking and aims to ensure the alignment of data with the actual production situation. The findings highlight the importance of effective communication in maintaining data accuracy and preventing information gaps, which requires an understanding of stakeholder information needs. An annual clock of the Process Control is developed, visualizing recurring tasks throughout the year and recommending improvements to interdepartmental communication practices. The research indicates that accurate data and proactive communication are crucial in cross-functional processes in manufacturing complex products.

KEYWORDS: Information flow, bill of process, management accounting, interdepartmental communication, annual clock, manufacturing company

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TIIVISTELMÄ:
Monimutkaisten tuotteiden valmistuksessa tiedon sujuva kulkeutuminen niin järjestelmissä kuin osastojen välisessä viestinnässä on tärkeää. Tiedonkulun katkokset ja viivästynyt tiedon saatavuus voivat aiheuttaa haasteita poikkitoiminnallisen prosessin myöhemmissä vaiheissa ja altistaa virheille. Tapaustutkimuksessa tarkastellaan muutamia vuosia sitten tapausyrityksessä perustetun Process Control osaston roolia ja merkitystä. Tavoitteena on roolin selventämisen lisäksi tutkia ja parantaa osastojen välistä tiedonkulkua, sekä optimoida kustannustarkkuutta ja ylläpidetyn tiedon yhdenmukaisuutta tuotantoympäristön kanssa. Process Controlin ylläpitämä data yhdistää tuotantoprosessin, tuotteen rakenteen ja kustannustiedot yhdistäen useita osastoja. Osaston merkitystä tarkastellaan erityisesti talous- ja tuotantofunktioiden välillä, kartoitetaan eri osastojen tietotarpeita ja tutkitaan nykyisiä viestintäkäytäntöjä.

Ensisijainen tutkimusaineisto koostuu puolistrukturoiduista haastatteluista ja havainnoinnista, kun taas toissijaisen aineiston muodostavat sisäiset raportit ja dokumentit. Aineisto analysoitiin temaattisen analyysin avulla, jossa tunnistettiin roolin ja merkityksen jakautuvan kahteen pääteemaan. Ensimmäinen teema liittyy standardiprosessin tietojen luomiseen ja ylläpitoon, jossa yhdistetään tuotteen rakenne, tuotantoympäristön prosessi, sekä talousfunktioiden tarpeet kustannusten seuraamiseen. Standardiprosessista poikkeavissa tilanteissa tulee esille toinen rooli, jossa osasto tukee kustannusten ohjaamista poikkeavissa tilanteissa ja pyrkii varmistamaan järjestelmissä olevan tiedon vastaavuuden tuotannon kanssa. Havainnot korostavat tehokkaan viestinnän merkitystä tiedon tarkkuuden ylläpitämisessä ja tietokatkosten ehkäisemisessä, mikä edellyttää sidosryhmien tietotarpeiden ymmärrystä. Tutkimuksessa kehitetään Process Controlin vuosikello, jossa visualisoidaan vuoden aikana toistuvat työtehtävät ja ehdottaa parannuksia osastojen välisiin viestintäkäytäntöihin. Tutkimus osoittaa tarkan datan ja ennakoidun viestinnän olevan olennaista poikkitoiminnallisissa prosesseissa monimutkaisessa valmistusympäristössä.

Avainsanat: Information flow, bill of process, management accounting, interdepartmental communication, annual clock, manufacturing company

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Abbreviations

ABC	Activity-based costing
BOM	Bill of Materials
BOP	Bill of Process
BOP1	Bill of Process 1
BOP2	Bill of Process 2
BPM	Business Process Management
CFPM	Cross-functional Process Map
EBOM	Engineering Bill of Materials
ERP	Enterprise Resource Planning
IT	Information Technology
MBOM	Manufacturing Bill of Materials
MES	Manufacturing Execution System
PC	Process Control
PLM	Product Lifecycle Management

1 Introduction

In the manufacturing industry, the product process and the order-to-delivery process can be considered one of the most important business processes (Sääksvuori & Immonen, 2010). These processes cover the product lifecycle from the emergence of a customer's need to the final delivery of the product. Especially for complex products, the time between order and delivery can be long, requiring the cooperation of multiple departments and organizations to manufacture the final product (Brière-Côté et al., 2010). The product is typically considered complex when manufacturing processes are complex, structures are multi-level and intricate, and the time between order and delivery is one to one and a half years (Wang et al., 2023). A successful outcome requires the creation of coherent and accurate information and efficient transfer of information between various organizations and systems.

When examining the manufacturing of a product, the need to manage production processes and resource consumption becomes apparent. To enable this, modern approaches create a Bill of Process that covers more details on manufacturing a product and resource consumption that are not provided by a Bill of Materials (Sly, 2018). This approach involves constructing the product structure, process structure, and plant structure as individual entities, which are then combined into a single structure that supports the entire process (Sly, 2018; Zhan & Li, 2022). This linkage is essential to monitor the resources consumed during production and for managing costs. Maintaining the functionality of a unified structure requires collaboration in management and maintenance, along with commitment from the company (Sly, 2018).

1.1 Research Gap

In companies manufacturing complex products, the Bill of Materials transfers information and connects multiple departments (Wang et al., 2022). It integrates the requirements of design, manufacturing, process manufacturing, cost accounting, and planning.

Typically, this data is transferred across three core systems to respond to the information needs of different departments (Avvaru et al., 2020; Bruno et al., 2019). Research has been conducted to enable the flow of information between systems, resulting in standards that support information transfer (Chen, 2005).

Berente et al. (2009) emphasize the importance of understanding data transformation to optimize business process efficiency. While the information systems facilitate the seamless transfer of information, it is crucial to transform the information in the event of change to ensure its accuracy. This requires greater collaboration and understanding of the information needs involved in the process (Berente et al., 2009). Furthermore, Wen et al. (2025) highlight that the flow of information in an organization significantly impacts decision-making efficiency. Despite the availability of powerful organizational communication technologies, they note that the challenge of communication between teams persists.

Current research primarily focuses on the transfer of data between systems and the technical facilitation of this process. A distinct area of research has examined communication within the organization and the sharing of information between different departments. As previously stated, the interconnection of product structure, process structures, and plant structure requires management and collaboration (Sly, 2018). Despite this, there has been little research on the need for interdepartmental communication to maintain the accuracy of information in changing situations. As the data structure connects various departments in a company, ensuring its accuracy is essential and requires further research.

1.2 Research Problem and Questions

This case study is conducted in a company that manufactures complex products. A few years ago, a department called Process Control (PC) was established in the case company, responsible for maintaining the bill of process data structures of the plant. The data must accurately reflect the structure of each product, the process of production environment, and include information on the amount of capacity utilized in manufacturing the product, which generates costs. The research problem is the ambiguity of the role of the department and how it is identified by stakeholders within the organization. A key challenge is the delayed transfer of information to the Process Control, which can compromise the accuracy of the data. The research problem is addressed through the following three objectives and research questions.

The first objective aims to investigate and clarify the current role and impact of the Process Control department in supporting coordination between production, specification management, finance and control functions. This leads to the following research question:

RQ1: What is the role and strategic importance of the Process Control Department in coordinating production and finance functions within the organization?

The second research objective is to identify and analyze the essential information needs of the production, product specification, and finance departments, and to examine how these needs support each other to enhance process efficiency and ensure accurate cost management. Based on this objective, the second research question has been formulated:

RQ2: What specific types of information are required by the production, product specification, and finance departments, and how can these be effectively aligned to enhance process efficiency?

The third objective is to evaluate current communication methods and propose strategies for improving interdepartmental information flow. A specific focus is on how the Process Control department can enhance accurate costing and ensure consistency with the production environment and the data. To investigate this, the third research question is defined as follows:

RQ3: In what ways can the information flow and collaboration between departments be improved to optimize cost accuracy and ensure consistency with the production environment and the data?

By answering these questions, this paper aims to clarify the role of the Process Control department as a link between different departments and promote cross-functional information flow with the aim of improving cost accuracy and process efficiency. Furthermore, this study contributes to understanding the role of communication at system interfaces, where communication gaps can have an impact on the functionality of processes and the accuracy of information.

The case study addresses the topic from the perspective of the Process Control department, focusing specifically on the department's information needs in cross-functional processes. The stakeholder departments have been identified and narrowed down to those most relevant to the research. The interdepartmental information flow between stakeholders is examined horizontally, which limits the examination of the vertical flow of information within the organization.

This thesis consists of six main chapters. The introduction is followed by a review of the relevant literature. It contains conceptual frameworks and a theoretical background, followed by two subsections on the literature related to the topic. The third chapter discusses the methodology and implementation of the research. Subsequently, the fourth chapter presents the results of the research and establishes an annual clock of the Process Control. Finally, chapter five discusses the main findings, and the final chapter concludes the research.

2 Literature Review

The literature review focuses on the information transfer between systems and communication between departments within manufacturing companies. First, the theoretical background of the study is examined, followed by two main themes. The first theme examines the literature on barriers to effective communication in cross-departmental processes, consequences, and strategies for improving information flow. The second main theme delves into understanding processes to stabilize them after changes.

2.1 Conceptual Frameworks and Theoretical Background

The theoretical background discusses themes from a general level to more detailed topics related to research. First, management accounting and cost accounting are reviewed, including a view of cost assignment. Secondly, information flow between departments is presented, and a system-level hierarchy that includes the aspect of information flowing in systems. Finally, the previously discussed topics will be connected with a theoretical background about routing, which combines the transfer of information between departments and systems.

2.1.1 Management and Cost Accounting

The theoretical background will begin by explaining the difference between management accounting and financial accounting, followed by a discussion of management accounting and its importance in a company. The discussion then turns to cost accounting and its relation to management accounting.

Accounting can be divided into two main branches in a company, which are financial accounting and management accounting (Drury, 2018). Financial accounting can be described as external accounting, as it provides information to external stakeholders of the company (Neilimo & Uusi-Rauva, 2005). It is mandatory and regulated by International Financial Reporting Standards and must follow Generally Accepted Accounting Principles to ensure consistency and precision (Noreen et al., 2011). In contrast, management accounting is optional and focuses on internal reporting (Drury, 2018). The time dimension is on the future by utilizing information from the past, while financial accounting reports on the past. The purpose of this future-oriented information is to improve decision-making and enhance the effectiveness and efficiency of operations.

Calculations in management accounting may serve various purposes to support decision-making. For instance, calculations can support investment decisions, while a budget is an example of target calculations (Neilimo & Uusi-Rauva, 2005). The alternatives are assessed to determine the most appropriate option (Noreen et al., 2011). Monitoring the implementation of the plan ensures that the implementation proceeds as expected. For this purpose, control calculations are used to report the realization of objectives to management, allowing corrective actions to be planned in response to deviations (Neilimo & Uusi-Rauva, 2005). This emphasizes the time dimension of management accounting towards the future.

The information needed to support decision-making must be relevant to the specific issue and may contain both qualitative and quantitative data (Noreen et al., 2011). For example, make or buy decisions involve assessing whether it is more profitable to manufacture a component in-house or to purchase it from an external supplier (Drury, 2018). However, decision-making should not be limited to a mere comparison of costs but should consider factors such as the alternative utilization of available resources. Noreen et al. (2011) recommend taking into account the effect of quality control on Make or Buy decisions as well as the potential risks when relying on external suppliers. To accurately assess the profitability of outsourcing, a company must have precise information on current capacity costs to enable comparison.

Kitsantas et al. (2020) emphasize that in today's global competition, the accuracy of costing is crucial for decision-making and planning. Management accounting focuses on utilizing appropriate information in which costs play a central role. Without determining costs, the profitability of business operations cannot be determined (Neilimo & Uusi-Rauva, 2005). Thus, a cost accounting method is required for a company to monitor its costs. For this reason, the theory of allocating and tracing costs in a manufacturing company is discussed.

A cost object refers, for example, to a product to be manufactured or a department whose costs are examined (Drury, 2018). Figure 1 below illustrates a cost object in blue to which direct and indirect costs are assigned (Horngren et al., 1999). When considering the product to be manufactured, direct costs can be traced to the specific cost object (Noreen et al., 2011). When a cost object is a product, the direct materials required for manufacturing the final product can be determined in advance (Drury, 2018). Moreover, direct costs include direct labor hours spent converting raw materials into the final product.

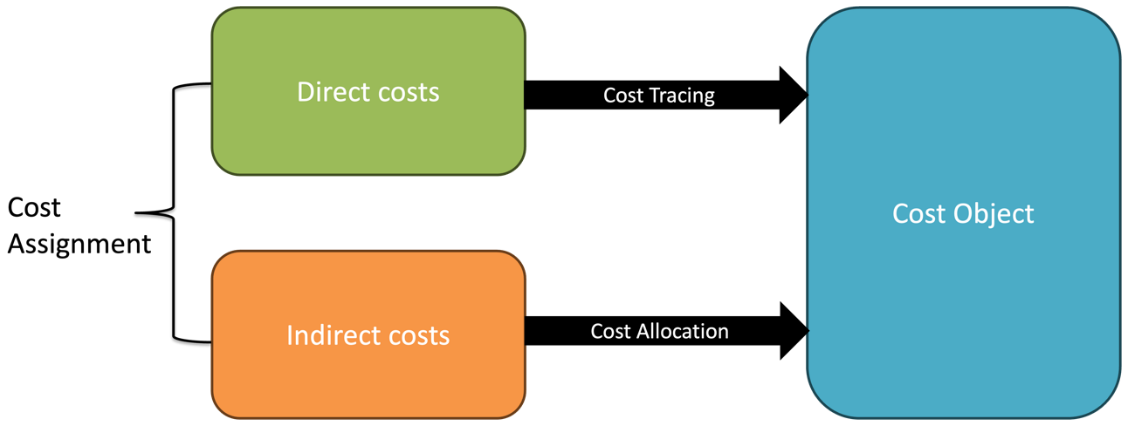

Figure 1 Cost assignment to a cost object (Based on Horngren et al., 1999).

Indirect costs include manufacturing and non-manufacturing costs excluding the direct costs discussed earlier, and are often referred to as overheads (Drury, 2018). Manufacturing overheads consist of equipment, and machine repairs, costs of production facilities, and indirect labor costs. Non-manufacturing costs include administrative overheads, marketing, and distribution overheads. Costs are assigned to cost objects for a variety of reasons, including pricing and managing consumption (Noreen et al., 2011). The allocation of indirect costs to a cost object is more sophisticated and requires drivers to determine how they are allocated within a company (Drury, 2018).

There are direct and absorption costing systems to assign costs to cost objects (Drury, 2018). The direct costing system assigns only direct costs to cost objects, while the absorption costing system assigns both direct and indirect costs. The absorption costing system can be divided into two subcategories, which are traditional and activity-based costing (ABC). ABC system allows for a more accurate calculation of indirect costs when there is variability between products (Kitsantas et al., 2020). According to Drury (2018), simplistic pricing systems are cheaper to maintain but can lead to costly errors. If the overhead costs are increasing, there is a large variety in products, including complex operations, ABC could be useful (Cooper & Kaplan, 1990).

In ABC, the primary focus is on the activities rather than products (Neilimo & Uusi-Rauva, 2005). Costs are first allocated to resources and then to activities based on the use of resources. Activities include sales, purchasing, and manufacturing, while resources are facilities, machines, and materials. The design of ABC begins with identifying major activities (Drury, 2018). Next, the cost of resources is assigned to each activity. Resource drivers are responsible for allocating costs to activities (Alhola, 2016). After costs are allocated to activities, cost drivers are needed to allocate them to a cost object. According to Drury (2018), these are called activity cost drivers, and they can consist of duration and transaction drivers.

Noreen et al. (2011) discuss how organizations are utilizing a formal costing system for external financial reports, while ABC is for internal decision-making. However, the implementation of a highly sophisticated costing system is costly (Drury, 2018; Noreen et al., 2011), so ensuring that the benefits outweigh the costs is essential. Cost information must support strategic decision-making in a way that exceeds the resources invested in its calculation. Akeem (2017) examines cost control and cost reduction in order to maximize profit, which is the goal of most organizations. As overhead costs rise, understanding their sources and identifying control methods becomes increasingly important. Effective cost management depends on proper data collection and analysis, with accurate cost accounting enhancing opportunities for cost control. As Rounaghi et al. (2021) note, strategic cost management with more accurate data facilitates decision-making for long-term and short-term decisions. Hence, an accurate cost accounting system not only aids financial reporting but is a tool for improving cost efficiency and supporting strategic decision-making.

2.1.2 Interdepartmental Communication and Information Flow in Manufacturing

This chapter explores the communication and information flow between functional departments. It first examines directions of information flow, followed by a discussion of the channels through which information can be transferred. The discussion then shifts to the role of information technologies in facilitating communication. Finally, the background of system integration and its impact on interdepartmental information flow in manufacturing is given in view of the following chapters.

Organizations are hierarchically structured and consist of functional units that work towards a common goal (Musheke & Phiri, 2021). According to Calçado et al. (2024), a company consists of functional areas called departments. They examined business process management and lean manufacturing to improve document and information flow and pointed out that functional units can plan improvements, ignoring the needs of others. Musheke and Phiri (2021) approach effective communication through systems theory. According to them, functional units of an organization do not operate in isolation but are interconnected, forming a unified system. What both views have in common is that the organization consists of functional units that have a common goal.

According to Paim et al. (2008), functional division appears to be restrictive in today's environment, as flexible and agile organizations are essential to sustain operations and improve organizational performance. They divide the identification of processes in a functionally divided organization into three different levels. If an organization identifies the internal processes only within functional units, there is functional management of functional processes. On the other hand, if cross-functional processes are identified in a functionally structured organization, this is called functional management of cross-functional processes. Thirdly, if management is guided by processes, it can refer to the process management of cross-functional processes.

It has been clarified that an organization consists of departments that need to communicate with each other to reach common goals without ignoring the needs of others. In this context, interdepartmental communication refers to the exchange of information between departments within an organization (Adler, 1995), and it can flow in various directions. Vertical information flow is possible in two directions, which are downward and upward (Wen et al., 2025). Horizontal information flow is in question between the same hierarchical level or diagonally between managers and employees from different functional teams. In modern organizations, collaboration is more extensive, and communication technologies are more advanced, facilitating diagonal communication (Wen et al., 2025).

Information is described as a critical factor for businesses, and it flows between two separate parts that are connected or related to each other. Information flows in an organization in various forms, including verbal, written, and electronic (Yazici, 2002). Durugbo et al. (2013) note that the use of multiple communication channels can improve the flexibility of information flow and ensure that important information reaches the recipient, even if the communication channels are overlapping. According to them, information flow is a significant part of the workflow in modern organizations, requiring synergy between people and computer systems. Studies on information systems suggest that information technology (IT) enhances coordination across departments and business units by supporting data sharing and system connectivity (Berente et al., 2009). While information integration is a key prerequisite for business process integration, it is not sufficient alone, as the individuals and groups involved in the process have different information needs and ways of working. When business processes are integrated, communication and coordination between process activities reduce (Berente et al., 2009).

When examining the flow of information between departments in a manufacturing company, the different departments are linked to each other via enterprise resource planning (ERP) systems (Abd Elmonem et al., 2016). It facilitates the sharing of information between various functions in the enterprise, for example, finance, manufacturing, and sales. In addition to internal departments, it allows information to be shared with external suppliers (Avvaru et al., 2020). Beyond timeliness, the quality of the data must be taken into account to ensure the accuracy of the information used by the different departments (Xu et al., 2002). To enable better decision-making with ERP data, the information must be accurate, complete, and relevant (Ouiddad et al., 2021).

Information systems play a crucial role in today's manufacturing enterprises, and maintaining accuracy requires cross-departmental collaboration. ERP is not the only software that transfers information, but it highlights how information connects different departments. As Sääksvuori and Immonen (2010) state, the most important business processes in the manufacturing industry are the product process and the order-delivery processes, which are both cross-functional and cross-organizational. Next, we will examine the system-level hierarchy of a manufacturing company and how the various systems within an enterprise exchange information.

2.1.3 System-Level Hierarchy: Integrating PLM, ERP, and MES

This chapter introduces three key systems used in manufacturing companies, and the hierarchy between systems will be clarified by the ISA-95 standard. The first is Product Lifecycle Management (PLM), which is a concept and a set of systematic methods used to maintain product-related information (Sääksvuori & Immonen, 2010). This functional entity includes the creation, maintenance, sharing, and control of product-associated information. While PLM does not refer directly to software, product data is typically maintained in PLM systems, where product data is used to integrate business processes and the products produced (Sääksvuori & Immonen, 2010).

The product data is divided into three subcategories. The first one is the product specification data, which defines the physical and functional characteristics of the product (Sääksvuori & Immonen, 2010). This can be described as a complete product definition. The second one is product lifecycle data, which covers information about design, manufacturing, use, maintenance, and recycling of the product. The third one is metadata, which is data describing and providing information about the product data.

Sääksvuori and Immonen (2010) note that product data and product structure are usually used as synonyms, despite the fact that product data is not hierarchical. The Bill of Materials (BOM) is strongly linked to the product data but is not a product structure. Instead, the BOM is a list of all materials used to assemble a specific product. However, whereas the BOM lists components needed for manufacturing, the Bill of Process (BOP) defines the combined and interconnected structure between them (Zhan & Li, 2022). The management and maintenance of these product structures is considered one of the most important tasks of a PLM system (Brière-Côté et al., 2010), as many other system functionalities depend on them (Sääksvuori & Immonen, 2010).

Different types of BOM serve distinct purposes throughout the product life cycle (Wang et al., 2023; Xu et al., 2007), two of which are discussed below. Engineering Bill of Materials (EBOM) represents the product from a design perspective according to relationships of items in drawings (Xu et al., 2007). Since EBOM does not correspond to the requirements of manufacturing, it must be transformed into a format suitable for production. This is achieved by combining information from the BOP with the EBOM (Xu et al., 2007).

In contrast, the Manufacturing Bill of Materials (MBOM) is structured to support the manufacturing of a product (Sly & Schneider, 2011).

Next, the focus shifts from PLM to the system-level hierarchy, which provides the basis for addressing the relationship between other systems to be discussed. Furthermore, the hierarchy can be exploited to better understand the flow of information between different systems. The ISA-95 standard provides a hierarchy of functional control between functions and systems (Erasmus et al., 2018). The purpose of this international standard is to integrate a manufacturing enterprise and control systems to ensure the flow of information to different parts of the company's functional areas (Chen, 2005).

Figure 2 below illustrates the ISA-95 automation pyramid with a timeframe and related system at every level in the pyramid (Katti, 2020). The pyramid consists of four different levels. In this research, the main focus is on level four, where the ERP and PLM are located. The previously discussed PLM system has not been directly implicated in every ISA-95 pyramid in the literature, although it is shown alongside ERP in Figure 2 (Katti, 2020). However, the information produced in PLM software is utilized at layers three and four (Erasmus et al., 2018). It is particularly important for the study to understand the information flow between PLM and ERP, as well as the up-to-date information from production to ERP. For this reason, the hierarchy between the systems becomes a key factor.

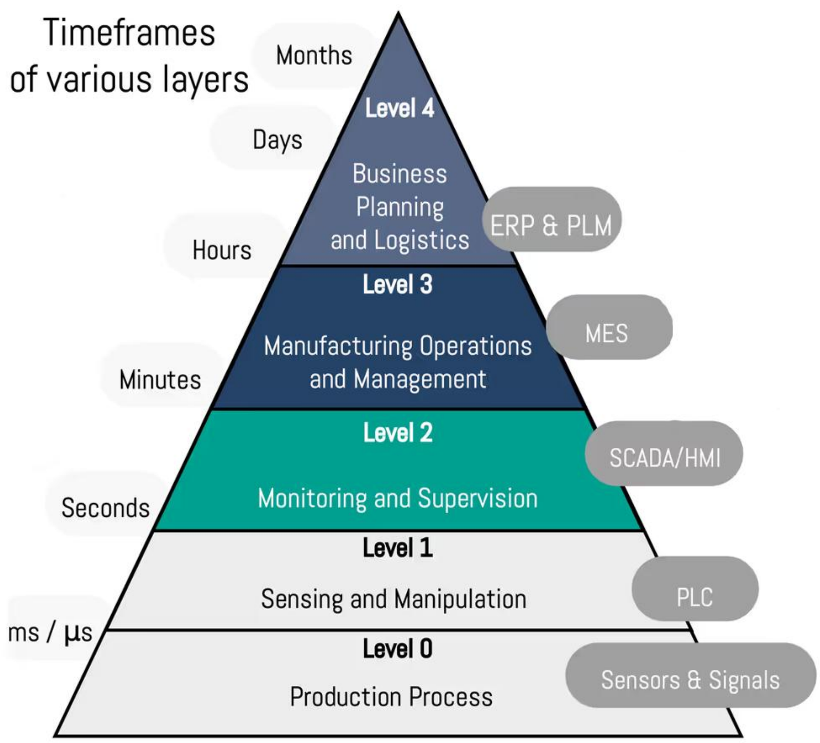

Figure 2 Automation pyramid according to the ANSI/ISA-95 model (Katti, 2020).

Next, the different functions of the ERP system at level four of the pyramid and its interconnection with other systems are examined. After this, a brief discussion about the Manufacturing Execution System (MES) at the level three in the pyramid is provided. In the literature, these three key information technology systems PLM, ERP, and MES, emerge as providing the central functionalities for enterprises to facilitate seamless flow of the data (Avvaru et al., 2020; Bruno et al., 2019). The use of these systems assists in managing manufacturing information.

The aim of an ERP system is to connect the different functional units of a company collaboratively (Abd Elmonem et al., 2016; Erasmus et al., 2018). These may include sales, production, human resources, and finance of an enterprise, for example. According to the ISA-95 pyramid, the ERP system at level four has the widest time frame, depending on the case at the monthly or weekly level (Erasmus et al., 2018; Katti, 2020). This level includes broader business management, such as resources and financial functions. The ERP system provides tools for production, including scheduling planning, budgeting, and materials management (Avvaru et al., 2020). To conclude, ERP can be utilized to monitor a company's resources, such as money and materials. Moreover, the status of commitments can be monitored, including orders and purchase orders.

From the product data point of view, PLM can be considered as a producer while ERP is the consumer (Sääksvuori & Immonen, 2010). The integration between PLM and ERP ensures that updated product data is accessible in all necessary areas of the enterprise (Bruno et al., 2019). The master data transferred to the ERP system is maintained in the PLM database, including BOM, procurement control, and subcontracting data (Sääksvuori & Immonen, 2010). Thus, data is transferred between systems to meet the needs of several different departments. For example, a purchasing team is responsible for ordering the components needed to manufacture a product (Sly & Schneider, 2011). The team requires information from MBOM to determine the components needed. Additionally, information on the time of need for the component is required. In this context, BOM information and routing are essential. In the next chapter, the BOP data used by ERP and the routing maintained in PLM are discussed in more detail.

In manufacturing companies, production is the central place where the product data maintained in the PLM is transferred, and from where actual information on the progress of production is transferred to the ERP system. MES acts as a bridge between the top level and the lower levels of the automation system in the ISA-95 pyramid (Govindaraju & Putra, 2016). The major challenge for companies is the functional integration of the system, as data needs to be transferred between multiple interfaces. Levels four and three in Figure 2 represent the interface between production scheduling and operation management and actual production (Chen, 2005).

MES is utilized to manage production operations from order release to finished product (Govindaraju & Putra, 2016). The necessary information about the product to be manufactured is transferred from the PLM system to the MES. These include work instructions, manufacturing processes, and BOM (Avvaru et al., 2020). MES concretely assists production by enabling materials to be called to the workstation. After the work is completed, the linked information systems receive information in real time. At level three, the time frame ranges from hours to minutes (Katti, 2020).

From the system hierarchy point of view, MES provides information exchange between the production and the enterprise level (Avvaru et al., 2020). The integration between ERP and MES provides information from the shop floor to the departments that need it in business processes. From a financial perspective, up-to-date information about production helps to monitor budget implementation and other activities that emerged when examining the activities of the fourth level of the pyramid in Figure 2. Moreover, efficient inventory management and purchasing functionalities, for example, benefit from the flow of information between MES and ERP (Bruno et al., 2019).

It can be concluded that production is a highly cross-functional process requiring the information flow and accuracy of data between different systems and departments. Data generated and maintained by different departments in the PLM system must be synchronized to ensure the complex BOM and BOP processes are seamlessly transmitted to the next phases of the system hierarchy. Although the role of PLM in the ISA-95 pyramid is not in all cases recognized in the literature, it has been highlighted as one of the most important systems in manufacturing companies alongside MES and ERP. According to Sääksvuori and Immonen (2010), PLM system can create a bridge between engineering and production. If changes are made to products, it is PLM's function to ensure that up-to-date information is transferred to production. On the other hand, there may occur problems related to the manufacturability of the product during the assembly phase. In this case, the bridge between production and engineering is used in the reverse direction, and problems identified can be resolved with the aid of the PLM system.

Interdepartmental cooperation and interfaces between different systems are essential aspects of the research when examining the flow of information between departments. Functional departments typically operate within a single system of the three discussed systems. The system hierarchy showed the importance of the data maintained in PLM for the departments operating in ERP. If the data in PLM is not accurate, the incorrect information is transferred to ERP. Consequently, it is critical to examine the interfaces of the system and analyze the key challenges that can hinder effective interdepartmental collaboration and affect data accuracy.

2.1.4 Routing and Bill of Materials as Key Enablers of Cost Information

The previous chapter discussed the system-level hierarchy in which information is maintained, created, and transmitted for various purposes to different systems in a manufacturing company. This highlighted the central role of the ERP system in integrating information. Two different BOMs were discussed, and next we will examine the importance of BOM and routing information from a cost accounting perspective. In order to understand the product structure and cost data transferred to the ERP system, the processes of constructing the BOM are examined in more detail.

Different BOM variants have distinct structures and attributes but are interconnected (Wang et al., 2023). Data integration has a significant impact on improving business decision-making. Furthermore, integrating different BOM variants can support the unification of business processes and ensure the consistency, correctness, and integrity of BOM data. Wang et al. (2022) examined the reconstruction process of BOMs in complex products. They note that managing the BOM of such products is a complex process due to the multi-dimensional structure and parallel work steps combined with the need for structural changes coming from the design. Additionally, the changes can emerge as a result of the developments in the production process.

Transforming the materials in the EBOM into a practical structure for the product to be manufactured requires the design of the production process (Zhan & Li, 2022). Manufacturing process design combines the design structure with the production characteristics and the production environment in order to produce high-quality products from raw materials. This process is described as the premise for the production of the product. These processes enable the product to be manufactured and provide a hierarchical structure between subassemblies (Sly & Schneider, 2011). According to Sly (2018), the bill of process describes how a product is built, in contrast to the Manufacturing Bill of Materials (MBOM), which represents what is built. Thus, MBOM is a representation of the planned processes in BOP, containing everything known about how to manufacture the product (Sly, 2018). BOP is a composite structure, a relationship between product, process, plant structure, and resource information (Zhan & Li, 2022). BOP, like other structures, needs to be constructed, managed, and regularly maintained (Sly, 2018). Therefore, collaboration and commitment are required to maintain an accurate BOP.

The information in the BOM is the basis for planning, process monitoring, procurement, and cost accounting, as well as the link between various departments when manufacturing complex products (Wang et al., 2022). Next, the previously discussed product structure is linked to data, enabling cost accounting. In this context, the BOP is maintained in the PLM system according to the system hierarchy, from which the data is exported to the ERP system. The theoretical background of ERP software functionality plays an important role in this context. Therefore, information from the literature will be combined with the practical application of the ERP system by applying SAP instruction manuals.

The planned assemblies of the product structure must be interconnected. This connection is routing, which is described as the core of the assembly process documentation (Sly & Schneider, 2011). Routing defines the high-level steps that link the process to produce assemblies. Furthermore, it provides a corresponding routing for each subassembly, defining the tasks it contains to produce the subassembly. The main tasks are called operations and sub-operations, which are necessary to produce the subassembly (Sly & Schneider, 2011; SAP, 2023a). Operations consist of a list of smaller tasks called activities. Hence, the sum of the time necessary to perform the activities is the time needed to perform the operation.

Process routings are configured in a similar way to products, considering a routing perspective (Sly & Schneider, 2011). It is important to maintain the configured routing information, enabling the reuse of fundamental process information. When examining the information that is necessary in an ERP system to link production and financial data, a production order emerges as essential information. The production order contains information on operations, production location, schedule, and cost settlement of the order (SAP, 2023b). An essential part of that production order is the information from the BOM and the routing data copied to the order. In the production order context, we will next delve into the level of operation that is linked to cost accounting.

SAP (2023c) classifies routing, BOM, and work centers as the most important master data for the production planning and control system. The work center is deployed at the operation level of the production order, and the data it contains is utilized for different purposes. Operating times and formulas are entered into the work center to enable the duration of the operation to be calculated (SAP, 2023c). However, the work centers have multiple functions, but the primary focus in terms of this theoretical background is on enabling costing. Hence, formulas for calculating the cost of the operation are included in the work center (SAP, 2023d). Figure 3 illustrates the linkage between the topics to be covered from a costing perspective.

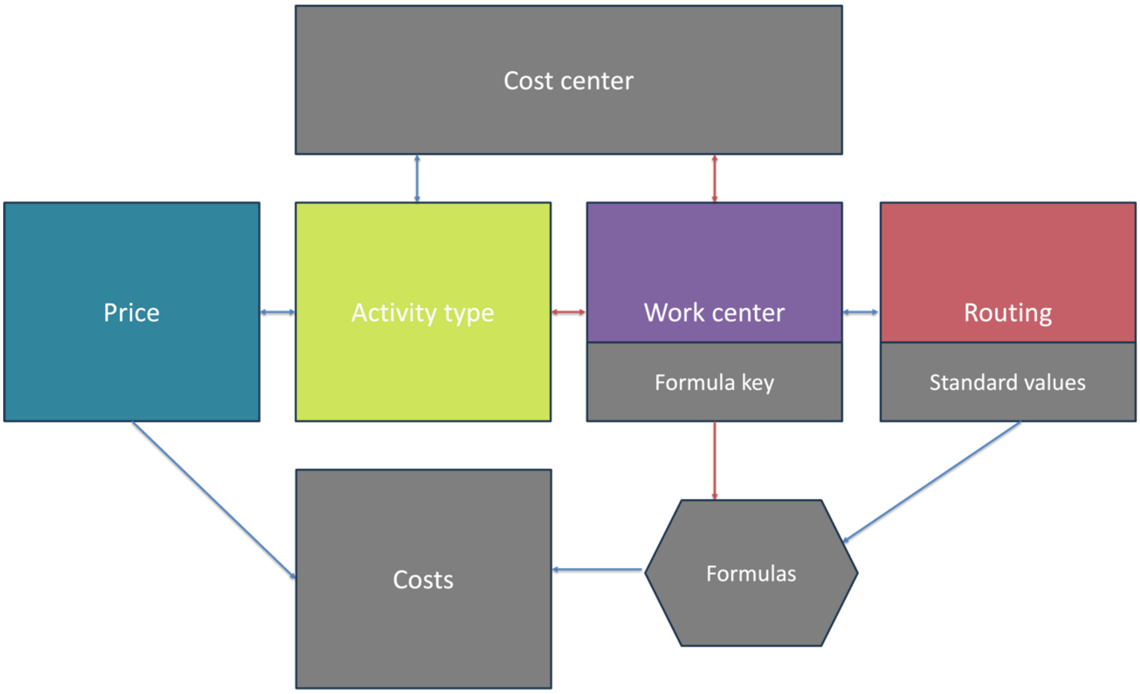

Figure 3 The link between cost center, routing, and work center (based on SAP, 2023d).

Various specifications are necessary for each operation in order for the calculation formula to function. Default values for operations can be entered in the work center (SAP, 2023c). For example, the control key and activity types play an important role in cost calculation. A control key is an indicator that can be used to determine whether an operation is costed (SAP, 2023e). This key can be used to define the subcontractor as the author of the operation. In this case, a purchase requisition is created when the order is created.

Previously, direct costs were discussed, which include material costs and labor hours to convert materials into the final product (Drury, 2018). Direct costs, excluding material costs, are assigned using activity types defined in the work center (SAP, 2023d). Consequently, the activity type, for example, setup, machine time, and labor time needed to prepare the operation can be added to the work center as a default value. The tracing of direct costs to a cost object was illustrated in the cost accounting section of the theoretical background. In ERP, this is implemented on the basis of defined activity values, which represent direct capacity consumption to produce the operation that constitutes the cost. Standard values are defined for each operation, indicating how much each operation consumes of each activity type, which are defined as default values (SAP, 2023d). These predefined values, along with other parameters beyond the scope of this theoretical background, enable the system to calculate the total cost of an operation (SAP, 2023d).

The work center used at the operation level is linked to the cost center. A cost center refers to a department or unit within an organization that incurs costs but does not directly generate revenue (Noreen et al., 2011). A department may have a cost center, with a manager responsible for controlling its expenses but not its income. Examples of cost centers include accounting departments and service units. Moreover, manufacturing facilities can be considered cost centers (Noreen et al., 2011). To enable cost tracing at the cost center level, the work center is connected to the cost center. A work center can be connected to one cost center, but a cost center can have several work centers connected to it (SAP, 2023c).

The topic has been addressed from a detailed level to a general level. Figure 4 below combines previously discussed topics while illustrating the linkage between them (SAP, 2023d). Starting from the right, with the heading routing, the standard values 1, 2, and 3 hours are defined for operation number 10. Activity types setup, machine, and labor are defined as the default for all operations executed in the work center in question (SAP, 2023d). When the activity types are known and the corresponding standard values have been defined by the operation, the cost can be calculated based on the price defined for the activities. By multiplying the price of the activity by the time spent, the cost of each activity can be determined, as shown in the box at the bottom of Figure 4. Once the operation is completed and confirmed in the system, it transfers the costs from the cost center linked to the work center to the production order.

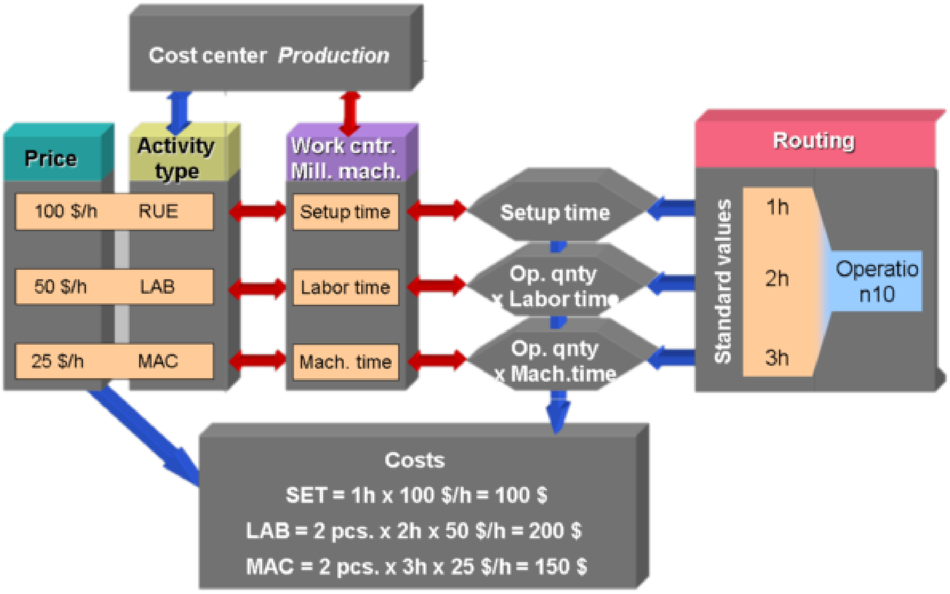

Figure 4 Costing with cost centers (SAP, 2023d).

2.2 Organizational Communication and Cross-functional Processes

Organizational communication is structured both vertically and horizontally. The vertical structure defines the hierarchical organization of departments and the flow of information between different levels, while the horizontal structure defines the cooperation and exchange of information between departments (Cornelissen, 2004). In the case of a cross-functional process, the workflow crosses departmental boundaries horizontally and involves more than one department or organizational unit (Paim et al., 2008). Functionally divided departments lead to a lack of end-to-end process knowledge, resulting in limited control of these horizontal processes. Thus, Paim et al. (2008) underline the difficulty of control without full understanding.

Organizational communication and cross-functional processes are closely linked, as implementing processes that cross departmental boundaries requires communication between the parties involved in the process. Understanding organizational communication and its barriers is essential when examining the information needs of different departments and the activities that require obtaining information from other departments.

Today, powerful organizational communication tools such as Teams and Outlook are available (Wen et al., 2025). Advanced communication technologies enable greater collaboration and facilitate communication. Despite this, there can still be a lack of communication between teams (Wen et al., 2025). The first subsection examines the barriers that are recognized in the literature to effective communication.

Previously, system-level hierarchy and the flow of information between various systems were addressed. Lack of communication or challenges in the accuracy of the data can cause problems at subsequent stages of the process. Implications will be explored in the second subsection to understand the role of communication and information needs in cross-functional processes. There, the focus is on the effects on process operation and efficiency, and examples of the accuracy of cost accounting and decision-making challenges are discussed. After examining the consequences, strategies for improving cross-functional collaboration and information flow are explored.

2.2.1 Barriers to Effective Communication

When examining barriers to effective communication, it is essential to clarify what effective communication implies. Effective communication is a combination of various aspects, including how well information is delivered and how effectively it is shared, utilized, and accessed (Yazici, 2002). Understanding the perspective of others is essential for effective communication. This subsection focuses on the structural, organizational, and informational principles that can hinder effective communication.

Previously, the focus was on the flow of information in manufacturing companies. Information flows between systems, providing information about production to different departments for their needs in business processes (Bruno et al., 2019). Consequently, Berente et al. (2009) acknowledge the difference between information transfer and transformation. Understanding the difference between these two flows is important to optimize the efficiency of business processes, which requires an understanding of the associated information flows. In the case of transfer, information can flow from one process to another without requiring changes. For example, when MES sends real-time production data to the ERP system, the data can be directly transferred without modification. If challenges arise in the transfer of information, the utilization of information technologies can enhance the process (Berente et al., 2009).

In contrast, when transformation is required, the information cannot be directly transferred to the subsequent part of the process (Berente et al., 2009). Actions such as data interpretation, analysis, or modification may be necessary. For example, the finance department receives cost accounting data from the ERP. If an improvement in direct labor hours is achieved, this modification must be updated in the systems from which it is transferred to the finance department. When enhancing a process that requires data transformation, it is essential to examine the content of the data in more detail (Berente et al., 2009).

Understanding how information flows within an organizational hierarchy between employees is essential for optimizing operational efficiency and decision-making effectiveness (Wen et al., 2025). Researchers have been interested in analyzing communication and information flows in organizational hierarchy, as it directly affects operations and decision-making. The organizational hierarchy can be thought of as a proposal evaluation mechanism that defines communication between employees horizontally and vertically (Wen et al., 2025). The research conducted by Wen et al. (2025) focused on examining organizational communication to bridge the micro-macro gap.

The study concluded that organizational hierarchy could regulate communication behavior and the flow of information between employees (Wen et al., 2025). First, the study found the influence of an employee's role in the communication network, meaning that the focal point in the communication network is linked to the role. The types of communication were mainly vertical and horizontal, while communication between the teams was insufficient. Employees working in similar roles can be divided into a community where there is a close relationship between the employee's role and communication behavior (Wen et al., 2025). If there is insufficient communication between different teams in the communication network of the organizational hierarchy, it can hinder effective communication. However, the study identified employees acting as a bridge between different communities despite their lower hierarchical positions (Wen et al., 2025). The bridging role can significantly impact information flow. On the other hand, information transfer should not rely on a single role. Instead, cooperation between teams should be improved by other means to ensure effective communication.

Yazici (2002) examined the role of organizational structure, task complexity, and information technology in effective communication. The study found that a more hierarchical organizational structure can lead to increased communication problems. Cross-functional communication is linked to organizational structure and has an impact on how effectively departments communicate with each other. Information technology was perceived to speed up the delivery of information and enhance its efficiency, but IT alone was not perceived to be a significant factor in effective communication. The study found that the effectiveness of communication depends on the complexity of the task and the influence of the communication media.

Especially in complex tasks, the delivery rate of information is particularly important (Yazici, 2002). This reflects the limitation of information to only a subset of people, while others have to wait a long time to receive it. This can act as a barrier to effective communication and hinder the information flow. In a complex task, waiting for important information can halt the task until the information is received. In addition to the delivery rate, accessibility of information is highlighted as a barrier (Yazici, 2002). If information is limited to a restricted number of personnel who can receive it, it can hinder the smooth cooperation between departments. On the other hand, effective communication can be hindered by the difficulty of information retrieval, where individuals have to make a vast amount of effort to locate information (Yazici, 2002). This duplication of work may lead to inefficiencies that could be avoided by receiving information in a timely manner through easily accessible channels.

Berente et al. (2009) identified a combination of principles that together form a comprehensive framework for understanding and analyzing how information is transferred and integrated within organizational processes. The first principle is the accessibility of information flows. In addition to hindering the flow of information, problems in accessing information become an obstacle to completing tasks. For example, Yazici (2002) highlighted scenarios where the accessibility of information emerged as a barrier to information flow and caused problems in performing a task. On the other hand, accessibility can be affected by organizational structures and the challenges this poses to the flow of information.

The second principle is the timeliness of information, ensuring that information is available when needed (Berente et al., 2009). For example, from a decision-making perspective, information must be up-to-date (Husada Tarigan et al., 2019). Decisions made based on outdated information can lead to increased costs and inefficient processes. A further two principles are transparency and granularity of information flows (Berente et al., 2009). Transparency ensures that the receiving parties understand the meaning of the information as intended. It is essential that the meaning of the information remains in the subsequent stages. Thus, the perspective of the recipient must be taken into account when communicating, as stated in the definition of effective communication (Yazici, 2002). Similarly, the granularity of information takes into account the variation in detail between recipients (Berente et al., 2009).

In order to best convey information to the recipient, the modification of the level of granularity of the information must be considered (Berente et al., 2009). Shaping the level of accuracy of information between recipients requires a clear understanding of the purpose for which the information is delivered. The need for detail varies between functions and groups, creating a need to balance between conciseness and completeness (Berente et al., 2009).

To summarize, communication barriers in cross-functional processes arise from both organizational hierarchies and challenges related to the principles of information flow. In cross-functional processes, information must flow between different departments in the organization. If there is a lack of information transfer between teams, this can hinder the operation of cross-functional processes (Wen et al., 2025). While IT solutions can improve information transfer between processes (Berente et al., 2009), they are insufficient in cases when information transformation is required. In such cases, a deeper understanding of information is necessary to ensure effective communication. If information does not align with the discussed principles, these communication gaps can lead to the consequences examined in the next section.

2.2.2 Consequences of Communication Gaps

In a manufacturing company, the most critical business processes are cross-organizational, meaning that information must be transferred between multiple departments (Sääksvuori & Immonen, 2010). If there are information gaps and relevant information does not reach the necessary stakeholders, this can lead to a variety of consequences. Within the scope of the study, the focus in this chapter is on the consequences of the bill of materials, cost accounting, and decision-making.

The theoretical background and conceptual framework addressed the use of three core systems in manufacturing companies. Information flows between these systems, allowing different departments to access it as relevant to their needs (Avvaru et al., 2020). Berente et al. (2009) highlighted the difference between information transfer and transformation. IT systems are efficient in transferring information to different departments, but there is a risk that the information would require transformation to ensure accuracy due to changes. Therefore, for the information in ERP to be up-to-date, the information in PLM and MES must be accurate and correspond to the actual production. Product data maintained in PLM is transferred to MES and ERP in a form that serves the purposes of the system. If the data in the PLM system is incorrect, transferring it to subsequent systems can cause problems later in the process.

BOM connects different departments in the manufacturing process and is the basis for process tracking, planning, and cost calculation (Wang et al., 2022). It effectively combines the product structure, the business data of the product, and the relationships between components (Wang et al., 2023). Since manufacturing, purchasing, and cost accounting rely on BOM data, accuracy and timely data are vital. However, configuration of BOM between different stages of plan management is challenging for complex products (Wang et al., 2023). Configuring a BOM for a complex product requires information to flow between several teams. The information in every step must have coherence, as the configuration process will halt if the system detects inconsistencies or deficiencies in the data. If there are obstacles in configuring the BOM and it is not completed within the required timeframe, departments that depend on the data will not be able to perform their functions. As a result, this may cause delays and deficiencies in production.

Zhao et al. (2024) highlight the challenge of effective management and application of complex product lifecycle data from a different perspective. Stakeholders involved in business decision-making at different life cycle stages may be geographically dispersed from each other, posing challenges to data consistency and completeness of information delivery. This highlights how maintaining consistent information is challenging, yet essential to the functionality of the process. Information transfer must be efficient and consistent, not only to preserve the completeness and consistency of information, but also to support effective decision-making by stakeholders (Zhao et al., 2024).

According to Wang et al. (2022), reconstructing the BOM of complex products is a highly complex process. They mention that the need to update BOM data can arise from various sources. These include production, design, process changes, and observations made in the maintenance environment. The changes made may cause inconsistencies between production and BOM data (Wang et al., 2022). For instance, if changes are made in the production environment without informing those responsible for the product data, the data becomes unsynchronized with the production environment. This may complicate the manufacturing of the product and cause additional effort to obtain system support. Consequently, both BOM and BOP require continuous maintenance, which requires co-operation between departments (Sly, 2018). Wang et al. (2022) emphasize the importance of a dynamic feedback mechanism to support BOM data for product design and manufacturing changes. The objective is to ensure that BOM structures support the requirements of the manufacturing environment.

The discussion now shifts from the synchronization of production and BOM data to the importance of cost accounting and product cost synchronization. Previously discussed ABC improves profitability measurement, provides accurate allocation of overhead costs, and improves strategic pricing decisions (Kitsantas et al., 2020). The role of cost management is to provide information that contributes to the company's strategy (Rounaghi et al., 2021). In large-scale customized manufacturing, BOM plays a key role in refining the accuracy of cost estimates (Chao & Trappey, 2024). The data in the ERP system must serve as a reliable basis for cost estimation. Consequently, the data in the systems must be up-to-date to support cost accounting and enable decisions to be guided by accurate information. Information quality is one of the main determinants of the quality of decision-making (Ouiddad et al., 2021).

To ensure that the data in the ERP system provides up-to-date and accurate information for cost accounting and decision-making, the data must reflect the actual situation in changing circumstances (Wang et al., 2022). Kadir et al. (2020) emphasize that cost estimation requires a significant amount of knowledge about manufacturing that needs to be synchronized from design to production. After complex configuration processes, the BOM transfers cost accounting data. Thus, the data provided by the ERP is at the level of accuracy defined in the BOM. For example, if there is a change in the subcontractor of a subassembly, the information must be changed in the systems so that the costing aligns with the actual process. If the need for change is not communicated due to information gaps in cross-functional processes, problems occur in cost accounting and production orders. As a result, outdated data is transferred to the systems, which is inconsistent with the actual process.

In manufacturing companies, various departments utilize information from the ERP system that manages business processes in the organization (Avvaru et al., 2020). One of the core functions of the MES system is to provide real-time data on production progress and exchange information between the organizational level and production (Avvaru et al., 2020). If the progress of production reported in the MES is inconsistent with the actual progress of production, this causes an information gap. Consequently, departments utilizing data from the ERP system will not receive up-to-date information. This influences the accuracy of the business resources and order status monitoring in the ERP system (Avvaru et al., 2020). If the system is not up to date with the actual status, the information received by other departments will be unreliable (Husada Tarigan et al., 2019). Accurate and timely information on the costs of processes, cost objects, and activities is a prerequisite for managing an organization (Kitsantas et al., 2020).

These findings indicate that the quality of data transferred between systems plays a crucial role in the success of cross-functional processes. To ensure data accuracy in dynamic environments, information must flow through cross-functional processes to the right departments to ensure that the data aligns with actual processes. In manufacturing companies, the accuracy of the BOM is essential not only for ensuring seamless production operations but also for cost accounting and management accounting. Liang (2025) highlights that in modern industrial enterprises, strengthening cost management and enabling timely executive decision-making requires precise and efficient cost accounting. Accurate and up-to-date information is vital for making informed decisions. Inefficient communication can lead to costly errors and waste, as communication serves as a source of information that managers rely on for decision-making (Musheke & Phiri, 2021).

2.2.3 Strategies for Enhancing Collaboration and Information Flow

Strategies to enhance information flows and cross-functional collaboration are presented next. When discussing the barriers and consequences of communication gaps, it emerged that information technologies can support integration between business units or organizations through data and systems integration (Berente et al., 2009). However, information integration alone is inadequate for the seamless operation of processes, as individuals and groups have different information needs and practices (Berente et al., 2009).

Information flow is an essential part of workflow, requiring synergy between people and IT (Durugbo et al., 2013). To improve information flow, it is crucial to first understand the current flow in the organization, for example, by modeling. Furthermore, it is important to identify interdepartmental communication barriers that inflexible organizational processes (Durugbo et al., 2013). Similarly, Berente et al. (2009) emphasize the importance of first understanding process-associated information flows when aiming to improve business processes in an organization. They note that when striving to improve organizational performance, it is critical to understand information, its flow, and the technologies that support it.

Paim et al. (2008) presented three methods for coordinating processes to facilitate the effective implementation of process management in an organization. The first one is to plan and define how the process will be performed. The second one is to see the day-to-day process management, and thirdly, to learn about the evolution and history of the process. Albino et al. (2002) proposed a methodology to describe the information flows involved in coordinating production processes. They define process coordination as consisting of the management and execution of interdependent tasks, which includes processing and transferring the information required for the process. By understanding how tasks are interdependent and related information flows, process coordination and improvement can be achieved (Albino et al., 2002).

In the context of cross-functional process collaboration and improving information flow, the literature emphasizes that the first step is to develop a better understanding of information needs, supported by process modeling or design. Once the process has been designed, it can be developed based on observations, considering the flow of information and all the stakeholders involved in the cross-functional process. This approach helps ensure that the information needs of each party are acknowledged and not overlooked during process changes. Furthermore, a combination of principles related to information flows should be considered. According to Berente et al. (2009), this includes accessibility, timeliness, transparency, and granularity of information flows.

Literature suggests that modeling information flows in organizations is useful for continuous process improvement, organizational collaboration, and improved information sharing (Durugbo et al., 2013). However, information modeling is challenged by the definition of organizational networks, information synchronization, and information flow focus. Damelio (2011) highlights various reasons for mapping processes. It provides a context for the work and facilitates identifying the part and whole workflow relationships and the contribution to the enterprise. Process mapping also improves communication and shared understanding by highlighting key areas that require attention and explaining their significance (Damelio, 2011). Moreover, process mapping should be performed when establishing new workflows or when changes are made to the enterprise-level processes. With the aim of improving collaboration and information flow in cross-functional processes, concrete examples of modeling and process design are presented.

A relationship map provides a visual representation of organization-level relationships without specifying work tasks (Damelio, 2011). It can be used to highlight the contribution of different parts and illustrate how inputs and outputs are interconnected across different parts of the organization. Additionally, a relationship map can be a useful tool for identifying the organizational boundaries that work must cross to create value in the process (Damelio, 2011). This, in turn, helps clarify the role and contribution of different stakeholders within the organization. A typical relationship map consists of three components, which are Supplier, Organization, and Customer, shown in Figure 5 below (Damelio, 2011).

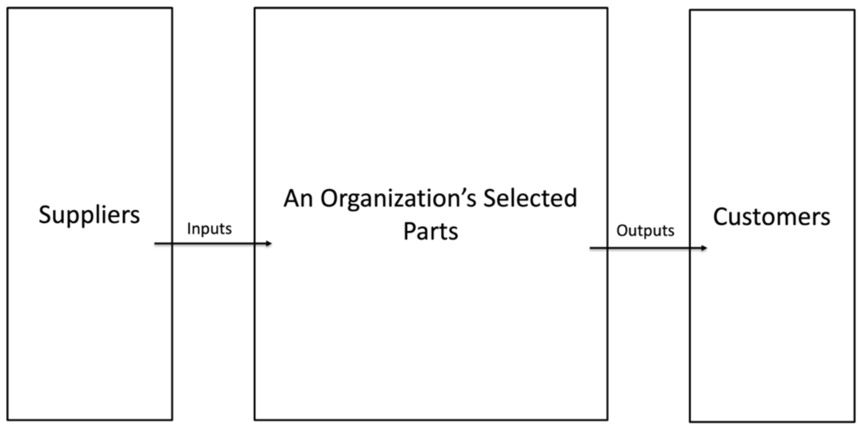

Figure 5 Relationship map template (Damelio, 2011).

When the purpose is to enhance collaboration and information flow, the current information flow in cross-functional processes should be modeled (Durugbo et al., 2013). Diagrammatic modeling methods of information flow include, for example, pictorial, matrix, and graph. Examples of graph modeling are presented next. Organizational workflows can be illustrated with a Cross-Functional Process Map (CFPM) (Damelio, 2011). This map illustrates processes that span multiple functional areas and outlines the specific work to be performed within each area. It describes a cross-functional process in medium detail, without detailing activities the work includes (Madison, 2005).

CFPM, also known as a swimlane diagram, simultaneously visualizes the tasks involved and the organizational units responsible for their execution (Damelio, 2011). The diagrams are useful to illustrate organizational handoffs and find the activities that have challenges with the flow of information between them (Damelio, 2011; Madison, 2005). Understanding process-associated information flows is essential when seeking to improve business processes (Berente et al., 2009). Therefore, when the work is placed as a part of the whole with the help of CFPM and a context is created, the meaning of the own work task can be better understood in the cross-functional process (Damelio, 2011). Improved understanding can enhance the flow of information by identifying where to concentrate in the process. When a more detailed chart is required, a flowchart represents the activities to create a specific output (Damelio, 2011).

This chapter has examined how visual tools such as relationship maps and cross-functional process diagrams can clarify information flow across departments. The focus of the research is on the Process Control department, thereby its information needs are a central factor in optimizing interdepartmental information flow. The information needs associated with the annual cycle can be visualized using an annual clock, which can function as a coordination tool according to Ruotsala (2014). This shared tool can help to overcome functional boundaries and motivate collaboration. However, the annual clock alone does not guarantee sustainable cooperation but requires other actions to support it. Ruotsala (2014) notes that the annual clock can be utilized as a practice script, providing a means for developing collaboration in the future. Thus, it can serve as a tool to improve collaboration among cross-functional processes and to highlight information needs in their context.

To conclude, improving information flow and collaboration across departmental boundaries begins with examining how information flows within processes (Berente et al., 2009; Durugbo et al., 2013). Modeling can be utilized to identify areas for improvement and the need to develop new processes. The visualization of processes can provide benefits by setting the work of different departments in context and enabling a better understanding of the information needs of others.

2.3 Process Control in Organizational and Manufacturing Settings

The definition of process control begins with the process control of physical processes, from which it shifts to the management of business processes. The aim is to examine the literature on the meaning of process control and to connect the role of process control in organizational and manufacturing settings.

When process control is viewed from a physical system perspective, understanding the process is a prerequisite for designing a successful control system (King, 2016). King (2016) emphasizes the differences between the roles of the process engineer and the control engineer in this context. The process engineer is responsible for designing the stable state of the process. In contrast, a control engineer is required to have a deep understanding of the dynamics of the process to maintain it steady under changing conditions and in the occurrence of disturbances. Therefore, a control engineer is required to have an understanding of process parameters and their movement between steady state, as well as the dynamics of the process and its impact on the control system.

Thus, controlling physical processes requires an understanding of the steady state of the process and how to stabilize it in the event of a disturbance. In addition to the process and control engineer, collaboration is required with the technician, instrumentation engineer, and systems engineer (King, 2016). The steady state designed by the process engineer is only a starting point. In the event of a disturbance, the process must be restabilized. Effective process control is not the responsibility of a single role but requires collaboration and the input of multiple experts.

Process control is centered on the control of specific processes, while process management focuses on processes as a whole. Next, the discussion shifts from physical processes in general to processes with input, process, and output as illustrated in Figure 6 below (Munro et al., 2015). The figure presents a feedback loop designed to help in process control. Munro et al. (2015) discuss two alternative approaches. The first states that the role of process management is to collect information on inputs and outputs that are utilized to improve processes. The second suggests that process improvement should be designed as part of the process. They point out that a business system is designed to execute a set of processes, and it is critical to ensure the appropriate inputs and resources are available for the process. The business system should aim to continuously improve processes, products, and services, which requires the collection and analysis of relevant data (Munro et al., 2015).

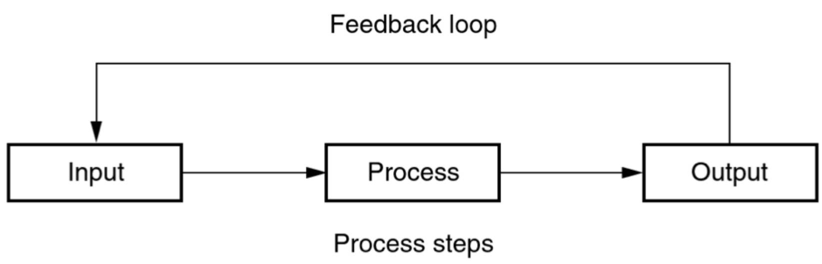

Figure 6 Feedback loop between output and input of a process (Munro et al., 2015).

When it comes to process improvement, Business Process Management (BPM) is a discipline that integrates management sciences and information technology to support and enhance operational business processes (van der Aalst, 2013). Erasmus et al. (2018) describe BPM as an effective tool for organizing and coordinating work between people, information systems, and different business functions. Its objective is to increase productivity and reduce costs through process modeling, analysis, and optimization (van der Aalst, 2013). While BPM does not necessarily require the use of technology, tools such as ERP systems can support its implementation. Van der Aalst (2013) highlights process-aware systems, such as ERP systems, that are designed to support the processes they manage. Moreover, Erasmus et al. (2018) emphasize the growing importance of BPM as new modules are introduced into the ERP system.

Similarly to the maintenance required to control and maintain the stability of physical processes, BPM requires continuous effort after the implementation of the system. Processes require management, as changing circumstances may require modifications to the process. Consequently, continuous monitoring is essential for both business and physical processes (van der Aalst, 2013).

2.3.1 Coordinating Function

In an organization, processes may require input from several functional units. Business processes can span multiple organizations, becoming more complex over time and dependent on information systems (van der Aalst, 2013). It is emphasized that processes between organizations can only function properly if there is a shared understanding of the required interactions. This highlights the importance of process modeling, which is therefore widely applied in modern organizations (van der Aalst, 2013).

According to Berente et al. (2009), a key starting point for business process improvement is understanding the flow of information. When an organization has a clear picture of the operation of the process, the information that flows through it, and the information needs of others, the process can work efficiently. In this way, BPM can be utilized in processes across business functions and improve integration between them (Berente et al. 2009).

Business process integration aims to minimize coordination and communication between process activities, thereby requiring the four principles of process integration: accessibility, timeliness, transparency, and granularity (Berente et al., 2009). Erasmus et al. (2018) point out that the manufacturing industry suffers from fragmented process management when multiple information systems are used. The ISA-95 standard aims to promote integration between systems in manufacturing companies (Chen, 2005). However, Erasmus et al. (2018) highlight that the standard focuses on ontological standardization and the exchange of data, thus neglecting process integration. As the literature review has emphasized, information flows in systems, but ensuring its accuracy remains a challenge. Especially in cross-functional processes and as processes become more complex, the need for interaction is essential to be understood (van der Aalst, 2013). It is vital to understand how the process functions and the information needs of others to be able to provide the process participants with the information they require.

2.3.2 Managing Change

At the beginning of the chapter, the physical process was discussed, where a deep understanding of the process is required to define a stable state (King, 2016). To re-stabilize the process after a disturbance, an understanding of the operation and parameters of the process is essential. This approach is next applied to cross-functional processes. In these, a change to part of a business function process may require a change to other parameters of the process to maintain the functionality of the process.

In a manufacturing company, the bill of materials is critical information for the different functional units of the organization, such as enabling production, product, and process planning (Wang et al., 2022). The reconstruction of the BOM is an example of a process where multiple departments combine information to create the final MBOM. Wang et al. (2022) note that BOM data is dynamic and subject to change due to factors such as design improvements or technological developments. As a result, inconsistencies or outdated information may only become apparent later, for instance, during manufacturing. Therefore, it is essential that all departments involved understand how changes in BOM data affect one another and ensure the consistency of information.

Whether creating new processes or maintaining existing ones, a thorough understanding of the process's functioning is essential. Achieving a stable operational state is only one part of process management. As van der Aalst (2013) explains, BPM does not end with the implementation of a process but requires continuous monitoring and adaptation. When circumstances change, the process must be adjusted to maintain stability. Ultimately, process management is at risk of failure without effective communication of changes between functions.

2.4 Summary

The central focus of the literature review has been the flow of information in cross-functional processes within manufacturing companies. Information is transferred across multiple systems, enabling departments to access the data they require. The review has examined the data transferred in the system, for example, to enable cost accounting and to support informed decision-making with accurate information. The summary presents the key findings of the literature review.

Management accounting focuses on the future and utilizes both quantitative and qualitative data to support decision-making (Drury, 2018; Noreen, 2011). The accuracy of cost information is essential for decision-making and planning (Kitsantas et al., 2020), highlighting the importance of reliable data in cross-functional processes. Information flows vertically, horizontally, and diagonally in an organization (Wen et al., 2025), being a significant part of the workflow (Durugbo et al., 2013). While IT facilitates coordination between departments and speeds up the delivery of information, it alone is insufficient to ensure effective communication (Yazici, 2002).

The core systems of manufacturing companies, PLM, ERP, and MES, have been introduced. The interfaces between the systems play a critical role in enabling data transfer between departments. The ISA-95 standard facilitates the flow of information across systems to different functional areas of the organization with varying information needs (Chen, 2005). However, the standard focuses on data transfer without considering the accuracy of the transferred data.

The final subsection of the theoretical background and conceptual framework has connected the system-level hierarchy, information flow, and the data required for cost accounting using routing and BOM. In the production of complex products, the BOM serves as a link between departments, transferring information for various operational and financial purposes (Wang et al., 2022). As a result, information accuracy becomes essential. Cost accounting requires information such as direct labor hours, which are included in systems via routing and related master data. This master data is created in PLM, transferred to ERP, and monitored in real time through MES.

The following themes in the literature review have emphasized the importance of understanding information flow within processes as a prerequisite for improvement. Berente et al. (2009) highlight the need to understand the information in the process, its flow, and supporting technologies when aiming to improve organizational performance. To be able to transfer up-to-date information through systems, the data must be maintained. There must be a common understanding of the interaction required for the effective functioning of cross-functional processes (van der Aalst, 2013). Effective communication requires accessibility, sharing, and use of information, and an understanding of the information needs of others (Yazici, 2002). These principles serve as a foundation for improving the information flow, as the first step is to understand the current situation and the barriers in order to overcome them. Visualizing the flow of information can help to understand the information needs of others and thereby support communication.

Consequently, as a stable state must be maintained in physical processes, sustaining business processes requires a comprehensive understanding of the operation. To ensure accurate information flow between systems after a change, there must be an understanding of how the process can be restabilized. This requires effective communication with relevant stakeholders to implement the necessary changes. Without such communication, transferred information within systems may cause problems in later stages. Understanding processes and recognizing the information needs of others is the first step towards enhanced communication.

3 Methodology

This study was conducted as a qualitative case study focusing on the role of the Process Control Department in a manufacturing company. The objective was to explore the importance and role of the PC between management accounting and production, while examining the interdepartmental information flow and information needs in the cross-departmental processes. Information flow and collaboration between departments were reviewed with the aim of optimizing cost accuracy and data consistency with the production environment. The following subsections discuss the design of the research, data collection, and data analysis. Finally, reliability, validity, and limitations of research are addressed.

3.1 Research Design

This research is a case study that examined the phenomenon in a real-life context (Yin, 2009). There are two types of single-case study design: a study with one or multiple units of analysis. This research is a single-case study with multiple units of analysis, where the work categories of the PC represent different units. The division of the research into units facilitated a deeper exploration of themes relevant to the research, as each unit involves specific challenges and stakeholder departments.

The research has an inductive approach, which seeks to achieve a better understanding of the phenomenon through empirical data (Bryman, 2012). Inductive reasoning enables the formation of broader theoretical insights by interpreting patterns that emerge from the case context. The research design is exploratory, as it seeks to examine relatively under-researched topics (Saunders et al., 2007). At the same time, the research contains elements of evaluative research. These are expressed in terms of an assessment of the current information flows and processes. Furthermore, suggestions for improvement are proposed.

3.2 Data Collection

The aim was to obtain a comprehensive understanding of the case in question (Yin, 2009). The purpose of the data collection was to acquire an overall picture of the matter, from which a more detailed analysis of the topic could be conducted, focusing on aspects relevant to the research. Data was collected from several sources to complement and support each other (Yin, 2009). The subsections first describe the observation and the collection of secondary data. This is followed by a review of the interviews that were conducted as part of the primary data collection.

3.2.1 Observation and Documents

Observation and document collection were utilized to obtain a comprehensive picture of the case. According to Simons (2009), observation can provide a holistic view of the case that cannot be achieved through discussion alone. Observation provided context to the information that emerged from the interviews while allowing for cross-validation. Direct observation was conducted by observing work activities and meetings. The advantage is revealing the information in its original context, which is not possible in interviews (Puusa et al., 2020). Notes were taken of the observations, allowing access to the collected information afterwards. Observation enabled the identification of topics that were not found in the documents related to the case. This allowed the research to focus on these topics through interviews.

According to Simons (2009), documents can highlight key aspects of a case before interviews, which was the intention of document collection in the research. Simons (2009) uses the word *document* for any written or recorded matter related to the context of a case or produced from the context. The documents utilized in the research included an organizational chart, PowerPoints, flowcharts of cross-functional processes, an annual clock, and a worklist maintained by the PC. The worklist contains completed and in-progress activities, including background information about each task. In addition, the cases and orders discovered in the research were examined using ERP software. The documents provided a general overview, for example through flowcharts, while also enabling access to more detailed information. However, the information received from the documents was treated as clues (Yin, 2009), which were verified by interviews.

3.2.2 Interviews

Interviews represent the primary data collection method in the research. The interviews were conducted first for an interviewee from the PC. First interviews were guided and open-ended, containing only a few guiding questions, focusing on the department's work tasks and responsibilities. This was followed by semi-structured interviews for the interviewee from the PC to explore specific topics in more depth based on the analysis of open-ended interviews, documents, and observations. A semi-structured interview was chosen to allow for a more focused discussion on issues that emerge during the interview (Simons, 2009). The interviews were conducted in person and recorded with transcript functionality. Afterwards, each interview was transcribed for the analysis.

Based on preliminary analyses, the stakeholder teams and departments of the Process Control relevant to the research were identified. Parallel collection and analysis of data enabled the identification of relevant interviewees and the generation of interview questions for the stakeholder teams and departments (Puusa et al., 2020). Five key stakeholder teams and departments were identified and are referred to in the research by letters A to E. The interviewees from each stakeholder group are listed in Table 1 below, which indicates the interviewee and the duration of the interview. A number following the letter indicates different interviewees from the same stakeholder group.

Table 1 Interviewees of stakeholder departments.

Interviewee	Duration of the interview
A1	57 min
B1	54 min
C1	30 min
C2	47 min
D1	60 min
D2	31 min
E1	52 min
E2	43 min
E3	53 min
E4	37 min

Interviewees were selected utilizing purposive sampling, whereby a person with comprehensive expertise on the subject was selected for the interview (Campbell et al., 2020). Additionally, maximum variation sampling was partially utilized, allowing different teams and experiences to be taken into account. This way, the research considers a broader perspective, as different teams have specialized and encountered different cases in their work.

The interviews were conducted in person in a planned order. However, the interview for B1 was conducted remotely to maintain the order. The interviews were scheduled for one hour and ranged from half an hour to an hour, with an average of 46 minutes. At the beginning of the interview, a slide about the research and the selection of the interviewee was presented, which was also attached to the interview invitation. Furthermore, permission for recording was asked, and the anonymity in the research was explained. Recording and transcription were conducted as in the PC's interviews. The stakeholder interviews consisted of two parts. The first part was the same for all interviewees, and the second part was customized for each department. The first section contained seven Likert-scale questions to obtain the interviewee's understanding of the Process Control department's operations, collaboration between departments, and the frequency of communication. The aim was to establish an overall picture of communication between the department and the PC. The questionnaire also included a question concerning the department's main areas of responsibility, as well as instances of communication between the interviewed department and the PC in both directions. The department-specific section, including open-ended questions, focused more specifically on cooperation, information sharing, and processes requiring collaboration between the department and the PC. The second part of the interview was semi-structured, allowing flexibility in the order of the questions and the possibility of further questions. This approach supported the natural flow of the conversation and allowed for a deeper understanding of the interviewee's perspective (Simons, 2009).

3.3 Data Analysis

Data collection and analysis were conducted in parallel, which is a typical procedure in qualitative research according to Puusa et al. (2020). Figure 7 below demonstrates the steps of data collection and analysis in the research process. Observation and document analysis assisted in constructing interview questions for the semi-structured interviews and discovering relevant subjects for the research. After collecting and transcribing interview data, thematic analysis was conducted.

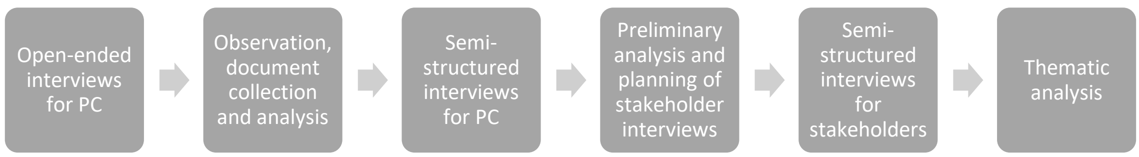

Figure 7 Steps of data collection and analysis.

Thematic analysis was selected as the method of analysis since it is suitable for analyzing qualitative interview data (Nowell et al., 2017). It can provide a comprehensive description of a phenomenon from different perspectives, emerging themes from the data, and identify recurring patterns. As thematic analysis is an adaptive form of analysis, it can pose a challenge to the consistency of analysis when developing themes (Nowell et al., 2017). The six-step method developed by Braun and Clarke (2006) was utilized to conduct a thematic analysis. They emphasize the importance of systematic analysis of the entire data, which was ensured at every phase of the analysis.

The first phase involves familiarization of the data (Braun & Clarke, 2006), beginning with the interview, continuing through the transcription, and reading the material. *The second* step in the analysis was the generation of codes, where particular attention was paid to systematically reviewing the entire dataset, as recommended by Braun and Clarke (2006). At this stage, all information relevant to the research and research questions was coded, meaning that significant information was extracted from the interview data and labelled with a descriptive title (Byrne, 2022). Latent coding was applied, where the researcher has a more active role in identifying the underlying assumptions in the codes (Byrne, 2022). The identified aspects were marked in the code using comments, allowing the progress of the reflection to be monitored.

The third phase began after the coding of the data was completed. The focus then shifted from individual codes to the data as a whole, using the codes to establish themes (Byrne, 2022). The codes were classified into themes using an inductive approach, whereby they were generated from the data without direct linkage to the interview questions (Nowell et al., 2017). However, since the case study has multiple units of analysis, these had an impact on the formation of the themes. Codes were not excluded at third phase, as Nowell et al. (2017) suggest in their paper. *The fourth* stage involves a review of the themes created (Braun & Clarke, 2006). At this phase, themes that were irrelevant to the study were identified and excluded from the data. Revisiting themes enabled greater coherence of the data and minimized overlap between themes.

At the beginning of the fifth phase, the themes were defined, and data that appeared outside the scope of the research were removed from the dataset. In *the fifth* phase, themes were defined and named (Nowell et al., 2017). Braun and Clarke (2006) describe this phase as examining the content of themes, which helps identify interesting aspects of the theme. The relevance of the theme to the overall picture and its relation to the research questions were addressed (Nowell et al., 2017). Finally, a preliminary order of discussion of the themes in the results section was established. This was intended to maintain a coherent and consistent whole across the themes and sub-themes. Thus, the results are a reflection of *the sixth* phase of the thematic analysis, which was producing a report.

The report applies narrative analysis within the themes identified through thematic analysis. This approach enabled deeper meanings to be explored within the themes, as the data was also analyzed as a whole in accordance with narrative analysis, without fragmenting the interviewees' stories only into individual observations (McAllum et al., 2019). The interviewees from the different stakeholder groups have unique narratives. Therefore, thematic and narrative analyses were applied to construct an overview to incorporate the different perspectives within the themes. Consequently, the report utilizes thematic analysis, which is further explored by narrative analysis within each theme.

3.4 Reliability, Validity, and Limitations

This chapter explores the reliability, validity, and limitations of the case study. In qualitative research, it is essential to address various criteria to ensure the trustworthiness of the study (Nowell et al., 2017). Puusa et al. (2020) note that the interpretations of a study are only credible if the analysis has been systematic and trustworthy. In order to achieve trustworthy data analysis, the following choices were made when analyzing the data. A codebook was maintained during the coding process, in which the generated code alternatives were recorded. When latent coding was utilized, observations were documented, allowing the development of interpretations to be traced. Furthermore, the different phases of the thematic analysis were documented in separate files to track the progress of the formed themes.

In qualitative research, validity refers to the strategies used to ensure that the results represent the participants' perspectives (Creswell, 2017). In this research, triangulation was utilized in data collection, which enhances the credibility of both the results and their interpretation (Lincoln & Guba, 1985). The results aim to capture the perspective of different departments on the subjects under discussion by taking into account the departmental views and information needs related to the topics under discussion. To ensure authenticity, direct quotes have been included to capture the voices of the participants.

Finally, the limitations of the study are acknowledged. The primary data collection method was semi-structured interviews, which limited the number of participants. However, the focus was on departmental information needs, which are less dependent on the sample size. In contrast, the evaluation of participants' knowledge of the PC can be influenced by the number of interviewees. The scope of the case resulted in further limitations. For instance, the research was conducted from the perspective of the PC and therefore, the information needs of other departments were not explored with the same level of detail.

4 Results

The results are structured according to the themes identified through thematic analysis, supported by narrative analysis of the data. The analysis revealed two main themes that describe the role of the Process Control department in the organization in coordinating and managing information between different departments. Table 2 below presents the two main themes and their related subthemes, along with the corresponding subsections in the results chapter. The first main theme concerns the creation and maintenance of data to support processes, while the second theme deals with cases that deviate from the standard process. In the latter cases, the PC can assist in updating the data in the systems to reflect the deviating situation, ensuring that the transferred information is accurate.

Table 2 Main themes and subthemes of thematic analysis.

	Main Themes and Subthemes
1	Creation and Maintenance of Data to Support the Processes
	4.2 Maintaining Routing for Cost Calculation
	4.3.1–4.3.4 Creating and Maintaining Routing Data and Managing Change
	4.3.5 Establishing New Processes
2	Cases Deviating from the Standard Process
	4.4.1–4.4.2 Additional Orders
	4.4.3 Exceptional Cases Related to Costs

The results begin with an introduction to the stakeholder departments, an overview of work categories to be discussed, and an exploration of the interviewees' understanding of the PC. This is followed by a discussion of the findings of the first main theme, which is divided into two chapters, including three work categories. As shown in Table 2, each of the work categories covered by theme one is divided into a separate subtheme. The second main theme of the thematic analysis and the related findings are discussed thereafter. According to Table 2, it is divided into two subthemes, which address additional orders and exceptional cases related to costs. The Process Control's annual clock is being developed alongside the results and is presented in more detail at the end of the results.

4.1 Overview of Work Categories and Stakeholder Departments

Work categories constituting the units of analysis in the research are presented in this chapter. Identified stakeholder departments are linked to the work categories and introduced, along with the primary system each department utilizes. Finally, the chapter describes the stakeholder departments' understanding of the PC's responsibilities, and the frequency of communication between the PC and its stakeholders is described.

The main theme of maintaining data to support the process includes three categories of work. These are united by the role of the PC in generating and maintaining data. This allows systems to transfer data to the necessary subsequent processes. The first category of work to be presented is a cross-functional process that considers the costs of manufacturing a product to determine the price. The responsibility of the PC in the process is to define and connect routing to the material number, which allows the capacity consumption of the different activities in the manufacturing to be taken into account in the pricing process (PC). The ERP system is used in the work category in question.

"So, I will say it's quite critical because the [product] *costing is one of the main inputs that is needed in the next step* [for the following organization]*." (C1)*

The second work category focuses on routing data of products to be manufactured. The PC maintains and generates a bill of process data structure to automate the generation of routing for each product family (PC). The data environment is maintained in PLM software and referred to as BOP1 in the research. The routing is transferred to the ERP system along with MBOM in various stages of the construction process (A1). Therefore, the accuracy of BOP1 data plays a significant role in ensuring that the data transferred to ERP is accurate. The third category of work within the first main theme concerns the creation of new processes. This typically involves modifications to BOP1 data but may include other activities and support from a process specialist. The second main theme concerns deviations from the standard process. These can be caused by additional needs or additional work in production. Additions or changes are made in the ERP system.

Considering the maintenance of product data in the PLM software, two departments emerge as key stakeholders for the PC. BOP1 must remain synchronized with BOP2, which is maintained by Department A. This highlights the need for collaboration between the PC and Department A. In turn, Department B constructs the final product structure, MBOM, with BOP1 serving as a link between the PC and B. These two departments are connected to the PC through the main theme one.

"We should not actually need to communicate with the Process Control, because, from our point of view, it is the maintenance of the data in the background." (B1)

The thesis examines the role and strategic importance of the PC between production and finance functions. The routing managed by the PC transfers master data from PLM to ERP, which is monitored by finance functions. One of these is stakeholder Department C, which is connected to the PC's areas of responsibility through several work categories. Stakeholder team D was identified through interviews with PC, as they are one of the sources of information in communicating changes in the production environment (PC). Team D is responsible for production development, for example, in terms of safety and flow (D1; D2). The final stakeholders are production project teams, connected to the PC through the second main theme. Their primary system used is ERP, and MES to some extent. Interviewees E1, E2, and E3 are project team managers for new products, while E4 is from a different department and is responsible for managing projects related to product changes.

Figure 8 below illustrates the main system used by each stakeholder, either PLM or ERP. Team D has been omitted from the diagram, as the main system is neither of the two mentioned. These five departments were identified as key stakeholders for the PC and were selected for interviews. Next, their understanding of the PC's responsibilities is examined to identify potential communication barriers that may need to be addressed in the results.

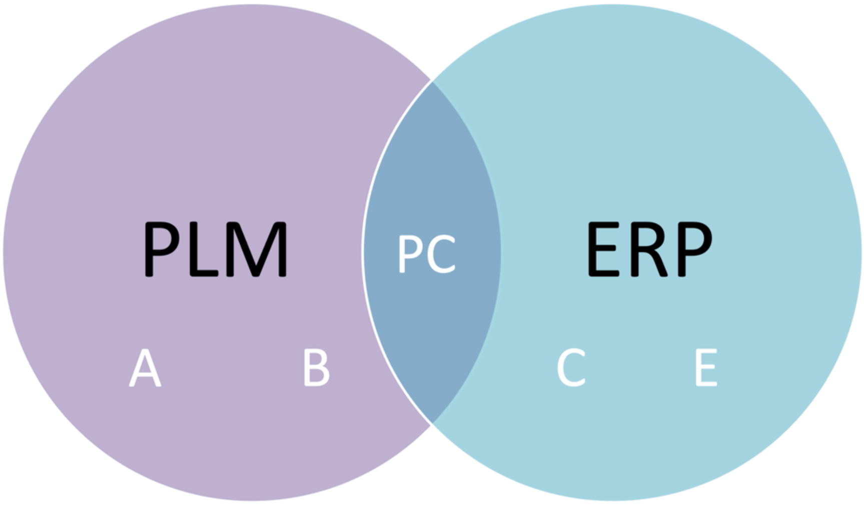

Figure 8 Main system used by the stakeholder departments.

Likert-scale questions were included in the interviews to assess the interviewees' understanding of the PC's responsibilities and work tasks, as well as the frequency of communication with the PC. Figure 9 below presents the responses. The interviewees' understanding of the responsibilities and work tasks of the PC is in the blue line **(Question A)**. On this scale, 1 indicates excellent knowledge and 5 indicates extremely weak. The orange line **(Question B)** addresses the frequency of communication between the PC and the interviewed department, with a scale of 1 - Daily, 2 - Weekly, 3 - Monthly, 4 - A few times a year, and 5 - No communication.

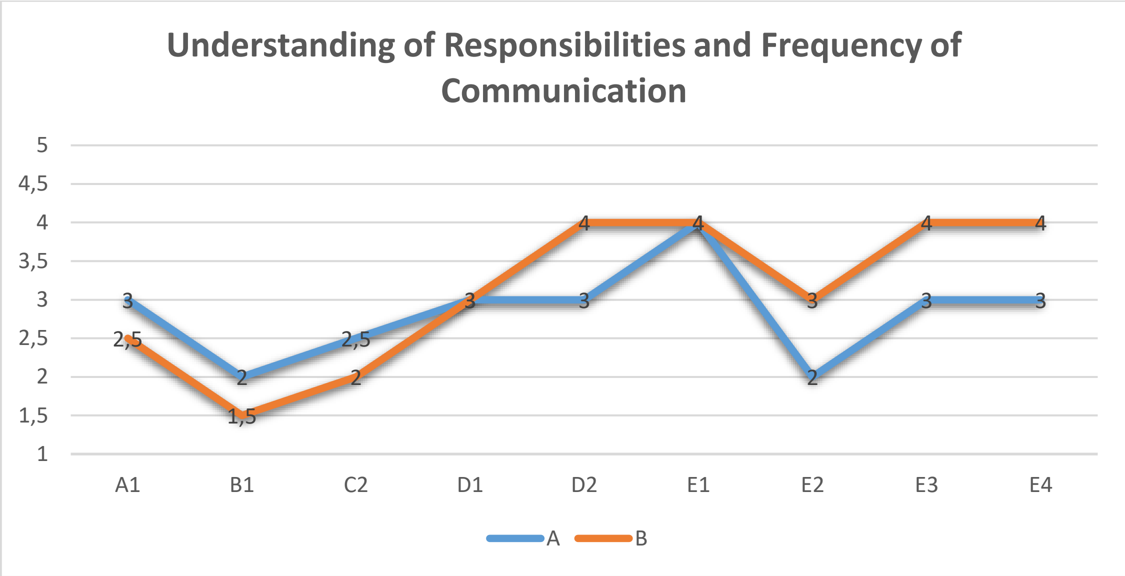

Figure 9 Understanding of responsibilities and frequency of communication.

There is a positive correlation between responses A and B, with a value of 0.67. In general, interviewees who reported more frequent communication also perceived themselves as having a better understanding of the PC's responsibilities. On the other hand, less frequent communication suggests a better understanding than the communication frequency is. Meanwhile, the three most frequently communicative departments have 0.5 units lower understanding compared to the frequency of communication. Moreover, Figure 9 indicates that the PC is most frequently communicating with departments A, B, and C, while communication with D and E is more occasional.

In response to an open-ended question about the PC's main responsibilities and role in the company, all interviewees mentioned maintaining routing or referred to it as BOP1. Furthermore, each interviewee appeared to be most familiar with the part of the PC's responsibilities visible to them, while unaware of other responsibilities. In particular, interviewees expressing limited knowledge were unable to connect PC's information needs to the broader context. For example, although they recognized certain information needs of the PC from past cases, they were unable to generalize the reason behind the need. This is a key finding, as it may help explain the communication gaps and delays in information flow identified later in work categories. Effective communication involves understanding the other party's perspective and information needs (Yazici, 2002). Failure to identify information needs may hinder the timely communication of essential information.

"Perhaps I would recognize it [cases to contact the PC] *better if I knew more about the Process Control's responsibilities. Then, I could ask other questions that I have not even thought of before." (E3)*

"There are certain things that I know where I can be in touch with the PC, but what else they do, I don't know precisely." (E1)

D2 describes having a relatively good understanding of the PC's information needs. "Sometimes it does come as a surprise that, wait a minute, there is someone else [the PC] that needs to be involved. It is kind of an invisible work, in a way" (D2). According to D2, the work is executed in the background, which difficult to identify information needs. While each department is responsible for communicating different types of information to the PC, the findings indicate that stakeholder departments do not always have an adequate understanding of the PC's information needs to enable effective communication.

4.2 Maintaining Routing for Cost Calculation

The first main theme examines the role of the Process Control function in ensuring the generation and maintenance of data. This chapter discusses the first work category, which is included in the theme. It is a part of a cross-functional process that involves departments A, B, and C in addition to the PC. The output of this cross-functional process transfers information to the subsequent organization as part of the pricing process. By examining this process, the aim is to clarify the role of the PC in the organization and the information needs between departments in the cross-functional process in question.

To promote interdepartmental cooperation, proposed solutions aim to enhance the efficiency of the process by proactively addressing the information needs of others. Simultaneously, it would enable capacity consumption calculations to be performed in advance, thereby improving the accuracy of costs and facilitating collaboration between departments. The modus operandi of the cross-functional process is considered first, followed by examining the role of the PC in the process. Finally, improvements to the information flow are proposed to address current challenges in the process.

4.2.1 Modus Operandi and the Role of the Process Control

In the context of cost accounting, the importance of costing accuracy in global competition for decision-making and planning has been emphasized (Kitsantas et al., 2020). Enterprises require cost information to determine the price of a product to ensure the profitability of manufacturing. The assignment of costs to a cost object is typically divided into direct and indirect costs, and this category of work focuses on direct costs.

The following section examines the information flow within a cross-functional process conducted quarterly. At the beginning of each quarter, departments B and C meet with the organization to which the process outputs are transferred (B1; C1). Product demand serves as the basis for deciding which products to select for pricing in the quarter (B1). Additionally, the costs of new products and variants are determined through the process. This enables monitoring of price trends for the relevant products. After the meeting, Department B updates the BOM according to a defined schedule and releases it in the ERP at the end of the quarter. Department C then proceeds to its part of the process, beginning by running a costing report. The report identifies modules without routing, emphasizing the necessity of the PC's role in the process. The information C needs is the data transmitted by routing, which is seen as missing in the report. This report is then delivered to the PC, which connects routing data to the required modules. Once all routings have been connected and C has run the report without errors, the product can be released to the next organization in the cross-functional process.

Department C's information need in the process is routing data, which PC described as follows: “The routing is used to assign the factory’s cost portion to the product, after which Department C calculates the monetary values.” Routing defines the division of operations, a work center that implies the resources of the work to be performed, and the number of hours for each activity type. Additional attributes are specified in subcontracted work. Thus, the required direct costs can be determined for a cost object, based on the PC's input of hours and the business function's input of a price for an hour. Hence, determining the price of work requires determining the working hours.

"I have to make sure that the hours are included in the formula and that they are correct." (PC)

The role and strategic importance of the PC is to ensure routings are connected to the product to account for direct labor costs in the process. This becomes particularly critical when master data must be defined for pricing purposes, such as for new products and variants for which activity values have not been specified in routing. To meet the information needs of the finance department in this regard, the PC utilizes previous calculations and estimations. Furthermore, Department A is involved in the design of a new product work process and can be consulted to estimate capacity consumption. However, the current process faces challenges regarding this, which are explored later. Consequently, the role of the PC in the process is to produce data for the needs of the finance department on direct costs. With this data, the PC contributes to supporting the pricing process. As PC states: “This is the generation of data for the use of various actors in management accounting."

4.2.2 Future State Process Model

The cross-functional process has been described from the perspective of Departments A, B, C, and the PC. Next, the current information flow is modelled, as understanding and modelling the information related to the process is the first step in development (Albino et al., 2002; Durugbo et al., 2013). The current state swimlane diagram of the process is presented first, and challenges in information flow from the PC's perspective are examined. This is followed by the future state process chart presenting development proposals for the information flow.

Figure 10 below illustrates the information flow of the process, including the departments within the scope of this research. The process begins with decisions about the upcoming pricing period made at a meeting at the beginning of the quarter, attended by departments B and C. At the end of the quarter, there is a deadline for department B, when information is transferred to department C. Subsequently, based on the report run by C, the loop shown in the diagram begins. From the perspective of the PC, a key challenge is the lack of visibility into the scope of each update round (PC). The extensive workload is limited to a relatively short period of time, and there is uncertainty about the schedule. PC highlights that due to insufficient visibility, anticipation of the process is difficult to achieve with limited resources. The list of routings to be connected is quite long, and the number of lists increases if the first work step is not completed on schedule (C1).

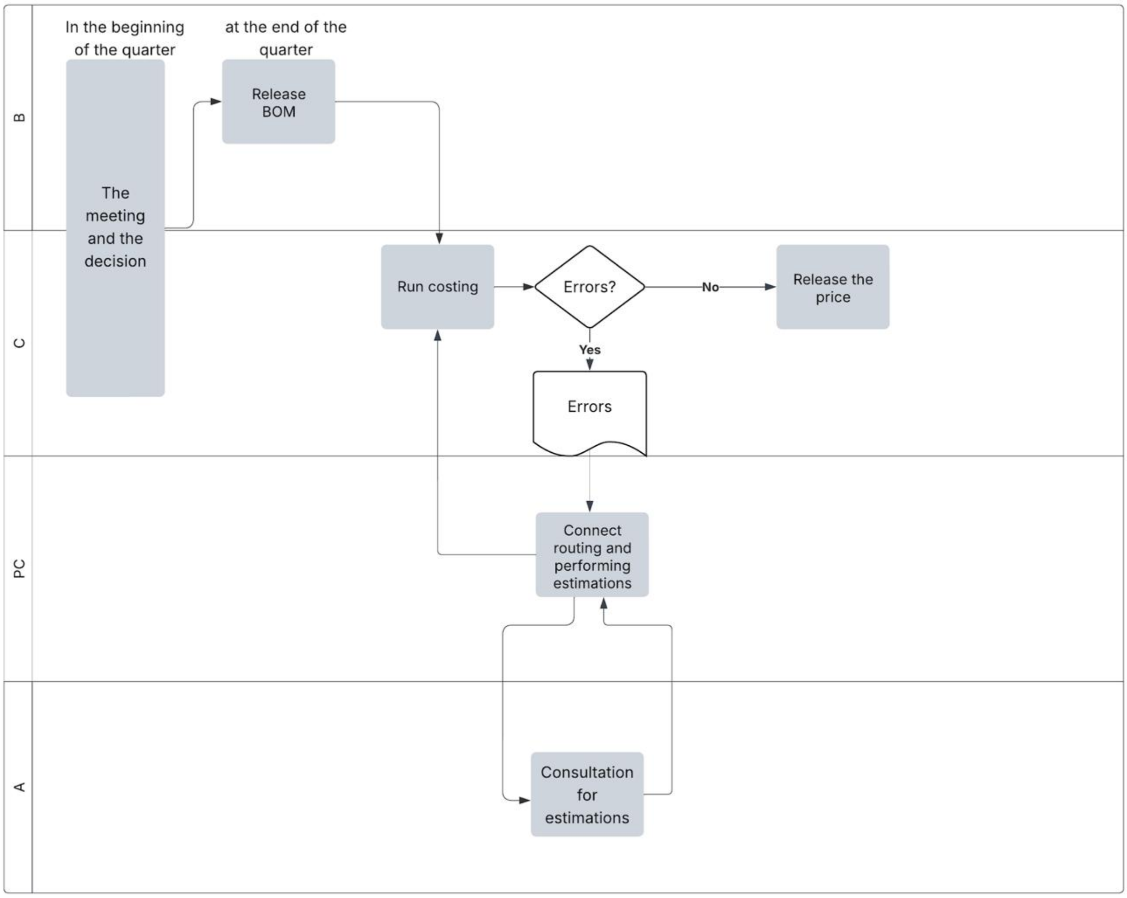

Figure 10 Current state of the cross-functional process map.

When examining the loop between the PC and A in Figure 10, the creation of routing for new variants and products arises. The responsibility of the PC is to determine the routing for a new product when activity time values are unavailable. The values of the capacity consumption of other products are used as a basis for calculations, along with knowledge of product types. If additional information is needed to complete the estimation, Department A can provide more detailed information on a new product type. However, due to the challenges described earlier, limited time prevents the communication between the PC and A in the process, despite the information demands of the PC. This highlights the need to improve collaboration and information flow in the process to improve interdepartmental collaboration.

In summary, the main challenges identified relate to limited visibility into the schedule and scope of the update. As a result, time constraints hinder interdepartmental consultation regarding activity time estimations. The objective is to improve information flow in cross-functional processes and enhance collaboration between departments, while optimizing cost accuracy. Consequently, the challenges are addressed by proposing solutions with a future state process diagram. The benefits of process visualization can be achieved through a better understanding of the information needs of other departments in the cross-functional process. This enables departments to recognize how their work impacts subsequent process steps and to identify the information needs of others more effectively (Damelio, 2011).

The proposed future state of the process model is illustrated in Figure 11 below. The cross-functional process requires routing information maintained by the PC. However, information sharing with the PC has been limited in the current state. The proposal to improve the information sharing towards the PC is a summary document regarding the decisions of the meeting. This would clarify the schedule and scope of the upcoming pricing period, including the products selected for update. Berente et al. (2009) discussed the importance of accessibility, transparency, timeliness, and accuracy of information flows. The proposed summary document could help improve these aspects by enhancing visibility within the process. The workload in the process remains the same, but the document would enable preparation and collaboration between the PC and A, which was identified as a challenge in the current state. When information is timely, the PC is able to perform estimations and consult Department A as necessary. This, in turn, would optimize costing accuracy and collaboration between departments by allowing more time in the process to meet departmental information needs. Anticipating the scope and products of the update can streamline a critical process step.

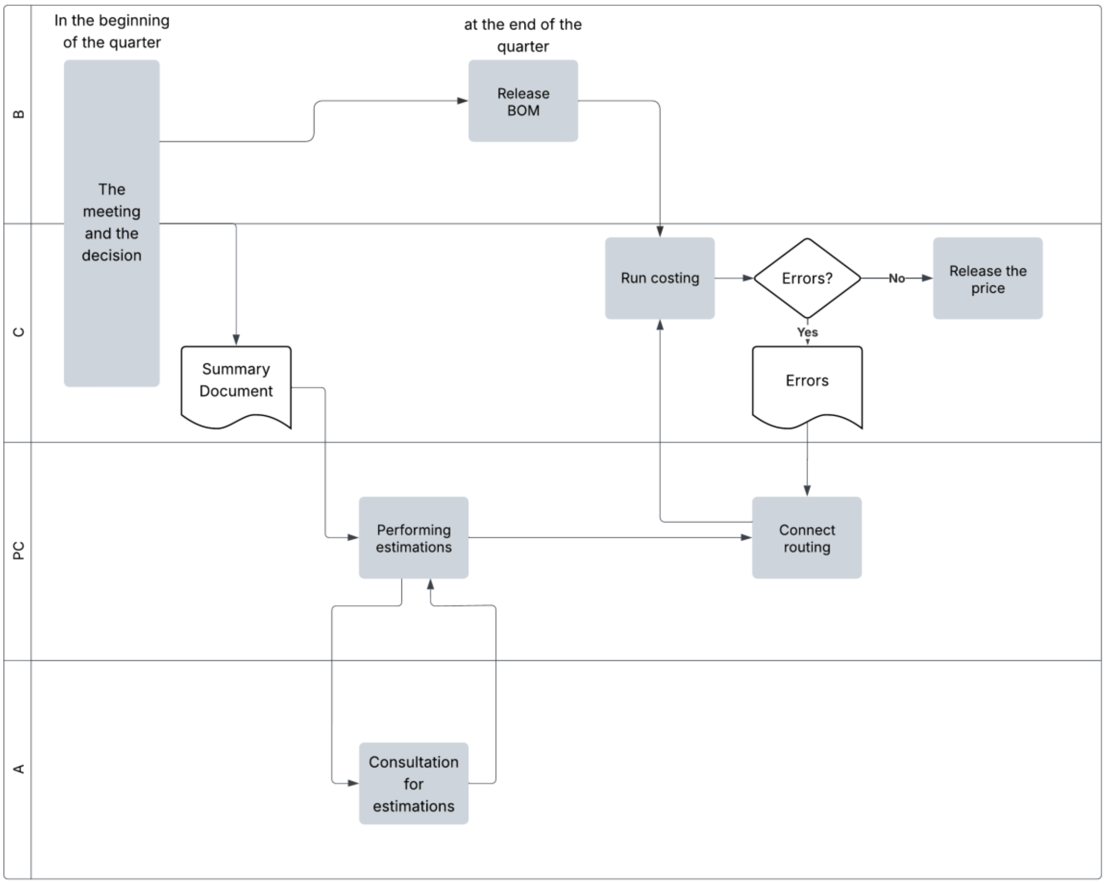

Figure 11 Future state of the cross-functional process map.

Considering the annual clock of the PC, Departments B and C, in cooperation with the organization in need of information about the process, should prepare and send the summary document at the beginning of the quarter. Furthermore, the pricing cycle based on the current state flowchart is included in the annual clock. The proposed improvements would address the information needs of the stakeholders in the process in a timely manner and with the accuracy required by the recipient. Understanding the needs of others in a cross-functional process facilitates their consideration.

4.3 Data Supporting the Process

The role of the Process Control at the interface of PLM and ERP in the ISA-95 pyramid is significant when analyzing the next category of work. The standard defines the transfer of information across various systems within a manufacturing company (Chen, 2005), and this work category discusses the role of the PC in generating information to be transferred. The data must be generated, maintained, and updated in accordance with changes. This highlights the need for data transformation to ensure accurate transfer of information across cross-functional processes (Berente et al., 2009).

The data transferred in the process by BOP1 must align with the production environment, product modularity, and divisions determined by the finance functions. Transferring accurate data in the process requires collaboration between departments and information flow, especially regarding changes. The first subsection provides an overview of BOP1 and its connection to the finance functions. This is followed by a discussion on generating a structure for new products and maintaining data.

The third subsection highlights the importance of accurate time values from the perspective of production and process development. Furthermore, a future state process for measuring accurate time is proposed. Subsequently, the PC's information needs regarding structural changes are examined, along with a review of current communication methods. Strategies to enhance cooperation and improve information flow are then presented. Finally, the role of the PC in establishing new processes and the factors to be taken into consideration are discussed.

4.3.1 Structure of BOP1 and Importance of Activity Hours

Different functional units within a manufacturing company have distinct information needs, and MBOM is essential for transferring information (Wang et al., 2022). An essential part of creating a production order is copying the BOM and routing to it (SAP, 2023b). This enables the ERP system to transfer relevant information to various departments in the manufacturing company. Next, the importance of the PC in maintaining routing and coordinating between the finance and production departments is discussed.

The generation of routing combines the role of the PC to produce master data that considers the information needs of the finance functions, connecting the production process and the modularity of the product. According to PC, the process structure within the plant is defined to support management accounting. Routing data is created for each product variant, and the data must be consistent with the production environment to enable cost monitoring. The data is generated by the PC using PLM software, which automates the generation of routing data during the configuration of MBOM.

“We are the entity that makes visible in systems the process that has been well-designed by others to manufacture a product and manage costs.” (PC)

Subassemblies are designed to optimize product manufacturability. Department A considers manufacturability at the component and assembly structure level by designing the optimal subassemblies in relation to the main process (A1). By creating a routing, the PC maintains the connection between the resources in the factory environment and the assembly process. The routing defines the party responsible for assembling each module in the production process, considering whether subassemblies are assembled externally by subcontractors or internally by company personnel, for example, as part of the main assembly (PC).

“One important task of plant-specific Process Control is to take the local conditions into account when defining the routing.” (PC)

The previous section addressed the role of the PC in defining routings at the subassembly level. The following section focuses on BOP1 at the operation level, where the linkage between work centers and cost centers enables cost control. The theoretical background discussed cost centers to which multiple work centers could be connected, but a work center can only have one cost center (SAP, 2023c). The company monitors costs according to the cost center allocation defined by the finance department. Work centers are connected to cost centers according to this allocation. Each operation is assigned to a work center according to the manufacturer of the operation, whether it is subcontracted or internal work. C2 summarizes the connection as follows: "One cost center has a work center, and the routing hour is connected to the work center, and the hourly price is connected to the cost center. This combination means that when that one hour is confirmed, the price defined as the hourly price in euros is transferred to the production order."

The importance of the PC is to maintain this connection between the modularity of products and the cost centers of the finance department to ensure that the production process in the factory is aligned with cost monitoring. The PC creates and maintains work centers at the operation level, enabling this linking and routing to be established through them. Department A defines the phase level of the product, which refers to the operation levels, for example, within modules. Therefore, BOP2 maintained by A and the BOP1 of the PC must be synchronized. BOP1 data is interconnected with several departments, and a lack of understanding regarding the Process Control's information requirements during change may result in incorrect data. Ensuring the accuracy of BOP1 is critical as any inconsistencies can affect the reliability of information transferred to the ERP system through the MBOM. Moreover, MBOM generation may fail if the data is not aligned with other changes. In this case, it consumes time to solve the problem and creates additional work, especially for Department B, which is responsible for configuring MBOM for the product.

As illustrated in Figure 3 in the theoretical background, the activity types necessary to execute an operation are defined within work centers (SAP, 2023d). A corresponding hourly price is defined by the finance functions for each activity, as explained by C2. The linkage and significance of the terms discussed in this chapter will be discussed next from the perspective of financial functions and cost accounting. This section provides contextual background for the following chapters by explaining how the presented information is utilized by finance functions.

From the perspective of the departmental main systems, and in alignment with the ISA-95 standard, stakeholder department C reviews financial data from the ERP system. As noted by C2, ERP is by far the most important for their operations, although data from MES is occasionally monitored. The information needed from production is obtained through production orders, and the trends of the cost centers are monitored (C2). On the other hand, the absorption is formed through the confirmation of routing hours, as the hours are allocated from the cost center to the production order. One of the main tasks of Department C is to monitor the master data to ensure that price information remains accurate and the process proceeds without disruptions.

Information in routings has a direct impact on the data received by the finance function. The hours defined for each activity are transferred from the cost center to the production order upon confirmation, thereby forming the absorption. Furthermore, the activity-type hours defined in the routing are used to forecast the expected level of confirmations. These forecasts serve as the foundation for calculating the hourly rates used by the finance department. Consequently, inaccuracies in the routing hours can lead to misestimations in hourly cost rates (C2).

"It would be much easier to manage production absorption if those [activity hours] *were more accurate for each product." (A1)*

Direct costs are transferred from PLM to ERP to the finance department via hourly values assigned to activity types. The finance function's information need is realistic time estimates, which are vital for the finance department to achieve accurate estimations of the hourly price (C2). Maintaining BOP1 structure emphasizes accurate cost management through activity hours, and data must be synchronized with the production environment and products. The strategic importance of the PC is to integrate both the changes in the production environment and the needs of financial functions by maintaining a unified data environment, BOP1.

4.3.2 Current Process for Creating Routing

Routing data is transferred as part of MBOM to the ERP, requiring maintenance of BOP1 for all product variants. In addition to the maintenance of BOP1, the current processes for creating routing for new products are explored, emphasizing the importance of cross-departmental collaboration. The discussion focuses on the definition of hourly values. Moreover, the data to be maintained includes several other parameters, which are excluded from the chapter due to the scope of this research.

New variants are introduced into existing product families, requiring the PC to generate routing data in BOP1 based on previous calculations. Existing routings within the same product family serve as the basis for generating the routing (PC). However, differences in modules or operations between variants must be calculated (PC). As BOP1 does not cover all product variants comprehensively, continuous updating will be necessary in the future. From the perspective of the annual clock of the PC, this work category requires monthly anticipation of upcoming new variants and products to ensure the extent of BOP1 and provide necessary completeness. Accordingly, the annual clock for this category of work takes into account the identification of new variants in upcoming products and the monthly review of BOP1.

"Product development designs new product variants, and it is our responsibility to maintain routings for them, regardless of whether they are iterations of existing ones." (PC)

The estimation of hourly values for BOP1 for new modules and products requires interdepartmental collaboration. The expert responsible for the product family in department A has designed the production process for the products and modules and has a deep understanding of the 3D model for new products (A1). However, the information need for the estimation of capacity consumption is in the PC. Findings from interviews indicate that the information sharing and meeting information needs of the PC to estimate capacity values of new products is currently non-standardized.

Figure 12 below illustrates the current state of the CFPM. Although Department A has the most current insight into the capacity usage of new products, resource shortages and a time-consuming system prevent them from performing capacity calculations for every product (A1). As a result, the loop between the PC and A, illustrated in Figure 12, is not fully realized in practice. Thus, the PC relies more on its own estimates and consults A to determine the expected capacity consumption. When calculations are available, the PC considers local conditions in the factory environment when estimating the routing hours (PC). Nevertheless, A is only consulted for the first new product, after which the process proceeds as on the right in Figure 12. Once the initial calculation is completed, it is converted into routing data for new variants by the Process Control.

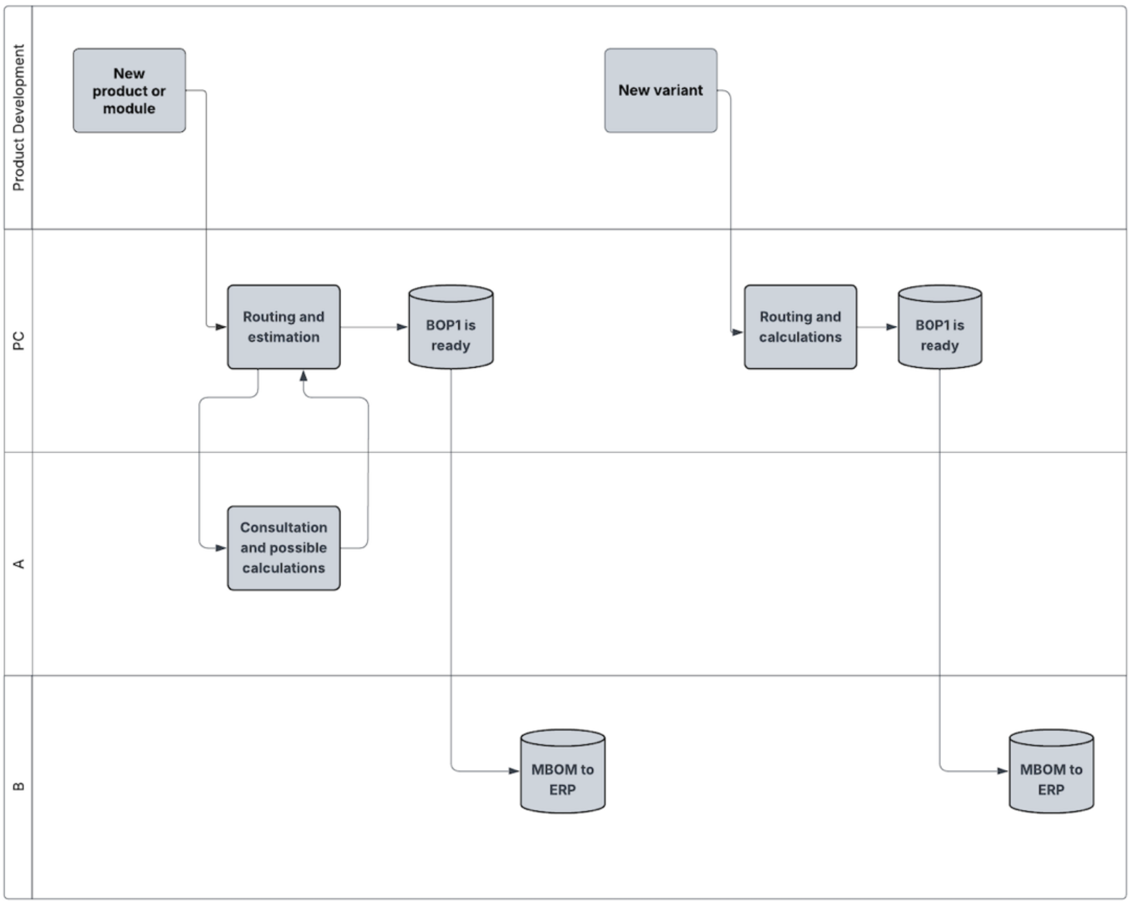

Figure 12 Current process for creating the routing of new products and variants.

The information needs of the PC are product development projects, as generating a routing for a new product family is time-consuming (PC). Inadequate recognition of this information need within the organization prevents the timely involvement of the PC in relevant projects. Department A is involved in product development projects from an early stage, defining the manufacturing process for the product (A1). Strengthening interdepartmental collaboration between A and the PC could ensure that critical information reaches the Process Control earlier, also enabling cooperation in creating routing. Proactive communication seems to be hindered by a limited understanding of the PC's responsibilities. Consequently, the challenges associated with the timeliness and accessibility of information pose barriers to the PC in creating the routing earlier (Berente et al., 2009).

"It is months of work with [A] *to define the structure and do the time calculations and then convert them into routing." (PC)*

The PC's responsibility is to generate routing data for new products in BOP1. This is essential information for the process, as production orders cannot be generated without routing in the ERP (A1). The hourly values of activities are crucial for routing, and the finance functions in particular need the information contained in BOP1. The current process for determining it would require a more robust process to improve collaboration between departments and optimize cost accuracy. Next, a challenge in the current process is described, which underlines the importance of the first estimation of values.

The estimated activity values are entered and maintained in BOP1, as discussed earlier. If the product remains unchanged, the number of hours determined remains the same. The PC does not independently modify the data unless an error in BOP1 is identified (PC). The initial estimate has not been verified in a production environment, causing uncertainty about the accuracy of costs. This practice highlights the critical importance of the initial estimate, as there is currently no feedback mechanism for refining or validating the values over time. This issue is central to the research, which aims to explore opportunities for enhancing interdepartmental collaboration and improving the accuracy of cost data.

"The first hours [to BOP1] *are obtained from the beginning of a product development project, and if there are no changes to them, they remain. They are copied and maintained in* [BOP1]*." (PC)*

4.3.3 Importance of Determined Times and Future State Process

The financial function of the case company is not the only stakeholder that benefits from a more accurate determination of activity times. This chapter provides a review of the requirements from the perspective of financial functions when it comes to capacity consumption. This is followed by a discussion of the need for accurate activity times for both production and process development. Finally, a future state is proposed, emphasizing the importance of interdepartmental cooperation and the need for more detailed time value measurement to achieve benefits for several departments.

The defined hours form the basis for calculating the hourly price, and absorption is determined based on the confirmed hours as discussed in previous chapters. Furthermore, the defined hours represent critical information in terms of the product's competitiveness (C2). According to interviewee C2, standardized hours are beneficial in the sense that product-specific challenges do not cause fluctuations in cost. However, C2 emphasizes the importance of ensuring that the level of standardized hours is accurate and realistic. The reliability of routing hours is highly important and should be reviewed frequently (C2). According to A1, determined times are currently generalized and rather product family specific. Consequently, some of the delivery projects may be completed under the specified time while others exceed it (A1).

"Their [routing hours] *level of accuracy is not the same or it does not match the design scope that those products actually have." (A1)*

Accurate routing hour data would serve multiple purposes within the organization. In addition to its utilization in financial purposes, teams responsible for designing assembly processes and developing production require reliable time data to identify areas for improvement and to evaluate improvement efforts. According to A1, more accurate time estimates would enable them to direct development efforts on challenging products. This refers to products with a considerably greater assembly time compared to others. D1 stresses that establishing a measurable baseline is a prerequisite for verifying the outcomes of improvement efforts. Without reference data, evaluating the impact of development efforts becomes impossible. Furthermore, D2 notes that accurate data could also support production optimization in addition to refining routing times. For A and D, accurate data would facilitate targeted improvement and informed decision-making in production and product development.

"We would need time measurements, because flow and lead time are critical [in production]. *This would, for example, enable us to balance the work between operations." (D2)*

According to D1, the team is expected to reduce installation time and associated costs. However, the lack of comparative data prevents them from demonstrating whether improvements have been achieved. As a result, these potential improvements cannot be reflected in routing time values, limiting the visibility of development impact within the system. In the present circumstances, A1 argues that changing the number of hours is irrelevant for the estimated time values. This is consistent with the maintenance of BOP1, as the values remain unchanged unless there are significant changes to the product. Thus, the system cannot be used to transfer information on reduced lead times if the values defined do not initially correspond to the design scope of the products.

As discussed, the hourly rates defined are relevant for Departments A, C, and D. At the end of the interview, interviewees were able to highlight challenges and suggestions for improvement regarding the topics discussed. The need to refine and validate hourly values was expressed in several interviews. C2 highlighted the need to validate routing hours to ensure the accuracy and that product types are comparable. A1 expressed a desire to maintain up-to-date values and to be able to establish them according to the duration of the activities. The main tasks in routing are called operations, representing a list of tasks called activities (Sly & Schneider, 2011). Accordingly, the time required for an operation can be determined by summing the durations of the associated activities.

D1 suggests that the times should be made more transparent and aligned more closely with actual assembly times. Interviewee further proposes defining time estimates for specific activities, which would also enable target assembly times to be transferred into the MES system. The importance of time measurements is emphasized for both production planning and the work of assemblers. When time estimates are based on factual data, it becomes easier to demonstrate to assemblers that the target times are realistic and achievable (D1).

"It is [measured time] *the only way we can improve operations — and for scheduling in production planning, it is invaluable."* *(D1)*

The proposals highlight the importance of values for several different departments, benefiting from different perspectives of accurate times. D1 suggested that the measured times could be defined in the PLM, from where the information would be transferred to the MES. Moreover, the flow of information could be implemented for other systems and functional units in alignment with the ISA-95 standard. The following section proposes a future state in which initial time estimates for new products are defined in BOP1 more precisely before production and updated after the product has reached sufficient maturity. Improved collaboration between Department A and the PC could enhance cost accuracy, and BOP1 data would more reliably reflect actual capacity requirements in production.

As illustrated in the proposed future process map in Figure 13 below, Department A would perform time calculations for every new product and module. With current tools, A is unable to provide calculations for all products due to the limited resources available. In a future scenario, these calculations could be embedded within A's process planning activities, removing the need for additional resource allocation (A1). The calculations would be transmitted to the PC, which would take local factory conditions into account when creating routing data. Once BOP1 is finalized, information is transferred to the ERP system through MBOM configuration procedures conducted by Department B.

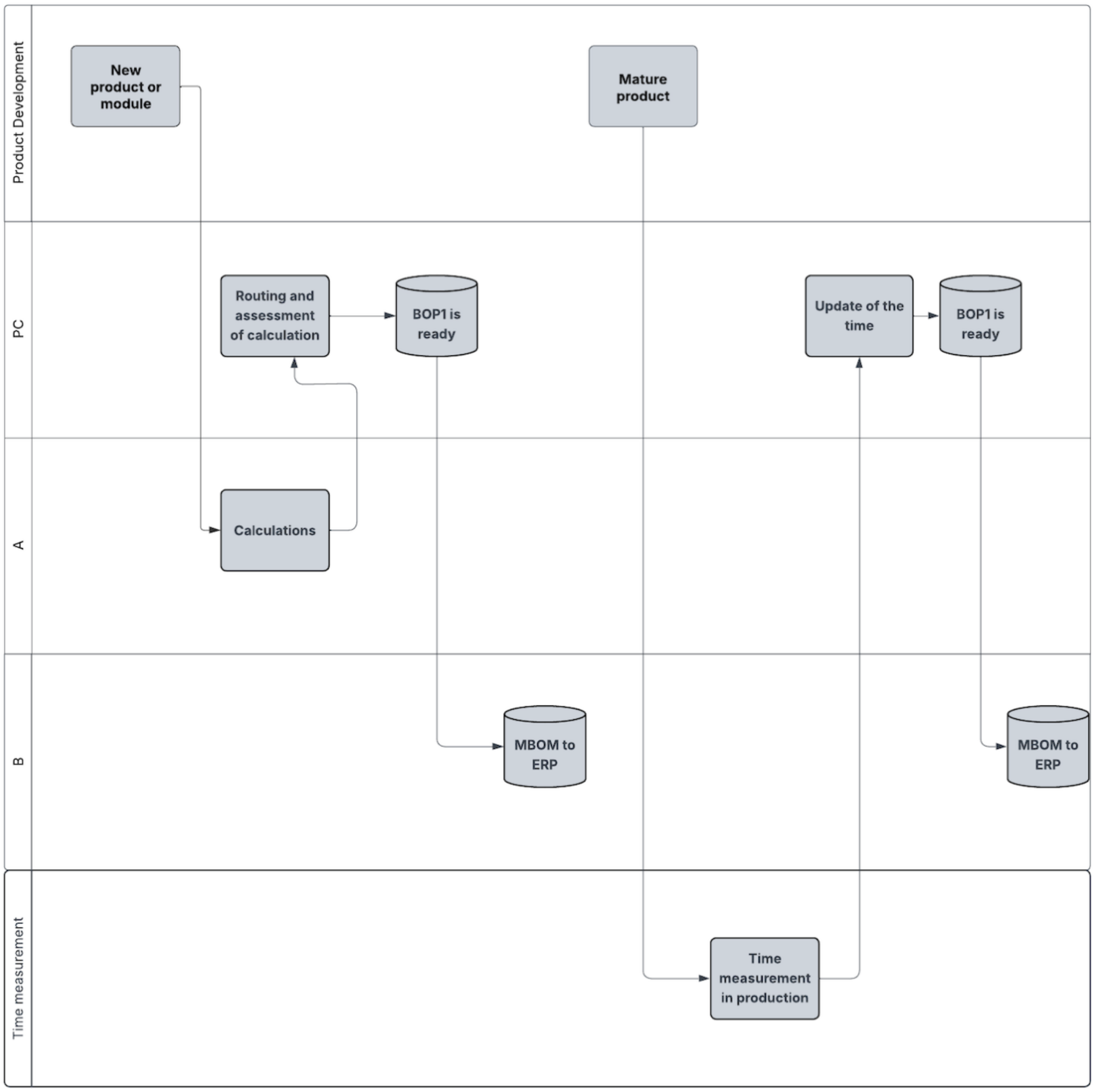

Figure 13 Future state process map for creating routing data for new products.

In the current process, the initially estimated values are not validated, which affects the accuracy of cost accounting regarding direct costs. The second step in the top swimlane of Figure 13 above illustrates the process for validating the calculated values in a proposed future state. Activity times of the new product would be measured in practice by a competent resource when the product is considered sufficiently mature. Based on these measured values, the PC would update the corresponding data in BOP1. As discussed in the chapter, accurate times would not only be important from a cost accounting perspective, but departments A and D could find areas for improvement based on the values. Thus, the development could be confirmed by measuring the time values again, enabling the development to be captured in the activity hours of BOP1.

Accurate time estimates are a key enabler for production planning, cost accounting, and process development. From the perspective of cost accounting, the determination of hourly rates and absorption depends on the availability of reliable time values. If Department A systematically conducted time calculations for all products and collaborated with the Process Control, cost estimates for new products could become more accurate. Additionally, tracing the actual capacity consumption of products in production is essential for verifying the reliability of first estimates and informing time-related needs in other departments. In this way, improvements can be measured and reflected in the routing hours, providing more accurate data for management and cost accounting.

4.3.4 Managing Change in the Process

The maintained information flows between systems and layers in accordance with the ISA-95 standard, transferring information to the different functional units of the company (Avvaru et al., 2020). Information transfer involves moving data from one process to another without requiring modification (Berente et al., 2009). In contrast, information transformation requires changes to the information. This chapter focuses on the latter case as the maintenance of BOP1 data in changing circumstances requires data modification.

The research identifies three main categories of change requirements for BOP1, which will be examined in this chapter. These are synchronization of BOP1 and BOP2, modifications to hourly values, and changes to the process. In addressing these categories, the challenges of information flows that may hinder the implementation of change are explored. Furthermore, barriers that can impact the effectiveness of communication will be discussed. Van der Aalst (2013) notes that in increasingly complex cross-functional processes, it is essential to understand the required interaction. In the case of BOP1, a lack of communication regarding changes may affect the accuracy of the cost accounting. The process and costing will be imbalanced if changes are made in the cross-functional process without communicating with the PC. The objective is to stabilize the effect of the change to ensure the process remains in a steady state.

The first category of changes is the synchronization of BOP1 and BOP2. Since Department A is responsible for the maintenance of BOP2, it must notify the PC of the required changes to BOP1. These changes include adjustments to the product structure, such as the addition or removal of subassemblies or operations. According to PC, when Department A introduces a new phase level in BOP2, the PC must be informed to update BOP1 accordingly. The theoretical background explained that a subassembly consists of main tasks, called operations (Sly & Schneider, 2011). The PC maintains the crucial parameters at the operation level in BOP1. Therefore, the addition or deletion of operations is essential to notify the PC to synchronize the structures. In particular, removing operations from BOP2 can cause problems for cost accounting, as MBOM creation can be successful, but the hours of the removed operations are not transferred to the ERP from BOP1. Conversely, the addition of operations to BOP2 may cause difficulties in generating MBOM if the operations are not included in BOP1.

A1 identified the creation of new subassemblies in BOP2 as essential for communicating with the PC based on the interview. Moreover, this can be found in the BOP2 maintenance swimlane chart in the case company. A1 describes the PC's information needs from the perspective of creating a production order. Consequently, changes to BOP1 and BOP2 are required to create a production order for the new subassembly in the ERP system. In the theoretical background, this was described as the need to copy the routing data to the production order to generate it (SAP, 2023b). However, it is also necessary to maintain synchronization in terms of cost accounting in BOP1, which was not explicitly recognized by A1 in the interview.

In changing circumstances, the strategic importance of the PC is to maintain the alignment between the product structure and cost accounting data. This ensures that financial information transferred to the company’s controlling functions remains accurate after structural modifications to products. For instance, when a subassembly is removed, the corresponding activity hours are reallocated to the operation structure of the main module (PC). This enables the PC to ensure that the operation-level labor hours correspond to the actual production environment. Achieving this requires that the PC is informed of changes to BOP2. Although the PC has typically received information regarding changes to subassemblies, the findings indicate that there are gaps in anticipation. Instead, in some cases, the PC has remained unaware of the changes at the operation level. The interview with A1 indicated that the need to communicate changes at the operation level of BOP2 may not be fully recognized as requiring corresponding changes in BOP1, potentially reflecting an incomplete understanding of the PC’s information requirements.

Effective communication is defined as the ability to share, access, and use information (Yazici, 2002). Without a clear understanding of the roles and information requirements of other departments, achieving effective communication across functional boundaries is challenging. Two communication disruptions related to operation-level changes are presented, where the PC did not receive timely information. In the first case, the main assembly in the BOP2 was modified, reducing the number of operations from eleven to six. However, this change was not communicated to the PC. As a result, the MBOM was generated without the corresponding updates to the BOP1 data. Although the necessary production orders were created, the hours associated with operations seven through eleven were not transferred to the ERP system, affecting cost accounting accuracy (PC). As emphasized by Berente et al. (2009), while IT systems are essential in transferring data across processes, the transformation of information relies on cross-functional communication and understanding of the information needs of others.

In the second case, Team D proposed changes to BOP2 to enhance production flow by reducing the number of operations from eight to seven (D1). As a result, Department A changed the main assembly operations in BOP2 accordingly. However, the information was delivered to the PC late. Consequently, the eighth operation remained in the system to maintain cost accounting accuracy, despite the change having already been implemented in the MES. To prevent these issues, it is essential to identify information needs in advance and ensure information flow as early as possible. Berente et al. (2009) define timeliness as delivering information at the earliest feasible point. Aligning communication with these principles can reduce the risk of a communication gap.

"If there are deletions or additions of operations, we [the PC] *have to cooperate with the* [A] *to prevent situations where some hours are missing completely* [from the ERP]*." (PC)*

The second category of changes is modifications to the hourly values maintained in BOP1. As previously noted, the values are currently mostly based on estimates. Consequently, minor changes to routing hours are currently not implemented (PC). Interviewee A1 mentions that if they had the resources for development activities to reduce the assembly time, this would have an impact on the hourly routing values. Similarly, if Department D implemented an improvement in production, it should be communicated to the PC. This would enable the improvement to be converted into updated routing activity hours and transferred to the finance department, thereby increasing visibility into changes in direct costs. With the current level of accuracy of hours, changes in this category are challenging to capture.

D2 notes the need for communication with the PC when assembly work is relocated from one operation to another in the production process. In BOP1, several parameters are maintained at the operation level in addition to activity hours, including work center, duration, and control key. When the workload is transferred between operations or from one subassembly to another, the PC ensures the correspondence of the parameters in the changed process. The PC is the entity ensuring the consistency of cost accounting and production environment data during such changes.

Department C is the third identified stakeholder in terms of hourly changes. Instead of direct requests for change, they are examining trends and comparing products with each other, which may lead to questions and the need for revision (C2). Since there is a direct connection between the number of hours defined and the hourly price, it is essential to inform Department C of changes to routing hours to maintain accurate and stable hourly pricing (C2).

The third main category concerns the changes to the process, which require modification in BOP1. These can include changes to cost accounting, to the production environment, or a new subcontractor into the production process, for example. The role of the PC in implementing such process changes within the systems is critical. A key factor in the successful implementation of these changes within the systems is the timely communication of relevant information. This enables the necessary updates to be made in BOP1, ensuring that accurate data is available and can flow through the systems. The maintenance of BOP1 is performed in the PLM system, and the data is transferred through MBOM generation via products to the ERP. If the data in BOP1 is incorrect, this information will be in the ERP and flow to the different functional units of the company.

"The interface is slightly vague for us, but the Process Control is strongly involved in it. They know how the information flows from one place to another, from the [PLM] *to the* [ERP]. *Because once the information has already come to the* [ERP], *it is too late for any action to be taken." (C2)*

In the interview with C2, the importance of collaboration between the PC and C on changes was addressed to ensure the transformation is successful and the information flows through the systems as planned. Changes in the processes being addressed could be described as stabilizing the physical process. Achieving a steady state after a change requires an understanding of the impact of the change on the process and collaboration between stakeholders (King, 2016). The PC is the entity capable of implementing the change as part of the process while ensuring the process remains stable. However, if communication about changes is insufficient, it can endanger the accuracy of the information being transferred.

Changes and additions to the production environment may involve new subcontractors in the manufacturing process or allocating a part of the product's manufacturing to a subcontractor (PC). The information about these changes is obtained from D, C, or production management, depending on the case. The PC requires information about who will perform the work in the future to maintain routing data and implement changes in alignment with the production environment. In the case of internal work, the required information includes the estimated number of labor hours. For subcontracted work, more attributes are required. The accuracy of operation-level attributes such as work center, control key, and activity types must be ensured in BOP1 to ensure that the cost calculation remains accurate after the change. C2 notes that they communicate with the PC on new subcontracting arrangements to ensure that data in the PLM system is accurate for pricing purposes. Based on the updates implemented in BOP1, this data is transferred through MBOM to the production order in the ERP system.

In addition to subcontracting, another example of a process change involves relocating part of the production process outside the primary manufacturing site while continuing as internal work (PC). The change in this example was driven by team D and implemented in the systems through updates to both BOP1 and BOP2 to support the modified process. The PC's responsibility is to align the updated product structure with cost accounting in the new process, ensuring that costing and the process in the production environment are aligned.

"If a satellite assembly is established [outside the primary manufacturing site], *whether it is in-house production or subassembly done by a subcontractor, it always requires an addition to* [BOP1]*" (PC)*

Certain changes initiated by finance functions must also be reflected in BOP1. For instance, modifications to cost centers require corresponding updates to work centers in BOP1 (C2). Since cost centers and work centers are interlinked (SAP, 2023d), these modifications must be implemented by the PC in BOP1. When a new cost center is created, the PC establishes the corresponding work centers and maintains the consistency of BOP1 data.

In terms of information flow and current communication methods, the interviews revealed a barrier in information flow to the PC about business tactical decisions. The challenge is that the PC is informed at the same time as the change is expected to be implemented in BOP1. Information concerning the change is not flowing to the PC in advance, and the department is not involved in the planning phase. Consequently, the extent of the change for BOP1 cannot be established in advance (PC). This increases the risk of decisions being made that cannot be implemented within the planned timeframe.

According to C2, their contact for consulting on implementing the change is the PC. However, engaging the relevant resource earlier would allow the expertise to be utilized during the planning stage, allowing the implementation aspect to be considered in the decision-making process. The PC explains that "We should be involved already in the planning phase of tactical change, so that we can establish an overview of how extensive the change will be for the [BOP1]." Planning the revisions to BOP1 in advance could potentially reduce the lead time required for implementation.

"We would like to provide information to management at an early stage so that the transition period is understood when a decision is made. This way we do not make decisions that the change is valid from a certain date, because in reality this is not possible." (PC)

4.3.5 Establishing New Processes

The previous chapter examined cases where changes to a defined process were implemented as a result of changes in the production environment or product structure. In the discussed cases, changes are implemented in BOP1 to align the data with the changes. This ensures the flow of information across systems as desired after a change. In addition to changes, there will be instances where establishing a new process is essential. This chapter explores the role of the PC in implementing new processes by coordinating between production and financial functions.

The establishment of a new process in systems requires design and the setting of parameters. It is essential to consider the information requirements of various departments during the initialization of the production process to ensure the seamless flow of information to the necessary functional areas. King (2016) notes that in the case of a physical process, a process engineer is responsible for designing a stable state for the process. Similarly, the functionality of a business process must be designed to ensure its operation. Berente et al. (2009) underline the need for the organization to obtain a clear picture of the operation of the process, the information flowing through it, and the information needs of the stakeholders for the process to function successfully. These considerations are critical both when developing entirely new processes and when expanding existing ones. Different departments in a manufacturing company have differing information needs about the process. For instance, the production department needs to manage the flow of materials using an ERP system (Avvaru et al., 2020), while other departments are interested in material price details. Therefore, the information needs of different functional units must be addressed for the operation of the process.

The creation of a new process is addressed with a case example of expanding the business by involving a new department in the production process. The component manufactured by the new department will be included in the BOM of products, and a cost center for the department will be created by the finance department (PC). When considering the role of the PC between the production and finance departments in an organization, the parameters for managing materials in the process and establishing process specifications are considered. In the new process, the finance department requires that the cost center be linked to the work center created by the PC to ensure that costs are correctly allocated in the system. The establishment of specific process parameters was essential to enable the flow of materials in the work queue for a new manufacturing location, and the PC played a central role in this effort. As the following quote illustrates, the PC's area of expertise includes both maintaining and developing the process of production plant.

"This entire production plant process, its development and maintenance, is our core expertise. We are involved in it and we must stay informed about what business management intends to do." (PC)

The role of the PC is to support the establishment of the process to ensure its functionality. When designing a steady state for a new process, the PC takes into account both the creation of work centers from a cost perspective and the control of the work queue from a production perspective. These two perspectives must align to ensure the functionality and efficiency of the process. According to PC, the functionality of the defined parameters is tested through a pilot to detect any necessary adjustments. However, achieving a functional process does not mean the end of responsibility. After implementation, the process must be monitored and adapted to meet potential future needs (van der Aalst, 2013).

"In a way, the responsibility never ends, but it temporarily fades into the background. After the definitions, the ramp-up phase begins. The process is tested and corrections are made if they are needed." (PC)

The new process could be considered as functional when it meets the information needs of all stakeholder departments. New processes need to be defined and designed to ensure that information flows as intended. All processes require maintenance and development to ensure proper operation, and this is the PC's area of expertise when it comes to the production plant processes. It is essential to consider the flow of information in the systems when planning a new process. At this interface, the PC provides several tools to support the process establishment.

4.4 Supporting the Connection Between Production and Cost Accounting

The previous sections of the results chapter addressed the first main theme, which focused on defining and maintaining data supporting the process. The focus now shifts to the second main theme, which concerns deviations from the defined process. This theme explores the role and significance of the PC in tracing the costs of such deviations within the systems. The chapter explores the finance department’s information requirements and the function of the PC in transmitting relevant cost information from production to finance functions via systems. To enhance the accuracy of cost allocation, this theme also examines current obstacles in information flow and explores suggestions for improving interdepartmental communication.

In the previously discussed first main theme, BOP1 was defined and transferred from the PLM system to the ERP during the creation of MBOM. According to PC, the underlying principle is that when MBOM is generated and routing is attached, it includes all the direct working hours required to complete the product. The execution of work deviating from the routing and standard process constitutes an information need for the PC. In this case, manual corrections are essential to trace the costs.

The first subsections will address various situations where a deviation from the defined process requires, for example, additional orders in the ERP system for a product. This enables additional costs and the need for materials to be managed in production processes. The second subsection discusses the challenges of information flow that hinder the transfer of information about additional needs to the Process Control. The final section discusses how the PC supports production through different tools, acting as an intermediary to align operational cases with cost accounting requirements.

4.4.1 Additional Orders and Allocation of Additional Costs

This subsection discusses exceptional cases where the costs specified for routing are exceeded for various reasons. The PC highlights the importance of cost traceability in such situations, stating: "If internal resources or subcontractor resources are needed for a work, one should ensure that the cost of that work can be allocated to [a specific cost object]." When a project involves additional work deviating from the standard process, there will be additional costs that need to be allocated (PC). In this case, the question of the existence of an order number is essential, as the additional costs must be correctly assigned and not left without a responsible cost object. Within this work category, the PC is responsible for assisting in the coordination between production and finance functions to ensure accurate cost tracing in deviating situations.

In cases where costs arise from deviations from the standard process, the PC can identify whether there is a corresponding order number and verify if the related costs have been accounted for in the maintained data. If no order number exists, the PC can initiate an additional order to which the incurred costs can be allocated (PC). This also enables the ordering of subcontracted work, and the operation transmits information about the work in the system. It describes the work to be executed, and the operation includes the materials necessary for the work. To allocate additional work, a cost object is required to which direct costs are assigned, as illustrated in Figure 1 by Horngren et al. (1999).

The PC ensures the work center and the required workload are included in the additional order at the operation level. A work center is linked to a cost center, which generates a cost for the number of hours, as discussed in the theoretical background.

"And I'm interested that there are the right number of hours here, which then forms the costs." (PC)

In this work category, the PC coordinates between the production and finance functions within the organization. It transfers information about additional costs incurred for a cost object to the ERP according to the information it receives. Simultaneously, the operations created by the PC are used to transfer information to other organizations, such as logistics, through the materials of the operation (PC). Moreover, a task can be assigned to the resources responsible for the work.

The information needs of the finance department include the hours of internal resources for additional work (C2). While in an ideal scenario, such work would not occur, in practice, organizations need to have tools to account for these situations. C2 raised an open question regarding the definition of at what level additional work should be accounted for, and when such work is considered part of standard work included in routing. However, when additional work is required that would be invoiced by an external subcontractor, the additional hours of work for internal resources must be reported using an additional order (C2). To ensure the accuracy of additional cost data, the PC acts as an intermediary for production, striving to capture exceptions to standard processes in the ERP system. This allows changes in the production environment and their cost implications to be reflected in the system and made visible to other departments.

Various cases in which additional orders are utilized are discussed next. **In the first case**, products within a certain product family have additional work requirements related to transportation, which are not accounted for in the orders formed by MBOM. To address this, the PC proactively initializes an additional order. This enables the additional requirement to be integrated into the production process and treated as part of a standard procedure. When the work task is pending completion in the near future, the control key of the operation is changed by another employee, creating a purchase requisition, and the work is ordered by a purchaser. In the annual clock, this is reflected as a monthly review, where additional needs for products are identified, and an additional order is initiated by the PC.

The second situation addresses a case in which the PC supports the management of a major quality issue by creating an additional order. According to E2, the PC has assisted when extensive rework, involving both labor and materials, has been required. For minor quality issues, a quality notification typically provides sufficient support. For instance, interviewee E3 mentions that quality issues of the team's projects have been resolved through quality notifications, and incurred costs have been reported in the same process. However, in the case of a major quality failure involving the repair of modules and the delivery of materials to different assembly stations, the quality notification will not provide sufficient tools to support the case (PC).

"The quality notification alone does not provide any support for this kind of material handling. It requires the creation of an order." (PC)

In these situations, the PC coordinates alongside production, ensuring that associated costs are accurately reported in the ERP system. According to PC, it may be necessary to split the work into separate operations with associated materials requirements in more extensive repair cases. This is facilitated by an additional order, which also enables the correct allocation of costs. Interviewee E2 described a repair case in which the PC created an additional order and provided guidance on what should be included in the order and which costs should be assigned to the corresponding quality notification. According to E2, this approach provided clarity in the process with subcontractors. In such cases, the PC can generate a process for the deviating case using an additional order. It assists both the management of materials in production to complete the repair and the control of the associated costs.

"It [additional order] *helped that the case proceeded correctly from a cost perspective." (E2)*

"..especially in expensive cases you have to involve [the PC] *and where there are multiple other parties involved, so that the subcontracting arrangements are clear to everyone, and it is known where and how to allocate the costs in each situation." (E2)*

The third case concerns additional costs caused by deviations from the standard process. BOP1 defines the standard process and the associated product costs as illustrated in the previous main theme. Consequently, deviations from the process involving internal work should be reported in the systems and allocated to the cost object through additional orders. PC notes cases in which products have remained in inventory and subsequently required inspection, for example. These, and other deviations requiring additional work, are managed using additional orders. It enables the specification of required materials, allocating extra labor hours to the cost object, or creating a purchase requisition for subcontracted work. The next chapter will explore the detection of such deviations in production and the associated flow of information.

In addition to new-built products, the case company occasionally performs modifications on finished products. **This represents the fourth case** to be addressed in the context of additional orders. These products deviate from the standard process for new products, although subsequent stages following the modification typically align with the new product process (E4). However, unlike in the case of new products, the system does not automatically import information about subcontracted operations into the ERP. As a result, the PC is responsible for manually creating the necessary operations for subcontracted tasks in the system. These operations generate purchase requisitions, from which a purchaser orders the subcontracted work. The order must be generated before an invoice can be processed, which is why C2 emphasizes the importance of timely order creation. Because operations related to change work are not automatically generated in the system, proactive information flow from E4 towards the PC is essential. Table 3 summarizes the four discussed cases requiring an additional order.

Table 3 Summary of the cases requiring additional order.

	Description of the Case	Primary Purpose of the Order	Responsible Informer
1	Additional processing for a product	Ordering subcontracted work	PC
2	Major quality case	Cost and material allocation	E
3	Deviation from the standard process	Cost and material allocation	E
4	Product modification	Ordering subcontracted work	E4

4.4.2 Challenges in Identifying Additional Production Costs

The focus will now shift to case three, where deviations from the process result in extra work and additional costs. In particular, the challenges associated with identifying these cases by teams E and informing them to the PC are examined. This discussion is followed by a flowchart that is presented to optimize information sharing between the PC and E in these cases. Finally, the information flow in case four will be discussed through a case example, followed by a proposed addition to the annual clock to improve communication.

In the work category under examination, the point of contact to the PC is the E teams. Consequently, these teams are responsible for identifying cases that may require additional work deviating from the standard process. The results section begins by presenting interviewees' awareness of the PC's responsibilities and the frequency of communication, as illustrated in Figure 9. The low frequency of communication and lack of understanding of the PC's responsibilities may explain part of the communication gaps involved in the cases. The need for additional order is an exception that varies across teams E in both frequency and nature. Each case can differ, which may complicate early recognition and hinder the timely involvement of the PC in the case.

"They [additional needs] *are always a bit of a grey area in production: how to recognize them, how to make them appear." (PC)*

According to PC, most additional order cases are communicated by the E teams. However, it was discovered that cases sometimes appear through indirect means, such as from meetings unrelated to the subject. In a general discussion, there may have arisen cases where the interviewee PC has asked further questions and expressed the need to manage the case with additional orders. The primary challenge highlighted by PC is the identification of additional order cases by E and proactively communicating this information to the PC. E2 mentions that when moving vertically upwards in the organization, cost-related issues are more likely to receive attention, allowing the case to be directed to the PC. However, as C2 pointed out, there is no explicit definition of how much additional work must accumulate before additional orders become necessary. Clarification on the limits and increasing E teams' awareness of cost tracing could enhance the accuracy of costs and improve information flow towards the PC.

"Maybe I would recognize better [the issues to consult the PC about] *if I knew more about what they actually do in the Process Control. Then I might ask about other things I have not even thought of asking. But there have not been that many cases where I have ended up asking, or at least not often." (E3)*

In a specific case example, a deviation from the standard process resulted in additional work, which was noted at an early stage before its execution. Although communication with other departments was initiated at the start of the additional work, a delay occurred before the PC was consulted and involved. Consequently, the additional order was created and costs recorded after the work had been completed. This highlights the difficulty of sharing information proactively and communicating effectively without clearly defined communication responsibilities and understanding of the case from a cost perspective. Lack of timeliness or accessibility of information challenges the flow of information and can lead to inaccuracies in the data (Berente et al., 2009).

Figure 14 below presents a swimlane chart that models the optimal information flow between E and the PC for managing cases involving additional needs. To enhance communication and cooperation between the PC and E, E must identify relevant cases in advance. The process begins when E recognizes a case that deviates from the standard process and may lead to additional costs. Information is then communicated to the PC, which reviews the case and creates a follow-up task in the worklist. As more information emerges, E is expected to inform the PC, allowing order to be created in the ERP system. After the work is completed, E confirms the additional order in the ERP system and notifies the PC. Previously, the PC confirmed the order. However, by training E teams, the confirmation can be performed by E closer to the actual work.

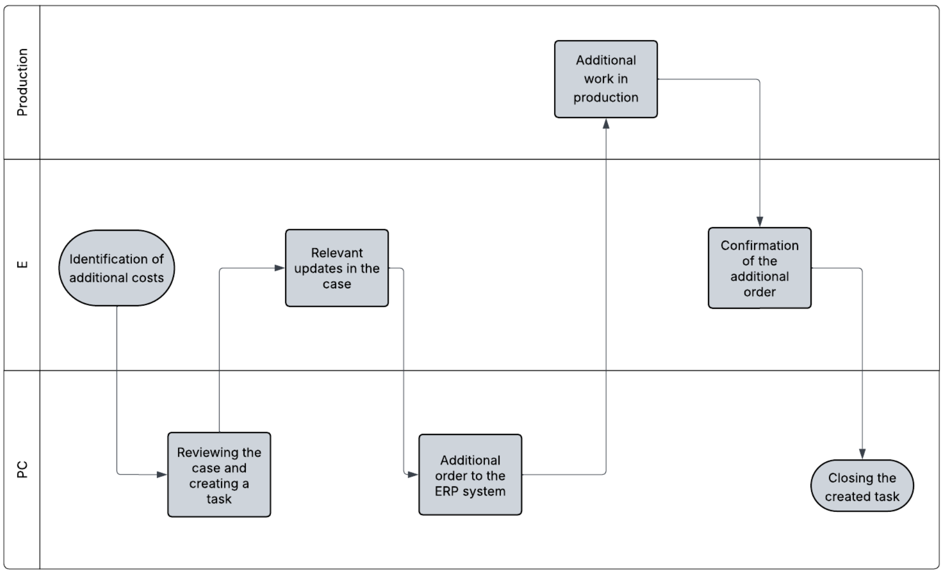

Figure 14 Swimlane chart of optimal information flow in additional orders.

Finally, a case example concerning case four, modified products, is discussed. Information about the necessary subcontracting operations for the products must be transferred from E4 to the PC to create a purchase requisition. In one instance, PC described a situation where the physical products had progressed to subsequent stages in the process, where a subcontracting order was required. However, instead of receiving information from E4 of needed orders, the PC was contacted directly by the subcontractor due to the missing order. According to E4, information about needed operations is transferred to the PC shortly before subcontracted operations begin. This practice challenges the anticipation of the next steps in the process and may delay the order.

"I am actually in touch at the later stages, when we can see that the [product] *will be completed on schedule, perhaps around then." (E4)*

According to PC, an overview of the required operations should be established at the beginning of the project. To promote a proactive approach and information flow, a meeting between E4 and the PC on upcoming projects is proposed every three months, which will be included in the annual clock. When subcontracted work begins in the near future, E4 would transfer the information to the PC. An overview of upcoming projects enables foresight in the creation of operations and ensures enhanced information flow between E4 and the PC.

4.4.3 Ensuring Accurate Data for Costing in Exceptional Cases

The data transferred from PLM to ERP with BOP1 enables tracking of product assembly progress when operations are confirmed in MES or directly in the ERP system. The integration between MES and ERP ensures that the finance department can access accurate information on production progress, provided that up-to-date information is maintained in the MES system (Avvaru et al., 2020). This chapter examines the role of the PC between the financial and production functions regarding the confirmation of orders. Moreover, the assistance provided by the PC in specific cost-related cases is described.

Interviewee C2 expresses that Department C's information need regarding production is the status of product progress. Although Department C accesses information through the ERP system, the data may not always align with the actual production status. Consequently, obtaining accurate information on the production status through systems represents an information need for the finance function that is occasionally not met.

Interviewees E1, E2, and E3 indicated that the PC contacts them at the end of the month regarding unconfirmed orders. E2 describes the contacts as follows: "It [the PC] is [in contact] in these monthly confirmations, quarterly confirmations. Or if it is unclear why a confirmation is not received." Interviewee E3 emphasizes that the PC initiates contact if unconfirmed orders remain at the turn of the month in completed operations, while interviewee E1 highlighted the importance of completing confirmations on time. As illustrated in Figure 15 below, E teams operate at the MES–ERP interface, whereas the PC functions at the PLM–ERP interface. Department C receives its information through the ERP system, with the PC striving to ensure the accuracy and timeliness of this data as the month changes.

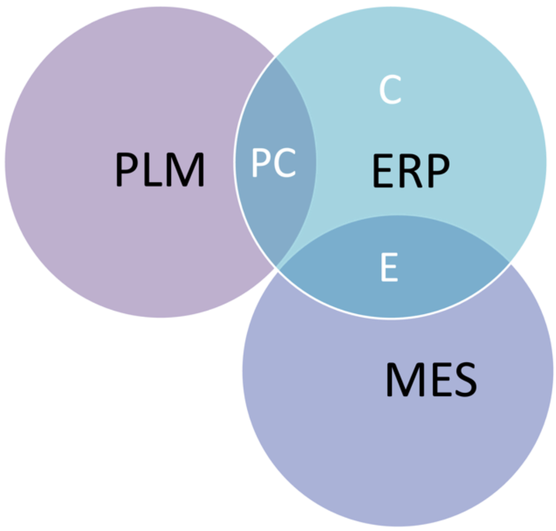

Figure 15 The primary systems used by departments and their interfaces.

Checking the confirmation status is a recurring task at the end of each month in the annual clock of the Process Control. At the turn of the quarter and the monitoring becomes increasingly precise. Thus, the PC aims to ensure that at the turn of the month, quarter, and year, up-to-date information flows through the systems to the other departments. This ensures consistency between the production environment and data in the ERP system. The unclear cases and confirmation issues identified in checking can be resolved with the help of the PC. For such cases, the E teams can proactively contact the PC, as raised by E3 in the interview.

In addition to confirmations, a second sub-theme highlights the PC's role in supporting communication between production and finance functions, particularly in exceptional cases involving cost uncertainties. While the additional orders chapter addressed the allocation of additional costs due to deviations from the standard process, this sub-theme focuses on how the PC can be consulted for more detailed clarification in special cost-related cases. Consulting may involve, for example, to special cases related to invoices or to allocating costs to the appropriate order in various scenarios (E2). A unifying feature of these cases is the support of the PC in cost-related issues and cost allocation. Whereas the first main theme centers on establishing the process, the second highlights the PC's strategic importance in managing exceptional cases within the ERP system.

"And in general, I would say that it [the PC] *always helps to make sure that the matter in question is managed correctly in terms of cost." (E2)*

The support described in the second main theme is required only when there is a deviation from the standard process in production. In such exceptional cases, it is essential that E teams proactively communicate with the PC to maintain consistency between cost data and production. Enhancing the flow of information between the PC and the E teams depends on increasing the awareness of the support the PC can provide. As a result, the exceptions become part of the cost calculations, enabling the finance function to access more accurate information about these exceptions.

4.5 Annual Clock of the Process Control

Alongside the results, the annual clock of the Process Control has been developed, including recurring work tasks related to each work category. This chapter presents the annual clock that summarizes the activities discussed in the results. This visual tool enables the demonstration of connections to stakeholder departments through the different work categories and the representation of the Process Control’s work tasks.

Ruotsala (2014) notes that the annual clock can serve as a tool for developing cooperation between departments and act as a practice script for development. The interviewees primarily identified the PC's responsibilities related to the maintenance of routing or concerning their tasks. Consequently, the visual representation of the annual clock may help stakeholder departments to gain a more comprehensive understanding of the PC’s responsibilities and recognize where their contributions are needed to enhance the overall workflow. However, it should be noted that the clock only contains recurring tasks.

Figure 16 illustrates the annual clock of the Process Control, created using a template provided by Visma Plandisc (n.d.). The clock is structured into three rings, each representing the different categories of work discussed in the paper. These rings are divided into weekly sections, with the outer margin displaying the months and quarters. The first main theme of the research, maintaining data to support the process, is divided into two categories of work. The innermost purple ring represents work related to the connection of routing and its establishment to maintain cost calculation in the cross-functional process. The middle ring in light blue corresponds to the maintenance of BOP1. The outermost part of the clock in pink is a work category related to the second main theme. This includes the importance of the PC to maintain the connection between production and cost accounting. Recurrent tasks are illustrated on a light background within each ring. On a black background, tasks identified in the research are indicated, which are intended to improve the flow of information between departments.

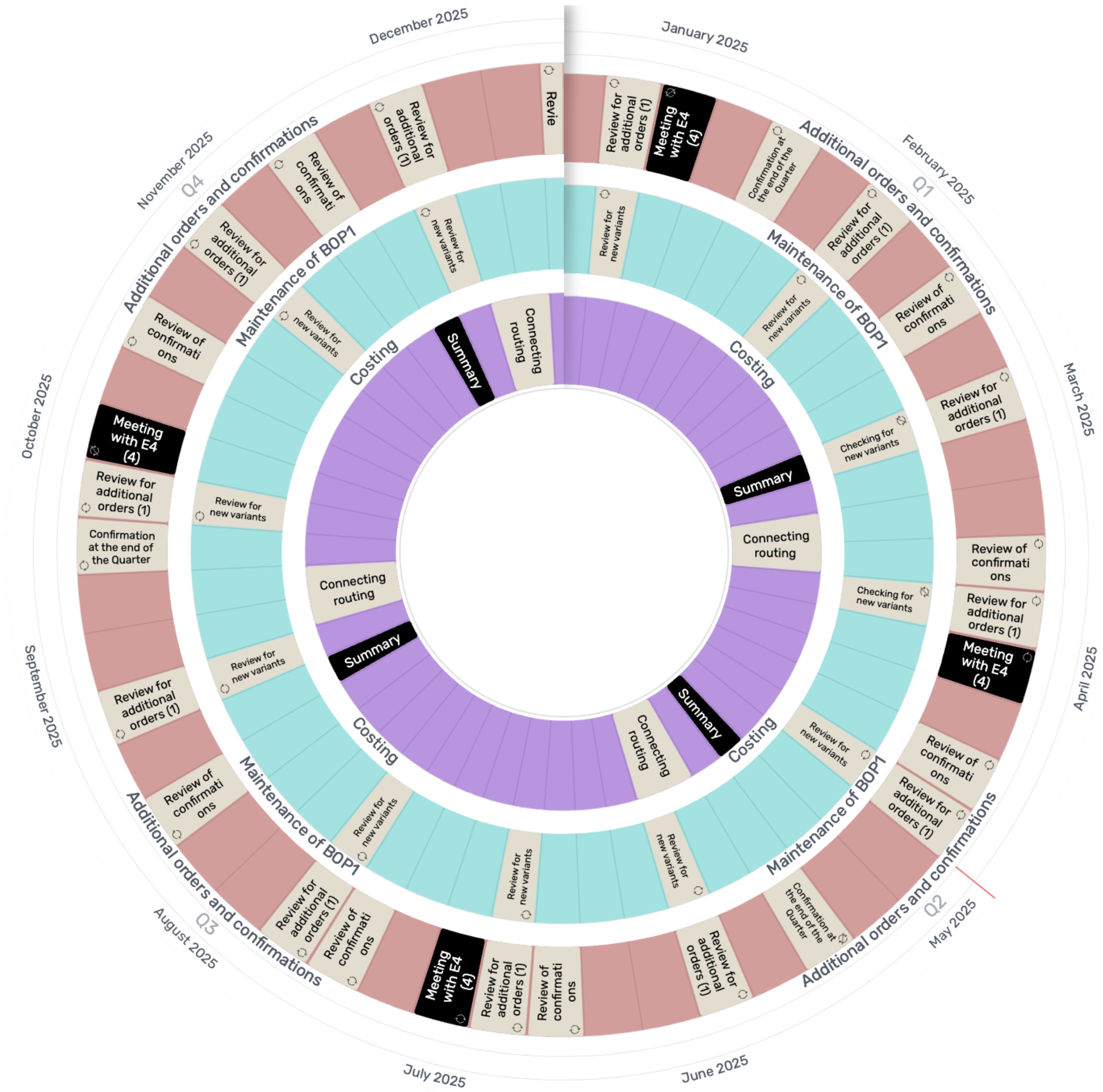

Figure 16 Annual clock of the Process Control.

In the innermost work category of Figure 16, the light-colored task refers to the connection of routing to the products to be priced in the quarter. This task is repeated at the end of each quarter and typically requires approximately two weeks of work from the PC per quarter. As part of the results, a development proposal was introduced suggesting the utilization of a summary document to improve visibility into the pricing period for the upcoming quarter. The submission of the summary document is aligned with the annual clock of the cross-functional process and is shown on a black background in the work category. The stakeholder departments involved in this work category are B and C, as well as A, concerning possible routing calculations. The light blue ring, representing maintenance of BOP1, includes a monthly review of upcoming products. This review ensures that BOP1 covers upcoming new variants and products. In this work category, Department A acts as a stakeholder for possible estimations if new products are identified.

The pink ring represents the third category of work. First, the PC reviews each month the first case presented in Table 3 for additional product orders from the incoming product, and the necessary additional orders are created. The task on the black background illustrates a proposed meeting for case four in Table 3 to review upcoming projects with E4. Regular meetings every three months would enable improved foresight and ensure the flow of information between the PC and E4. This work category also includes reviews related to the confirmation of orders. At the end of each month, the PC reviews the correctness of confirmations. Furthermore, at the end of the quarter, there is a more detailed review of the timeliness of confirmations. The PC notifies teams E if the confirmations are misaligned with the actual production. This visual tool aims to illustrate the recurring tasks of the Process Control and to promote the flow of information between departments.

5 Discussion

The aim of this research was to clarify the role of the Process Control department within the organization and to examine how the flow of information between departments could be improved to optimize cost accuracy and ensure data consistency with manufacturing processes. The role of interdepartmental communication in maintaining data accuracy within manufacturing companies and the consequences of information gaps have not been sufficiently addressed in previous research. This research aimed to address this gap in the literature. The core finding is that the role of the Process Control is to create and maintain data to coordinate product structure, production environment, and to assess the capacity usage of products. This assessment serves as the basis for calculating direct labor costs. Ensuring data accuracy and process functionality requires cross-functional collaboration and an understanding of each other's information needs.

5.1 Main Findings

The findings of this thesis indicate that the strategic importance of the PC is to transfer information to finance functions, connecting the direct costs, the product structure maintained by A, and the process of the production environment. Moreover, the findings indicate the need for accurate time values for multiple stakeholders in addition to financial functions. The findings suggest that the delay in information transfer to the PC is primarily due to an insufficient understanding of the PC’s information needs. To improve the accuracy of capacity consumption, it is recommended to establish a systematic approach for defining values, which would also require greater collaboration between departments. Each of the four key findings will be examined in more detail next.

The findings suggest the importance of the PC between financial and production functions in maintaining data by interconnecting product structure, direct costs, and the production environment from the perspective of cost management. The findings imply that there is currently no exchange of information between the finance department and A.

Consequently, the finance functions do not receive information on direct labor hours and their connection to the product structure without the PC. The role of the PC can indicate a bridging function between different communities, as identified by Wen et al. (2025). Besides operating between A and financial functions, the PC's role can indicate a bridging role for information transfer in production cases deviating from the standard process, thereby ensuring information flow in interdepartmental processes.

The finding suggests the function of the PC as a data producer in PLM, serving the information needs of the finance function as a data consumer in the ERP (Sääksvuori & Immonen, 2010). The information produced is vital for cost management, which requires proper data collection (Akeem, 2017). Without maintenance of data, changes would lead to data becoming obsolete, and MBOM would no longer provide financial functions with the necessary information on capacity consumption. The literature underscores the importance of up-to-date information in management accounting (Drury, 2018), which the PC seeks to address in the process as described.

The second main finding indicates the need for accurate time values of direct labor hours and activity times, serving not only financial functions but also the needs of other stakeholders. The PC converts the data into a usable format for the financial functions, although the time values are often estimates. Providing more accurate data for managers can help them in both short and long-term decision-making (Rounaghi et al., 2021). The findings imply that financial functions would benefit from more accurate data, for instance, for managing absorption. In contrast, from the perspective of A and D, accurate data would enable them to allocate resources to challenging products, potentially shortening lead times. While several departments identified the necessity for this information, the responsibility for clarifying the values was not assigned to any specific department, nor were resources allocated for this purpose. Without conducting time measurements, areas requiring development will remain unidentified (Munro et al., 2015). Consequently, it becomes challenging to assess the effects of the improvements implemented.

When exploring ways to improve the information flow, understanding the current situation is essential (Durugbo et al., 2013). The findings indicate that there is a lack of anticipation in the flow of information to the PC. The observations and case examples suggest that stakeholders do not sufficiently identify the information needs essential for achieving effective communication. Timeliness of information is a principle that is perceived as a challenge in most cases (Berente et al., 2009). This finding is significant because identifying the barrier to information flow enables the development of targeted solutions. Berente et al. (2009) emphasized the importance of a thorough understanding of information when it requires transformation in a process. Based on the findings, a deeper understanding of the PC's information needs among stakeholder departments is essential for enabling effective communication, which in turn is critical for ensuring the accuracy of the maintained data.

With the aim of enhancing interdepartmental collaboration and information flow to optimize cost accuracy, the findings suggest the need for a systematic approach to strengthening cross-functional collaboration. The findings indicate limited collaboration in estimating direct labor hours in the current situation. Furthermore, there are no resources allocated for measuring the actual values. As previously discussed, cost accuracy is essential for decision making and planning (Kitsantas et al., 2020), and more accurate and reliable data also affects the quality of decision-making (Ouiddad et al., 2021).

The current limited collaboration between A and the PC in determining capacity consumption estimates may be due to the responsibilities of the department A, which currently does not consider the generation of this information. In the case of new products, Department A may have the most informed perspective on preliminary estimates due to other responsibilities. However, without sufficient cross-functional collaboration, this information may not be utilized when assessing capacity consumption. The literature highlights the positive impact of information flow modeling on collaboration and improvement in information sharing (Durugbo et al., 2013). Consistent with this, the findings of this research suggest a need to implement structured processes to ensure information flow to take into account stakeholders' knowledge. Consequently, processes that support interdepartmental collaboration could enable more accurate data to estimate capacity consumption, which could have a positive impact on cost accuracy.

Taken together, the research demonstrates that the data structure created and maintained by the PC integrates data from several sources, serving especially the information needs of financial functions. More accurate and measured values would serve not only financial functions but also development functions. However, maintaining the data is challenged by stakeholders' inadequate understanding of the PC's information needs. There is a need for stakeholders to enhance their understanding of these information needs and to establish together more systematic processes for information sharing. Such improvements would not only enhance the accuracy of costs but also ensure that the expertise of different departments is transformed into information. Thus, the role of the PC suggests a bridging role between different departments, requiring interdepartmental cooperation and communication.

5.2 Key Findings in Response to the Research Questions

The following section presents responses to the three research questions addressed in the introduction chapter, based on the main findings of the research. The first research question examined the role and strategic importance of the PC in coordinating between financial and production functions within the organization. The results indicate that the strategic importance of the PC is to produce data in the systems, connecting the product structure and the production process, thereby providing financial functions data for their needs in the process. Accordingly, the data produced and maintained by the PC serves as a bridge between the product structure and the information needs of the finance department.

The second research question addressed the information needs of different departments and how these can be effectively aligned to enhance process efficiency. The findings indicate that multiple departments require more accurate data. Furthermore, the data structures maintained by different departments must be consistent to ensure that Specification Management receives the correct information and that the generation of the MBOM does not encounter issues. The accuracy of BOP1, in turn, is a critical information need for financial functions, as well as ensuring confirmations align with the actual production situation. The effective functioning of the process requires that information related to changes be communicated to all stakeholders in a timely manner.

The third research question focused on improving the flow of information and interdepartmental collaboration to optimize cost accuracy and ensure alignment between data and the production environment. The findings suggest that this requires effective communication between departments in order to take into account the information needs of the others. When the information needs of other departments are understood, more systematic practices can be developed to meet them, thereby enhancing collaboration and the information flow.

5.3 Contributions

The contribution of this research is evident from both theoretical and practical perspectives and is discussed next through three themes. From a theoretical perspective, the observations support the significance of effective communication in information flow, particularly within cross-functional processes. Furthermore, these findings complement the insights of Berente et al. (2009) by highlighting the importance of a profound understanding of each other's information needs when information transformation is required. From a practical point of view, it is recommended that familiarization efforts be extended to cover the information requirements of stakeholders more effectively.

In the second theme, this research contributes to the discussion on the significance of accurate data in decision-making. Based on the interview data, measuring accurate time values could be beneficial not only for financial purposes but also for development functions. Furthermore, it is recommended that efforts be made to improve the accessibility and transparency of measured data. This would promote the availability and transparency, which are one of key principles of information (Berente et al., 2009).

Thirdly, the research provides the case company with practical contributions that clarify the role of the PC within the organization and enhance stakeholders' understanding of the PC's information needs. The findings reveal causes for the disruptions or delays in information flow, enabling the case company to take action for improvement. These measures can enable alignment of data with the production environment and prevent the impact of information disruptions. Through these three main contributions, this research strengthens the theoretical discussion and provides practical recommendations to improve information flow and meet the information needs of various departments.

5.4 Limitations and Future Research

This research is limited to one case study organization with a unique organizational structure, data structure, and processes. Therefore, the results cannot be directly generalized to other manufacturing organizations. The research primarily addressed interdepartmental collaboration and information needs from a horizontal perspective, focusing on the main stakeholders within the context and scope of this thesis. This is essential to acknowledge as a limitation, as the interviews were not conducted in a vertical direction, limiting the ability to capture the impact of top-down decisions on the data accuracy. Furthermore, the qualitative data limits the generalizability and reproducibility of the findings. While this research presents insights from a single case, further research is needed to obtain a more comprehensive understanding of data maintenance practices combined with interdepartmental communication. Therefore, future research should focus on how companies manufacturing complex products maintain their data structures in changing situations to identify best practices for ensuring data accuracy.

6 Conclusion

This thesis examined the role of the Process Control department in supporting the finance and production functions. The aim was to explore the importance and role of the department by examining the work categories as separate units of analysis. This was necessary, as the information needs of the PC and stakeholder departments differ between the categories. Current communication methods and challenges were reviewed with the aim of enhancing interdepartmental communication and optimizing both cost accuracy and data alignment with the production environment. The answers to the three research questions that have guided the research are discussed next.

The first research question examined the role and strategic importance of the PC in the organization between production and financial functions. The thematic analysis indicated two main themes. In the first theme, the PC supports the process by creating and maintaining data. It maintains the BOP1 data structure, which connects the production environment process, product structure, and the financial functions' need to manage costs. By creating and maintaining data in changing situations, financial functions receive information about the costs of the product. In the second main theme, the role of the PC is to support production in cases of deviations from the standard process and to control costs with additional orders. The core aspect of the second main theme is allocating production costs and transferring information to financial functions.

Exploring the information needs of stakeholder departments was the second research question, where the findings strongly suggest the significance of accurate information. Specification Management requires the accuracy of BOP1 data to avoid challenges in the configuration of MBOM. Moreover, production relies on the MBOM and the production orders it contains, where BOP1 is required as it automates the creation of routing. Similarly, the accuracy of the data maintained in BOP1 and its transfer to the ERP is an information need of financial functions to monitor the costs incurred from production. These information needs are effectively aligned, provided that information flow in changing situations is ensured and BOP1 data can be maintained up-to-date as changes occur.

Based on observations and analysis, the flow of information and collaboration between departments improves when effective communication is achieved. This requires a greater understanding among stakeholder departments of the PC's information requirements, along with structured processes that include input from different departments for generating data. This ensures a more proactive flow of information to the PC in changing situations to maintain consistency between the production environment and BOP1 data, and to enhance cost accuracy.

The research findings suggest that information flow between departments plays a significant role in ensuring that the information maintained in the systems is up-to-date and can meet the information needs of data consumers. Moreover, it is essential to understand and consider the information needs of others to ensure effective communication. Thus, cross-functional collaboration is required to ensure the accuracy of the data and the functionality of the process. This research highlights a perspective that emphasizes the importance of interdepartmental communication in change situations. Hence, the research contributes to the understanding of the connection between data accuracy and cross-functional collaboration in manufacturing companies.

As the research focuses on one case company and horizontal communication, it limits the generalizability of the research. Further research is recommended to investigate the practices how other companies maintain bill of process data, requiring interdepartmental communication. Such research could uncover best practices for maintaining this vital data accurately. This research has contributed to the understanding that ensuring data accuracy demands effective communication for the consistent and accurate management of changes made across different departments. This ensures the flow of accurate information within systems in accordance with the ISA-95 standard.

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