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# NAVIGATING CHALLENGES IN STANDARDIZING PROCUREMENT PROCESSES WITHIN GAS COMPANIES
**Case Study**

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*Abstract*

Supply chain management, and procurement practices profoundly impact the success of construction projects. This is especially true to the Engineering, Procurement and Construction (EPC) industry. EPCs often encounter problems such as cost overruns, schedule overruns, delay in material supply and loss of productivity. This study explores standardization opportunities to combat these issues. It outlines barriers hindering standardization in EPC procurement and offers strategies for implementation. The main contribution of this paper is the provision of comprehensive strategies for EPC companies implementing standardization procurement practices.

*Keywords*

Standardization, Stakeholder Involvement, Conflict of Interests, Process Mining, User Training

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## 1. Introduction

Considering intensified global competition, nowadays organizations are compelled to enhance their agility, innovation and delivery of quality products on time, while minimizing transaction costs. Consequently, management of supply chain activities emerges as a pivotal determinant for securing competitive advantage and enhancing business performance (Mikalef et al., 2014). The significance of supply chain management is underscored by expenditure trends, with enterprises allocating an average of over 70% of their revenue to associated operations (ibid.). Nonetheless, the intricacies of supply chain network design pose formidable challenges, owing to factors such as scale, the stochastic nature of inputs and operations, and the dynamic interplay among various elements of the supply chain (Dotoli, 2009). Particularly, the efficacy of procurement practices assumes a paramount role in optimizing supply chain management efficiency (Lago Da Silva, Christopher, and Pereira, 2014).

Among the industries that are mostly impacted by procurement practices is the EPC industry1, in which procurement takes about 50-70% of the total worth of a project (Bajomo, Ogbeyemi, and Zhang 2022). The EPC Industry, despite being one of the largest ecosystems globally, faces challenges such as slim profit margins (approximately 5% Earnings Before Interest and Taxes) and low productivity improvements (averaging 1% per annum over the past 20 years, compared to 2.8% for the total economy) (Thameen 2023). During project execution, deviations in time, cost, and quality often occur, and procurement significantly influences these deviations, serving as a pivotal factor in either exacerbating or mitigating them.

As large-scale engineering and construction projects proliferate and technical complexity advances, standardization has emerged as a fundamental component of the overall

[1] The EPC industry stands for Engineering, Procurement, and Construction Industry. It refers to a sector that encompasses the planning, design, procurement, construction, and project management of large-scale infrastructure projects, such as power plants, oil refineries, chemical plants and transportation systems (Sharma 2019).

competitiveness of EPC enterprises. Nevertheless, despite the established advantages of standardization initiatives, numerous EPC companies encounter challenges to successfully implement those programs (Aerni 2004; Hesser 2006).

While studies such as Beukersm, Mark, Versendeel, Batenburg and Brikkemper (2006) have focused on creating an alignment framework for procurement, not many of them provide empirical insights. More recently, Batenburg and Versendaal (2008) reflected on how publications on supply chain performance often have a limited empirical base and that a considerable part of literature is conceptual in nature. This point of view is reiterated by Bajomo, Ogbeyemi, and Zhang (2022) requesting further research by an empirical approach.

Hence, this thesis aims to elucidate diverse perspectives on procurement performance and identify the barriers hindering the successful implementation of standardized procurement practices within EPC companies. Through an exploration of these facets, this study seeks not only to identify hurdles but also to propose viable solutions and strategies for EPC companies to embrace standardized procurement practices effectively, thereby fostering operational excellence and bolstering their competitive standing within the industry. The central question driving this research is:

*How can standardized procurement processes be successfully implemented in EPC companies within the gas industry to overcome existing barriers?*

The remainder of this paper is organized as follows. Section 2. provides an overview of previous academic work on standardization, barriers related to the implementation of these and cross industry insights. Subsequently, it describes the research methodology, including the analytical technique and the contribution of findings. Lastly, the study´s limitations and areas for further research are identified as well as managerial implications before reaching its conclusion.

## 2. Literature Review

### 2.1. Conceptual Overview of Standardization

In the genesis of standardization research, rooted in the conventional manufacturing industry, a standard typically denotes a shared set of quality norms or criteria. According to Jakobs (2000), a standard is defined as "a publicly available definite specification of procedures, rules, and requirements, issued by a legitimate and recognized authority" (Shin, Kim, and Hwang, 2015). In essence, standardization pertains to activities aimed at fostering unity and consensus (Bigley, 2019). The imperative for uniformity in manufacturing processes and products spurred the development of standards in engineering, production, and quality control. The study of standardization continues to progress, influenced by technological advancements, shifting global dynamics, and the growing interconnectedness of industries and societies.

Standardizing both products and processes has been demonstrated to yield numerous advantages. The favorable attributes associated with standardization encompass capacity availability and include functional unification, workflow utilization, scalability, data efficiency, and outcome predictability. Further evidence suggests that functional unification facilitates system updates, auditing, relocation to alternative facilities, and description using common semantics. Workflow standardization is facilitated through the implementation of standardized work instructions and procedures that govern operational activities. Standardization is also attainable through inputs and outputs featuring universally recognized and meaningful specifications. Scalability, as indicated by additional data, is both crucial for and a constraint on growth. Data efficacy highlights that standardization enables the application of metrics, which are indispensable for assessing operational performance. Predictability, another benefit of standardization, facilitates accurate and profitable pricing, tool creation, and ensures consistency (Bigley, 2019).

### 2.2. Challenges related to the Implementation of Standardization

Standardization faces several challenges that impede its seamless implementation and effectiveness. The complexity and diversity inherent in different sectors pose a significant hurdle. Crafting universal standards that accommodate the diverse nuances of industries and technologies proves challenging. Moreover, the rapid pace of technological evolution presents a conundrum – standards might become obsolete before they gain wide acceptance, leading to compatibility issues and inefficiencies. Interoperability, ensuring seamless functioning between systems adhering to diverse standards, remains a persistent challenge. As industries become more interconnected, ensuring that products and services align with established standards becomes increasingly complex. The speed of standardization often lags behind the rapid advancements in technology or market needs. The meticulous consensus-building process among stakeholders further elongates this timeframe (Snowden and Kavanagh 2006). Legal complexities arise in standardization, intersecting with regulations, intellectual property rights, and jurisdictional issues. Addressing security and privacy concerns in an increasingly digital landscape poses another challenge, especially with interconnected systems. Convincing users, businesses, and industries to adopt and adhere to standards can be an uphill task, particularly if immediate benefits aren't apparent or if the standards are perceived as restrictive (Micheli, Cagno, and Zorzini 2008). Achieving global alignment and consensus on standards is another formidable obstacle. Geopolitical variations, conflicting stakeholder interests, and differing regulatory frameworks among nations often hinder reaching unanimous global standards. Additionally, the costs associated with conforming to standards can be prohibitive for smaller businesses or developing economies, potentially stifling innovation or creating entry barriers (Bagby 2013).[2]

[2] see Figure 5. in Appendix B.

However, it remains unclear to what extent these challenges can be transferred to the EPC gas industry and what unique challenges may exist that also hinder the implementation of standardization practices (Asiedu and Adaku 2019).

### 2.3. EPC Industry Characteristics and Standardization

The Engineering, Procurement, and Construction (EPC) industry encompasses a wide range of projects, including those in the construction, oil and gas, and energy sectors. Among the seven largest services in EPC market are power and energy, roads and bridges, telecom, building constructions, railways, ports, airports, and inland water transport, as well as oil and gas. EPC projects involve the integration of engineering design, procurement of materials and equipment, and construction activities (Shen et al. 2017).

The EPC industries are characterized by various aspects such as tight schedules, short float dates for long-lead items, provisional sum and reimbursable or cost-plus in procurement, involvement of numerous stakeholders and disputes related to variables or change-orders during the close-out period of EPC projects (Ban and Hadikusumo 2017).

In specific, EPC supply chain involve intricate networks of suppliers, subcontractors, and partners due to the diverse nature of projects, leading to increased complexity and interdependencies. Further, supply chains are project-centric, tailored to specific requirements rather than standardized, resulting in dynamic and customized procurement processes. EPC projects often require long lead times for materials and equipment, necessitating meticulous planning and forecasting to avoid project delays. Lastly, managing risks related to project timelines, quality and cost is crucial in EPC supply chains due to the inherent uncertainties associated with large-scale projects (Paulraj, Chen, and Flynn 2006).

EPC oil and gas industry imposes specific challenges related to stringent environmental regulations, as well as the technological complexity resulting from the nature of gas processing and related constant technological advancements in gas extraction. According to Micheli, Cagno, and Zorzini (2008), the development of standards, the adoption of new technologies such as blockchain, and the need for effective project management underscore the significance of standardization in ensuring the success of EPC projects.

### 2.4. Cross Industry Insights

For the analysis of cross industry insights, the aerospace industry and the automotive industry are chosen as these industries have similar characteristics or face similar challenges as the EPC gas industry.

First, projects in the aerospace and defense involve complex engineering designs, specialized procurement of materials, and intricate supply chains with tight schedules and critical timelines (Manville, Papadopoulos, and Garengo 2019). They often require long lead times for components and face similar challenges in managing risk associated with project timelines and quality as the EPC gas industry. The aerospace industry has been at the forefront of using machine learning and artificial intelligence, which can be attributed to the high stakes involved in aviation, where safety, efficiency and reliability are paramount (Pinar 2022). In specific, the aerospace industry is, for example, leveraging big data and machine learning to address complex optimization problems in aircraft design and manufacturing, highlighting the industry's potential to capitalize on data-driven approaches (Brunton et al. 2021). Engineering design and manufacturing processes could undergo a revolution because to the employment of technologies that can simulate, test, and evaluate model designs for a fraction of the cost of real-world implementation, claim Brunton et al. (2021). By identifying the most effective techniques, their adoption can optimise processes. Establishing best practices for data-driven insights can indirectly support the process of standardisation. Boeing, for example, is using simulation and digital twin technology to standardise its aircraft design processes. Using virtual testing and simulation, these advances have reduced project timelines, increased efficiency and raised safety standards (ibid).

Second, the automotive industry may be considered as an industry for cross industry insights, since, in terms of material management, in the automotive industry, the Just-in-Time (JIT) inventory management system has revolutionized material management. Toyota's successful application of JIT serves as an exemplary case, wherein materials are procured and utilized precisely when needed in the production process, reducing excess stock and storage costs. This is not inherently a form of standardization, however it does involve standardized processes and practices to function effectively (Womack, Jones and Roos 1990; Waters-Fuller 1995). Drawing insights from these industries, implementing standardized supply chain management akin to aerospace’s´ advanced digital simulations or automotive´s JIT principles in the EPC gas sector may hold promise. By adapting such practices, the EPC gas industry could potentially reduce lead times, enhance efficiency, and optimize project execution, especially in procurement.

## 3. Research Methodology

### 3.1. Qualitative Research Design

This thesis advocates for a qualitative research approach, aiming to address the research question by inductively conceptualizing various stakeholder perspectives. Qualitative research, as defined by QRCA (2019), is designed to uncover a range of behaviors and the underlying perceptions that drive them regarding specific topics or issues. The relationships that may emerge from the analysis are deduced inductively, meaning a relationship is initially formulated from observations through an interpretation of existing literature, often describing relationships in specific cases only (Rüßler, 2017). Thus, induction leads not to absolute, but rather probable, generalizable relationships. According to Krusenvik (2016), the objective of a case study is to extend and generalize theories (analytical generalization instead of statistical generalization), aligning well with the research format. Qualitative research, by employing open-ended questioning, enables deeper insights into the subject matter, thereby facilitating a richer information yield. Additionally, qualitative research permits deductive relationship development thereafter, allowing for the acquisition of detailed and pertinent data, particularly in terms of internal validity. This lays the groundwork for introducing new practices at the company level (ibid.).

## 3.2. Data Collection

### 3.2.1. Principles and Advantages of Interviews

The core tenets of qualitative research find resonance in expert interviews. Firstly, the researcher's impartiality is ensured by the absence of predetermined outcomes. Secondly, interviews, with their proximity to everyday discourse, foster communicativeness. Thirdly, the precision of questions and the adaptability of the interview process facilitate elucidation. Reflexivity is also fostered through the reflective testimonies exchanged during interviews. However, the application of these principles hinges on the specific interview methodology, which will be elaborated upon subsequently.

Expert knowledge possesses a distinct characteristic wherein experts, unlike laypersons, operate with unequivocal and readily communicable expertise. From expert discussions, three tiers of knowledge emerge: technical knowledge, encompassing quantifiable facts; process knowledge, comprising insights into actions, interactions, and organizational dynamics; and interpretive knowledge, which delves into subjective perspectives and interpretations (Bogner et al., 2014).

### 3.2.2. Development of Interview Questions and Interview Design

The literature review acts as the foundation for crafting the interview inquiries. In doing so, the intent isn't merely to affirm or negate pre-existing relationships. Rather, the focus lies on substantiating the construction of the interview questions through empirical and theoretical justifications, as emphasized by Bogner et al. (2014). Consequently, the interview is structured in a semi-structured way[3]. Interview questions cover the topic of standardization, challenges and implementation strategies and a guide has been developed that serves as orientation for the interview (see Guideline for Interviews in Appendix A).

Before conducting expert interviews, informal, prerequisite interviews are hold as a first step. The purpose of such is multifaceted. Firstly, informal interviews allow the researcher to gain a contextual understanding of the participants backgrounds, experiences, and perspectives. This can inform the questions asked in the expert interview and provide a more nuanced view of the participant's expertise. Based on this, the expert interview can focus on more specific and complex aspects of the participant's expertise, benefiting from the foundation laid during the informal interview. Secondly, by conducting two distinct interviews, researchers can employ a triangulation method, comparing and contrasting information gathered in both interviews. This can enhance the validity and reliability of the data. Thirdly, for studies involving sensitive or personal topics, starting with an informal interview can help build trust and rapport before delving into more sensitive areas during the expert interview (Bogner et al., 2014).

## 3.3. Sampling of Experts

In the EPC industry, procurement serves as a functional link between engineering and construction (Bajomo, Ogbeyemi, and Zhang 2022). Hence, to explore opportunities for

[3] In the field of social science, semi-structured interviews are exploratory interviews that are most commonly used for collecting data for qualitative research projects. Although it normally follows a planned guide or protocol that is focused on a core topic to provide a broad structure, the semi-structured interview encourages exploration and allows room to follow current developments as the discussion progresses (Magaldi and Berler 2018)

standardization, it is crucial to analyze viewpoints from stakeholders from all steps within the EPC process. An overview of the process steps, including engineering, procurement, and construction as main categories, can be found in Figure 6. (see Appendix B.). Therefore, the interviewees were selected in a way to ensure the coverage of the whole procurement process. Figure 3. (see Appendix A.) depicts an overview of such standard process in EPC companies, in which a categorization of interviewees has been conducted. Hereby, 48 interviews fall in the category of procurement, 3 in the category of construction and 9 in the category of engineering. An overview of the interviewee's positions can be found in Table 1. (see Appendix A.) depicting that 51 informal interviews (II) and 10 expert interviews (EI) have been conducted. The interviews have been conducted at a gas company with a workforce exceeding 60.000 employees worldwide and that is considered a key leader in the industry.

### 3.4. Data Preparation and Analysis

After the interview, the transcription to text for a content analysis is done with the software MAXQDA. Hereby, as a first step, raw data of the interviews is coded. The related coding trees can be found in Figure 4. (see Appendix A.), which summarizes steps of the coding process. Since the goal is to create theory, the grounded approach provides a valuable approach in the data analysis phase. It's critical to view the expert's words as interpretive knowledge rather than just factual information. This entails going further to examine the implicit norms and action orientations that may be hiding inside the remarks made by the experts. This method seeks to identify the underlying motives and beliefs that inform their opinions.

Thus, the assessment is predicated on a particular research mindset that is best described by making use of grounded theory (Glaser and Strauss 1967). The coding of data, which generates a new arrangement of data based on the plausibility of causal linkages between individual elements, is the fundamental process of grounded theory. Here is where Kuckartz and Rädiker's

(2022) steps can be implemented. Sections are titled textually in the first step, which entails identifying trouble areas and grouping related passages under major topics. Comparable passages are looked for throughout each of the various texts in the second stageBecause of the data condensation that results from this, self-monitoring on a frequent basis is required. The final phase accomplishes abstraction. At this point, sociological categories are used to summarise and group various aspects of common expert knowledge in an effort to find commonalities in their relevance, typifications, and interpretations. This marks, in a way, the transition from the experts' own level of description to that of descriptions provided by others. Building systematic relationships is the fourth phase (Bogner et al. 2014).

## 4. Analysis of Findings

The analysis of the data from the interviews conducted, led to results in various areas including the impact of standardization in procurement of EPC companies, the challenges in the implementation of such standardization and the various strategies EPC firms may use to mitigate them. Some of the findings were reinforced with the literature review when found appropriate. An overview of the results can be found in Figure 7. (see Appendix B.), which summarizes the results in a mind map including challenges and implementation strategies proposed.

The analysis of the findings is structured in the following pattern. Findings are presented, then they are linked to the existing literature, potentially conflicts regarding other perspectives mentioned are given and lastly interpretations of the findings are proposed.

### 4.1. Identified Challenges

In this section the challenges discussed in the interviews are presented, which may be divided into two main subgroups, namely the uniqueness of projects and the contribution of various stakeholder groups throughout the procurement process. Overall, those subgroups can be concluded under the aspect of organizational complexity. Overall, the barriers described in the literature review can be validated by the interviewees. Those include complexity, rapid pace of technological advancements, meticulous consensus building, legal complexities, as well as convincing users. However, among the interviews conducted, the complexity arising from the involvement of diverse stakeholders in the engineering and purchasing process, as well as the uniqueness of projects are highlighted as most crucial factors. Hence, these aspects are discussed in more detail below.

To begin with, interviewees highlight the complexity arising from various stakeholder groups participating. In relation to this, they accentuate the difficulty arising in reaching consensus due to diverse opinions and approaches. The interviewee EI5 explains that standardization missions within the purchasing process have failed because “we have never been able to agree on a single approach“ (EI5). In specific, engineers´ inclination toward customized solutions rather than standardized ones poses challenges according to EI10. This can be exemplified by his argument: “And there you are under the better point. Either you are too much better, but you are not at the right point of quality, optimized quality. If I illustrate. {…}. If you want a compressor or you want an equipment, let's say maybe a lot, with a certain efficiency. To be at this efficiency, you will design what you want. {…}. And you push this to the supplier, please provide me an equipment as per this specification. This is the optimized point. If you standardize, meaning you have some frame. {…}. Either you buy a frame lower, either you buy a frame higher. If you buy a frame lower, maybe the valve will be smaller, or the compressor will be less performing. Cheaper, but less performing, so you will lose. On the opposite, maybe it will be better in efficiency. But for sure, it will be more costly than the optimized point. {…} why we struggle {is} because we are an engineering company. We are made of engineers. Engineers, they want the perfect fit between what they order and what they need" (EI10). This finding suggests that there is a conflict of interest between engineers thriving for the perfect fit of their designs to specifications of the items bought by the purchaser, and the purchaser seeking low costs. Further, this can hinder the introduction of standards in terms of designs because engineers may follow a "perfect match" approach that does not align with cost optimization. Interviewees propose that resulting from this is often a customized adaption of certain standardized systems, because no agreement on a standardized version could be found. This is highlighted by EI6 saying "Ninety -ninety nine percent of the cases, you will see that all EPC companies when they try to introduce standardized process tools, any type of new tool or product, the problem they face is that they would have something in mind but then ultimately ended up with something else, customized" (EI6).

Correspondingly, the complexity in rule management has been mentioned by various interviewees, highlighting the problem of adding new rules when changing a process rather than taking rules away and simplifying processes. EI2 says: "We add different rules. We add, add, add, add following the times but at the end people don't know, don't know why they use these rules and for who and for what purpose" (EI2). This finding may be linked back to the previous finding, suggesting that due to conflicting stakeholder groups involved in the consensus finding process, new, proposed simpler workflows often result in more complex ones than expected.

Overall, in relation to the complexity proposed above, interviewees highlight the underestimation of effort in relation to this consensus building (EI4 and EI6) on the one hand, but also the implementation then of such afterwards, on the other. This can be underlined by the following quote from EI9: "New tool implementation takes three times longer than development, often underestimated". EI4 points out the difficulty of keeping the then agreed consensus among employees by arguing "but as long as there is no incentive for people to do that, {…} and you don't get rewarded for that by whatever means, it's not clapping on the shoulder. So at the end of the day, it needs to pay out in one way or the other.” These findings suggest that there is a need for considerable time spend on not only the consensus building, but especially the implementation, whereby it needs to be ensured that employees are rewarded. Linking these findings to the previous argument, it is evident that the process on aligning opportunities for standardization itself is rather complex due to the inclusion of conflicting stakeholder groups among others. These arguments may be reinforced by the arguments presented in section 0 of the literature review. It needs to be noted however, that other aspects impede the introduction of standardized processes as well, for instance, the need for specific engineering tools resulting in "Technical barriers imped{ing}seamless data transfer between specialized tools and general ERP, leading to manual entries, rework, and errors" (EI9), highlighting the complexity of and difficulty of data interconnectivity and integration.

Further, challenges arise due to the unique project specifications. II27 points out that "In a world of engineering, standardization faces difficulties due to the intricate nature of projects with numerous variable parameters" underpinning the difficulty of setting up standardized plant projects, due to the uniqueness of each projects. Exemplified can this by the following quote from EI1 “{…} you have some conditions of earthquake of seismic conditions, which are very different also from earthquake to another. So that means that the raw materials are not the same” (EI1). In contrast to that, E13 argues that standardization of plants is feasible and have benefits including “standardization of our plants, that means it is a copy, {…} we save man hours for specialists, for project management, for project execution, for all... For all jobs, it allows us to save much hours. It allows also to have a bigger margin”. However, EI6 points out that “{…} unfortunately, we can implement the standardization when we have experience and a return of experience for type of equipment. When it is totally new, like the carbon capture project, that we are under innovation and development with suppliers, we cannot standardize because we are at the beginning”.

These findings suggest that besides the conflicting views towards the implementation of standardization between engineering and purchasing, the uniqueness of projects further complicate the standardization of plant designs. Whereby some interviewees highlight the opportunity to standardize plants, they point out the difficulty of projects including new technologies such as carbon capture, as there is a lack of experience that may be used as best practice for the building of standardized designs.

### 4.2. Proposed Strategies to Overcome Challenges

In this section, the strategies proposed in the interviews are presented and then linked to the challenges.

Initially, interviewees present the opportunities for standardization of plants and material. EI3 says that "standardization of our plants, that's mean it is a copy, a street copy for each project. It will be exactly the same. So that means we save man hours for specialists, for project management, for project execution, for all... For all jobs, it allows us to save much hours. It allows also to have a bigger margin" (EI8). EI3 points out that "{…} but{standardization} can also be our own manufacturing equipment. We are able to build some stock. So we can order a larger volume in advance of equipment. So you have a second lever, so first lever could be competitive, competitive, and the first lever is a volume associated to the standardization. Because there is no end date on the material, so if you know that you will still buy this type of pipe, or if I look at the bulk item, and if you look at the biggest item, if I'm sure that for this type of plant, I will need this type of exchanger or compressor, I can pre-order, or I can bundle several orders at the same time" (EI3).

These findings demonstrate a clear contrasting opinion towards the opportunity of standardization of plants and material as proposed by some interviewees and presented in chapter 4.1. Thereby, these findings underscore the existence of conflicting views, which may

be explained by the belonging to different stakeholder groups. This in turn again reinforces the argument of difficulty among consensus finding among stakeholder groups.
However, a way to address the opportunities for standardization of plants and materials that has been proposed by the interviewees is process mining. Emphasis should be placed on the comment made by EI9, stating that “process mining may be helping to find common ground”. This statement may be interpreted in the following way: Process mining may be used to analyze event logs helps in discovering recurring patterns and deviations in workflows on the one hand, but also project patterns on the other. These insights highlight where variations exist, whether due to different approaches by employees, exceptions, or inefficiencies in the current workflow. This in turn can help to find consensus among stakeholders to which extent plant structures from projects may be used as template for new ones for example.

Further, the informal interviews point out the need for transition towards the introduction of Artificial Intelligence (AI) and machine learning. Hereby, the interviewees express a clear need for adaption of such technologies, however it remains unclear for them how those can be used. This is underlined by expert EI9 saying: “I do not know how, but we need to adapt it”. This may be interpreted in a way that there remains a knowledge gap in what AI and machine learning can contribute. This may be linked to the literature review, which presents the opportunity of machine learning in engineering of the aerospace industry. The presentation of such opportunities in informal interviews has received interests. Further, such inclusion of machine learning can help find consensus among stakeholders, as the machine can provide most efficient data driven solutions that can serve as baseline for discussions for standardization opportunities (Horzela and Semrau 2021).

Hence, it may be concluded that process mining strategies may help to define opportunities for plant and material standardization. In this regard, machine learning, as used in the aerospace industry might be considered and practices might be adopted and applied in the EPC industry in engineering as well.

Further, in relation to this, some interviewees argue that it is crucial to follow a rather bottom-up strategy by including employees in decision making. EI2 highlights this by saying “Speak with people, listen collaborators about that. Okay, so training... Just to hear the frustrations.” And EI8 argues that “And if they participated, it would be easier to impose that people will follow this standardization of process.”. However, on the other hand, importance is also placed on top-down practices. EI8 underlines this by saying “you have to impose... It is, I know, a dictatorship, but you have to impose”, and EI1 notes “at the end, you cannot await the feedback of everyone. Otherwise, it's a mess”. EI7 also highlights the importance of ensuring that processes do not become too complex, saying “to a certain extent, I mean, you can, for sure debate the details. In many cases, our processes are way too complicated. They are standardized but they are too complicated“.

These arguments imply that, while collaborative efforts and inclusive input remain pivotal, a measure of authorities top-down imposition appears requisite to ensure efficacious standardization, preventing potential entanglement within perpetual feedback cycles, thereby ensuring that processes are made simpler rather than adding new procedures. To address this, EI6 highlights the opportunity of value stream mapping. He says, “Basically, there's something called as value stream mapping. So basically product is being procured, manufactured, assembled, but we add value and then we send it outside. Value stream mapping is quite the other way. So we check where do we create the most value? So where is, where is {value} added, where is values gone; and we put a map. Basically it's like a supply chain map that is called a value stream map. And within this value stream map, we see where do we increase this value“. This in turn can help to identify which stakeholders are involved in which process step and based on results decisions can be made among who to include in which decision-making process for standardization.

Another approach described as useful is the variation tree analysis. EI4 argues that “Variation trees can serve as a visual base for understanding different opportunities”. According to EI4, this in turn can help to identify which stakeholders are involved in which process step and based on results decisions can be made among who to include in which decision-making process for standardization.

A result from such value mapping and variation tree analysis can also be the definition of clear responsibility roles, which is considered important when establishing standardization processes. EI7 highlights that “when it comes to certain points down to the working level, they are blur and you can easily hide behind these, let's say, this blurry, I don't know, task descriptions, however you call it, and say, listen, as far as I interpret it, they're not responsible…and make people clear that it's part of their responsibility” (EI7). This may be related back to the top down approach says EI7, who points out that “you cannot, let's say, leave a level of freedom so people at the end tell me they are not responsible“ (EI7).

These arguments include that before making decisions on which stakeholders to include in the decision-making process, value mapping can also help to define clear roles of stakeholders, which in turn serves as basis for such decision.

Moreover, the importance of user training and especially the follow-up routine is highlighted. EI5 emphasizes: “To adhere to a standard, a robust system of follow-up is required. It is important to consistently use the same equipment number and avoid using new ones.” In relation to this, the interviews point out that regular communication of results is crucial. EI2 says: “{…} communicate about the result. But smaller, smaller result. Regular communication with businesspeople; {…} communication about the success.“. An example of this could be, as EI2 further explains a so-called lean day. “We did a day, a lean day in administrative. So we booked all the meeting rooms on the ground floor and we invite people during the lunchtime to see and to see the progress, the result. And it's not me that present. It's the team, you know, it's the business, it's accounting and procurement team.{…} it was a success.“, she points out.

Such results from standardization of workflows and data gathering may result in the following results: There is a clear emphasis on efficiency improvements resulting from standardization, as well as improved supplier relationships and competitive bidding. This includes streamlining workflows, reducing redundant steps and optimizing resources. In specific, interviews point out, “if we are succeeding in standardizing the equipment we want to purchase, it's easier to put in competition two or three suppliers. By doing so, you will have a first leader of procurement because the more suppliers you can compare easily. The most is easier to challenge“ (EI10), as well as “maybe {with standardization it} is easier to have some competitive bidding. Easier to follow the price evolution in between two orders. Saving in terms of time also to prepare the request for quotation and to analyze the offer to place the PO (EI10). This impact can be measured in terms of the number of suppliers compared, the ease of negotiations, and the savings achieved through competitive bidding.

Further, emphasis is put on quality improvement. EI2 and EI10 point out that standardization can be associated with maintaining consistent quality. In specific, standardization helps in minimizing change orders, which can lead to cost savings and better project execution. EI3 underlines this by saying “and you make less mistakes because in the world of engineering what costs a lot is the change order. Because for instance, when you negotiate a batch of equipment because all the studies have been made, you place the order and then studies in parallel are continuing. And then they realize that now we need to modify. If for instance the vendor has already launched his purchase and you ask him to change something, it would do it, but it's going to charge you double the price. Yeah. So change orders is what is what is” (EI3). According to EI2, quality in terms of data entry in SAP for purchase orders can positively impact other procedures along the procurement process. EI2 highlights “the most is the quality because I think we have the same quality. You know the same quality the same answer whatever. Second, easy work for logistics and policy guide to release the equipment, to know what it is included in each line of equipment” (EI2).

In conclusion, a regular follow up to present results is considered important. Such follow up may be linked back again to the different stakeholder groups involved. Initiatives such as “lean days” suggested by EI2 can enhance the overall understanding of process flows and may increase the understanding procedures introduced among stakeholder groups, thereby lowering their reluctance to change.

## 5. Discussion

The findings from the analysis of standardized procurement processes in EPC companies reflect a complex landscape. The challenges faced, stemming from uniqueness of project specifications and diverse stakeholder interests, highlight a fundamental clash between standardization's systematic approach and the inherent variability in engineering projects. The resistance to standardized solutions, particularly among engineers seeking tailored outcomes, poses a formidable barrier. This resistance often leads to adaptations and customizations, diminishing the efficacy of standardized systems. However, the proposed strategies are not merely reactive measures; they signify a nuanced understanding of these challenges. The recommendation for standardizing plants and materials is intriguing, aiming to capitalize on potential efficiencies despite conflicting views. The suggestion to utilize process mining for identifying opportunities is indicative of a more data-driven approach, seeking consensus by demonstrating patterns and efficiencies that could be achieved through standardization. Moreover, the emphasis on a balanced approach - incorporating bottom-up engagement and top-down direction – is a pragmatic attempt to navigate the conflicting demands for customization and enable On-the-

Ground Insights. The proactive steps – such as regular follow-ups, communication, and initiatives like "lean days" – indicate a recognition of the cultural aspect. By showcasing the direct benefits and impact of standardization, these efforts aim to bridge the gap between differing perspectives and foster a culture receptive to change.

Overall, these findings answer the research question and underscore a holistic approach to standardization – one that acknowledges the inherent complexities, integrates diverse stakeholder viewpoints, leverages data-driven insights, and emphasizes ongoing communication and education. Successful implementation does merely involve imposing standardized processes but rather orchestrating a collaborative transformation that balances the need for standardization with the necessity for flexibility within EPC procurement processes. The key challenges and key strategies identified are depicted in Figure 1. below.

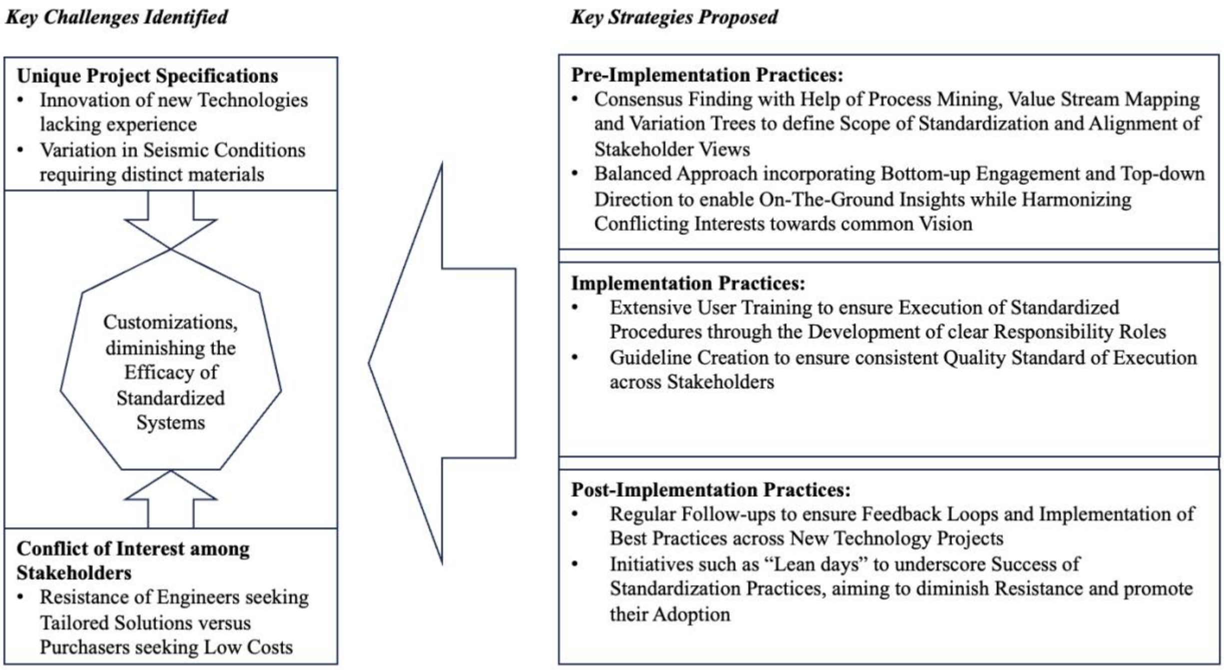


*Figure 1. Overview of Key Challenges Identified and Key Strategies Proposed*

## 6. Managerial Implications

This study suggests managers to follow the implementation strategies presented in Figure 1., if they desire to implement standardization practices. Particularly highlighted among the interview findings is the need for thorough pre-implementation practices. Proposed strategies include hereby Process Mining, Value Stream Mapping and Variation Trees. Figure 2. exemplifies how a variation tree analysis could help to make a standardization choice on the data entry strategy used for purchase requisition development in SAP as preliminary requirement for the creation of purchase orders. Purchase Requisitions are crucial to ensure that purchases are authorized and within budget and are hence a widely adopted within procurement processes. Such purchase requisition requires the data entry work from engineers, and usually approvals from buyers, cost controllers and project managers. Therefore, the development of such variation tree may be done through a bottom-up approach incorporating strategies proposed by participating stakeholders. The choice of variation chosen to be standardized should then follow through a top-down approach to ensure proper implementation.

**Variation Tree Example for Purchase Requisition Standardization Analysis**

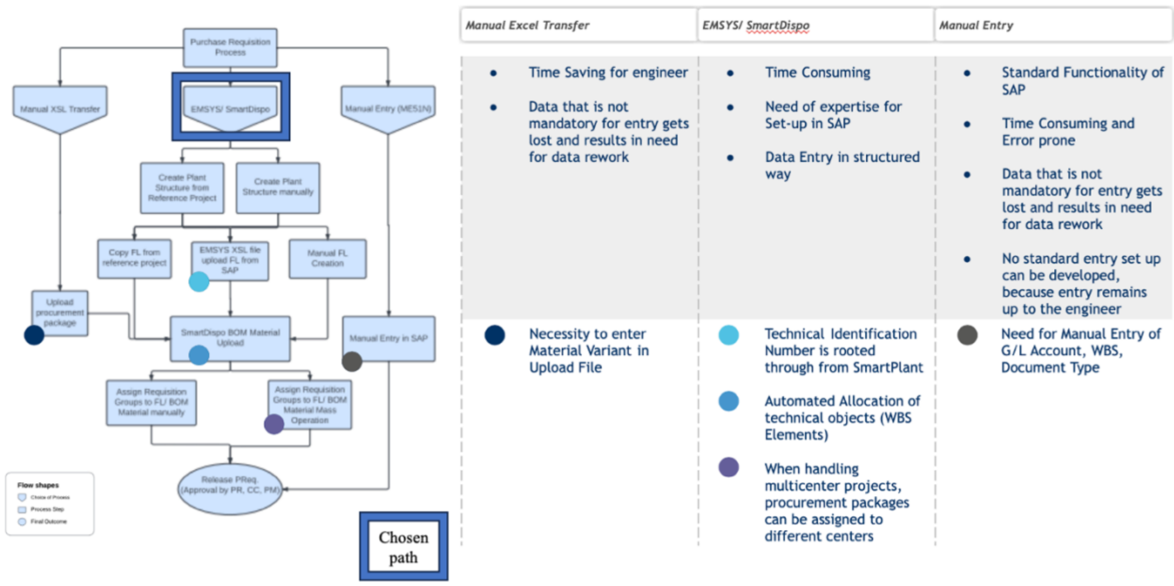


*Figure 2. Variation Tree Example for Purchase Requisition Standardization Analysis*

Following the pre-implementation practices, the establishment of guidelines, responsibility roles and training is needed. In the example described, such may include clear role descriptions and responsibilities for each step in the chosen variation, which can include the format of data entry in terms of standardized methodologies as well as training on how to use SAP in the most efficient way.

Afterwards, post-implementation includes regular follow ups and initiatives such as lean-days. In the example described, such lean days could include the presentation of time savings resulting from the standardized process, as well as statistics on reduced change orders and reduction in errors in purchase orders.

The thesis significantly contributed to the fulfillment of internship objectives by standardizing the purchase requisition process within the Engineering and Construction centers of the organization in focus.

## 7. Theoretical Implications

The analysis offers several research and managerial implications.

According to Matta, Nakouzi, and Kalach (2022), there is still a lack of research and awareness on standardization practices in procurement, especially within the EPC industry. Throughout this research, efforts were made to provide deeper insights, thereby strengthening existing knowledge on the topic and collecting direct evidence of how standardization affects procurement in EPC companies. Regarding existing theoretical knowledge, it was possible to validate that existing challenges can be transferred to the EPC industry. This could lead to the development of a theoretical framework illustrating the interplay of these challenges and their impact on the success of implementation of standardization practices.

In specific, a finding, that may be considered surprising, which could have a significant impact on the implementation success of standardization in EPC companies is the conflicting interest between engineering and other stakeholders within the procurement process. This finding could be considered surprising as the current literature only highlights the existing conflicts between stakeholder groups in general.

## 8. Limitations and Areas for Further Research

There have been various limiting factors for this research.

Firstly, according to Röbken and Wetzel (2016), the requirements for the qualification of the experts are high and the quality of the data is dependent on the choice of such. It is crucial to note that the abstraction derived from the interviews can only be applied under specific conditions, such as the involvement of the same stakeholder groups in other companies' procurement processes and the experts' underlying personal interests. Because of this, other businesses may not experience difficulties and may not be able to follow implementation techniques mentioned. Furthermore, although this study offers a wealth of empirical data, the analysis is predicated on a single case study. Subsequent investigations ought to take into account a multi-case study examination in order to validate or invalidate the applicability of the difficulties and strategies for surmounting them. It is important to note that the business selected for the case study is involved in the oil and gas sector. Other EPC industries may be investigated in future studies.

Secondly, no direct causal relationships can be derived with the present method, but interviews can provide crucial variables that indicate the direction of possible relationships.

Thirdly, as the procurement process involves several different divisions, the research is missing out on some of the other relevant factors, such as supplier interests to achieve a complete overview. For instance, some factors could be analyzing the supplier perspective and the cultural differences setting a base for challenges among standardization among different subsidiaries.

Lastly, it may not have been a sufficient number of interviewees. On the one hand, it might be relevant to investigate on a more significant sample. Notwithstanding, in contrast to the earlier interviews, the research's adding value appeared to have significantly decreased after the eighth interview. This might serve to illustrate a case of data saturation. In reference to the interview sample, it is important to note that, despite efforts to ensure a representative sample with respect to gender and nationality, all the experts interviewed were from European centers. Even though informal interviews were held with employees from centers outside from Europe, the restriction to European-based experts might limit the generalizability of findings to a broader global context within the EPC industry. The absence of perspectives from professionals in different geographical locations may omit critical insights or variations in approaches to standardized procurement processes, particularly in regions with distinct industrial practices or cultural influences. This limitation can be avoided in further research by having a more diversified and extensive sample.

## 9. Conclusion

Despite a lot of research on standardization, little is known about the challenges and implementation of such in procurement in EPC industries (Matta, Nakouzi, and Kalach 2022). This thesis identified industry specific challenges that hinder the implementation of standardization practices in EPC industries and offers a proposal for strategies to overcome those. Furthermore, this thesis supports prior research that general challenges hindering the introduction of standardization can be transferred to the EPC industry.

This study pioneers an investigation into the unique challenges within EPC industries regarding standardization, leveraging empirical data and insights. The study's observations and analysis aim to stimulate further research initiatives focused on successful standardization implementation strategies. Given the anticipated growth of the industry, embracing standardization presents substantial prospects, making it imperative to delve deeper into this area for potential advancements.

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**Appendix A**

**Guideline for Interviews**

1. **Pre-Interview Briefing**

*Note.* The following terms should be sent to the expert before the interview to explain their meaning in the context of the research question.

*Standardization:*

Standardization relates to activities concerned with unity and consensus (NEW 6). Standardization may be defined as the concentration upon specific products and materials, both in production and in use, to the end of bringing about the greatest possible industrial efficiency (26). According to (27), the first and most striking result of the standardization of supplies in public purchases is the clarification and simplification of the entire purchase, stock and distribution routine.

*Improved Procurement Performance:*

Performance in procurement refers to an organization assessing how successfully it works toward its stated goals, identifying areas of strength and weakness, and designing upcoming initiatives to initiate performance improvements.

2. **Questions**

**Block 1: Introduction**

- Welcoming the interview partner and thanking him/her
- Introduction of the interviewer
- Institutional context: Master Thesis at Nova School of Business and Economics
- Explanation of the topic of research intention

- Clarification of the estimated time frame of the interview: 45min

- Explanation of the interview process: Block system
- Requesting permission to tape-record the interview and to make the results of the interviews available to the public (anonymous)

**Block 2: Demographic information about the interviewee and general introduction standardization of procurement processes**

- What is your profession? What are your responsibilities?
- What is your understanding of the standardization of procurement processes?
- Where and when did you gain your practical experience with procurement processes?
- Whether and why do you see a potential for standardization in procurement?
- How important do you assess the importance of standardization practices in procurement to optimize performance?

*Note: Depending on the classification of the expert to the process step (see* Figure 6.*), appropriate questions from the ones presented below are selected*

- How do you perceive the impact of standardized material procurement practices on financial performance?
- According to your viewpoint, what strategies or measures can be aligned with standardized procurement practices and achieve the identified KPIs?
- How do you envision the future of procurement practices, particularly in relation to standardization and technological advancements?
- How do you believe standardized material procurement practices contribute to the professional development and job satisfaction of procurement team members?

- Could you provide an example where standardized procurement practices positively impacted the work experience for procurement coworkers, particularly in relation to material procurement?
- Can you offer examples from your experience where the implementation of standardized material procurement practices had a notable impact on procurement performance, especially in dealings with external suppliers?

**Block 3: End**

- Do you have any additional aspects that we have not yet addressed in the context of our objectives?
- Request for remaining questions, final comments and remarks.
- Thanks for the time

| Purpose of Interview | Interview Type | Data Type | Year | Quantity | Position of Interviewee | Lenght of Interview | In-text Reference |
|---|---|---|---|---|---|---|---|
| **Assessment of Challenges Identified and Proposal for Implementation Strategies as well as expected Impact** | **Expert Interview** | **Qualitative** | **2023** | **10** | | | |
| | | | | | Project Procurement France | 40 min | EI1 |
| | | | | | Global Procurement Manager | 40 min | EI2 |
| | | | | | Project Logistics Manager and Logistics | 60min | EI3 |
| | | | | | Management SAP | 45 min | EI4 |
| | | | | | Project Engineering Manager | 60 min | EI5 |
| | | | | | Category Specialist | 30 min | EI6 |
| | | | | | Project Procurement Manager | 45 min | EI7 |
| | | | | | Cagtegory Buyer Statical Equipment | 30 min | EI8 |
| | | | | | Project Shipping Manager | 30 min | EI9 |
| | | | | | Global Procurement and Quality Control | 40 min | EI10 |
| **Assessment of Challenges Identified and Proposal for Implementation Strategies as well as expected Impact** | **Informal Interviews** | **Qualitative** | **2023** | **50** | | | |
| | | | | | Buyer Piping Bulk | appr. 30 min | II1 |
| | | | | | SAP CC | appr. 30 min | II2 |
| | | | | | Category and Procurement Proposal German | appr. 30 min | II3 |
| | | | | | Category Buyer | appr. 30 min | II4 |
| | | | | | Category Buyer Fire Equipment | appr. 30 min | II5 |
| | | | | | Category Buyer Rotating | appr. 30 min | II6 |
| | | | | | Category Buyer Rotating | appr. 30 min | II7 |
| | | | | | Category Buyer Statical | appr. 30 min | II8 |
| | | | | | Category Manager | appr. 30 min | II9 |
| | | | | | Category Specialist | appr. 30 min | II10 |
| | | | | | Chief Engineer | appr. 30 min | II11 |
| | | | | | Data and BI GCC Director | appr. 30 min | II12 |
| | | | | | Digital Transformation | appr. 30 min | II13 |
| | | | | | Digital Transformation | appr. 30 min | II14 |
| | | | | | Director Business Solutions | appr. 30 min | II15 |
| | | | | | Director Site Activities Europe | appr. 30 min | II16 |
| | | | | | Discipline Manager/ Construction | appr. 30 min | II17 |
| | | | | | E&C VP, Strategy & Performance | appr. 30 min | II18 |
| | | | | | Expediting Group Manager | appr. 30 min | II19 |
| | | | | | Global Category Management | appr. 30 min | II20 |
| | | | | | Global Procurement Director | appr. 30 min | II21 |
| | | | | | Head of Logistics | appr. 30 min | II22 |
| | | | | | Head of Project Procurement CHina | appr. 30 min | II23 |
| | | | | | Lead Engineer Proprietary Equipment | appr. 30 min | II24 |
| | | | | | Logistics | appr. 30 min | II25 |
| | | | | | Logistics | appr. 30 min | II26 |
| | | | | | Logistics | appr. 30 min | II27 |
| | | | | | Logistics Manager | appr. 30 min | II28 |
| | | | | | Manager Logistics & Expediting | appr. 30 min | II29 |
| | | | | | Procurement | appr. 30 min | II30 |
| | | | | | Project Buyer | appr. 30 min | II31 |
| | | | | | Project Engineer | appr. 30 min | II32 |
| | | | | | Project Engineer | appr. 30 min | II33 |
| | | | | | Project Engineering Manager | appr. 30 min | II34 |
| | | | | | Project Manager | appr. 30 min | II35 |
| | | | | | Project Procurement 2B1 | appr. 30 min | II36 |
| | | | | | Project Procurement China | appr. 30 min | II37 |
| | | | | | Project Procurement Delhi | appr. 30 min | II38 |
| | | | | | Project Procurement France | appr. 30 min | II39 |
| | | | | | Project Procurement Japan | appr. 30 min | II40 |
| | | | | | Project Procurement Manager | appr. 30 min | II41 |
| | | | | | Project Shipping Manager | appr. 30 min | II42 |
| | | | | | Purchase Requisitioner | appr. 30 min | II43 |
| | | | | | Senior Lead Engineering Rotating Equipment | appr. 30 min | II44 |
| | | | | | Senior Specialist Material Management | appr. 30 min | II45 |
| | | | | | SME, Material Management | appr. 30 min | II46 |
| | | | | | Supplier Quality Control | appr. 30 min | II47 |
| | | | | | Supplier Quality Management Group Manager | appr. 30 min | II48 |
| | | | | | Technical Specialist | appr. 30 min | II49 |
| | | | | | Transport and Logistics Manager | appr. 30 min | II50 |

*Table 1. Overview of Interviews conducted*

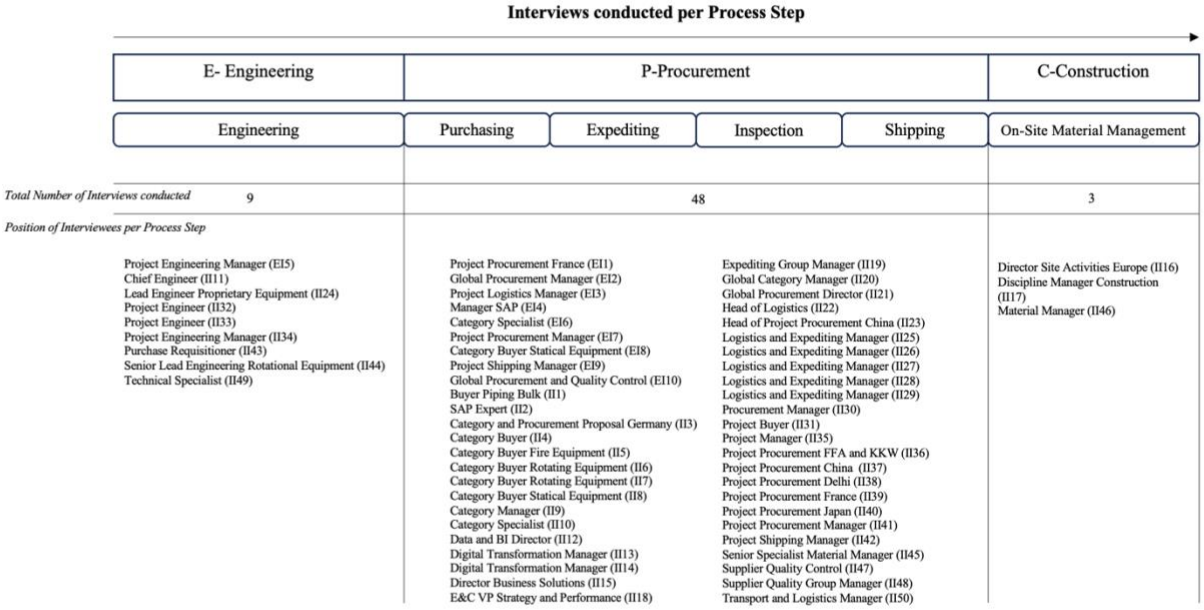


*Figure 3. Overview of Interviews conducted per Process Step*

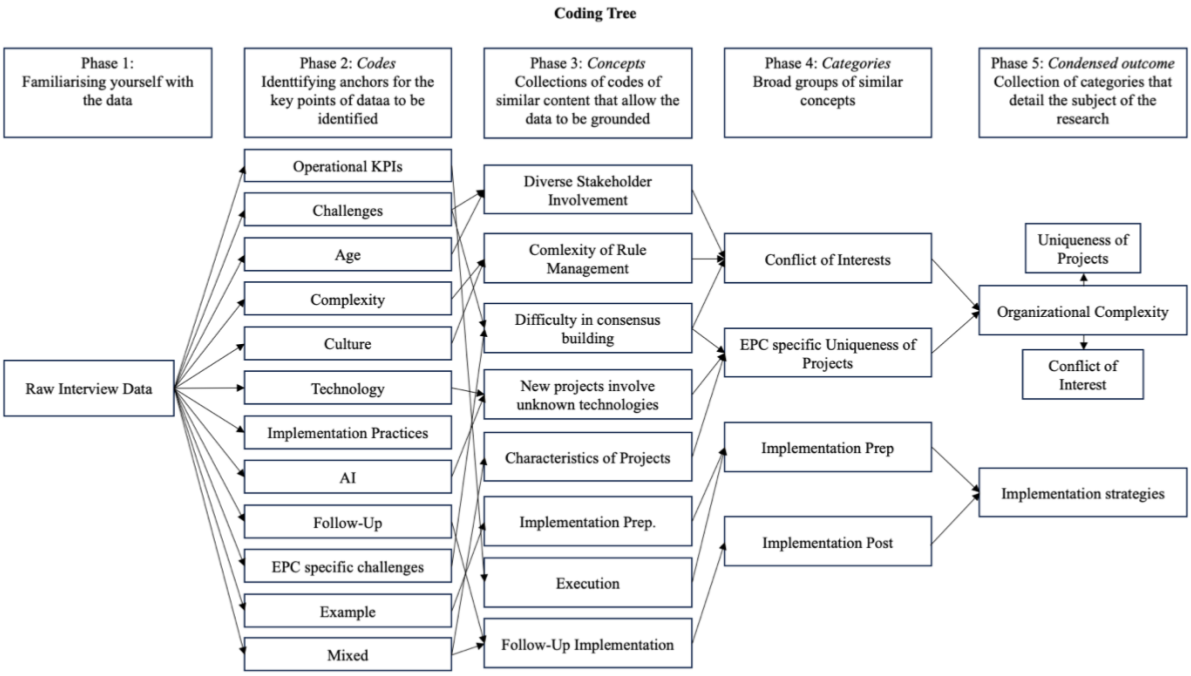


*Figure 4. Coding Tree*

**Appendix B.**

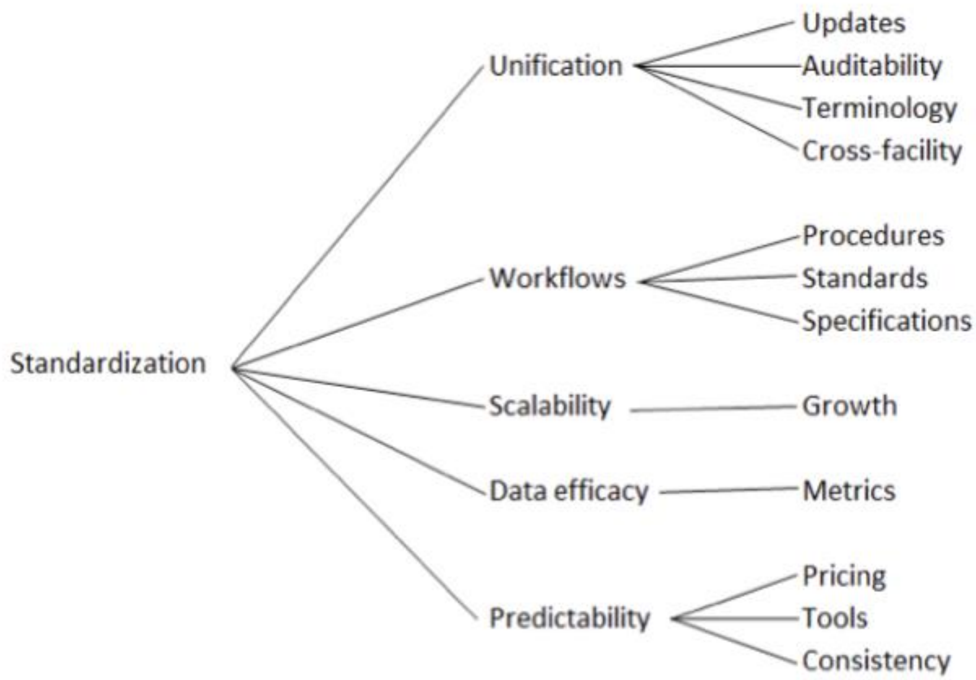


*Figure 5. Overview of standardization as a theme category into descriptive subcategories*

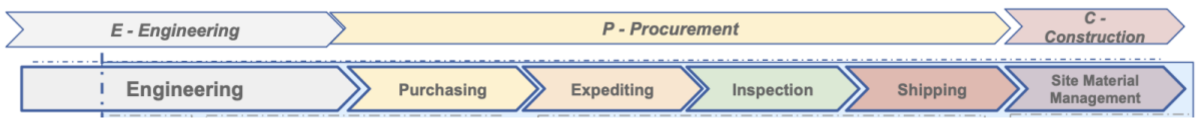


*Figure 6. Typical Process Map of EPC Company*

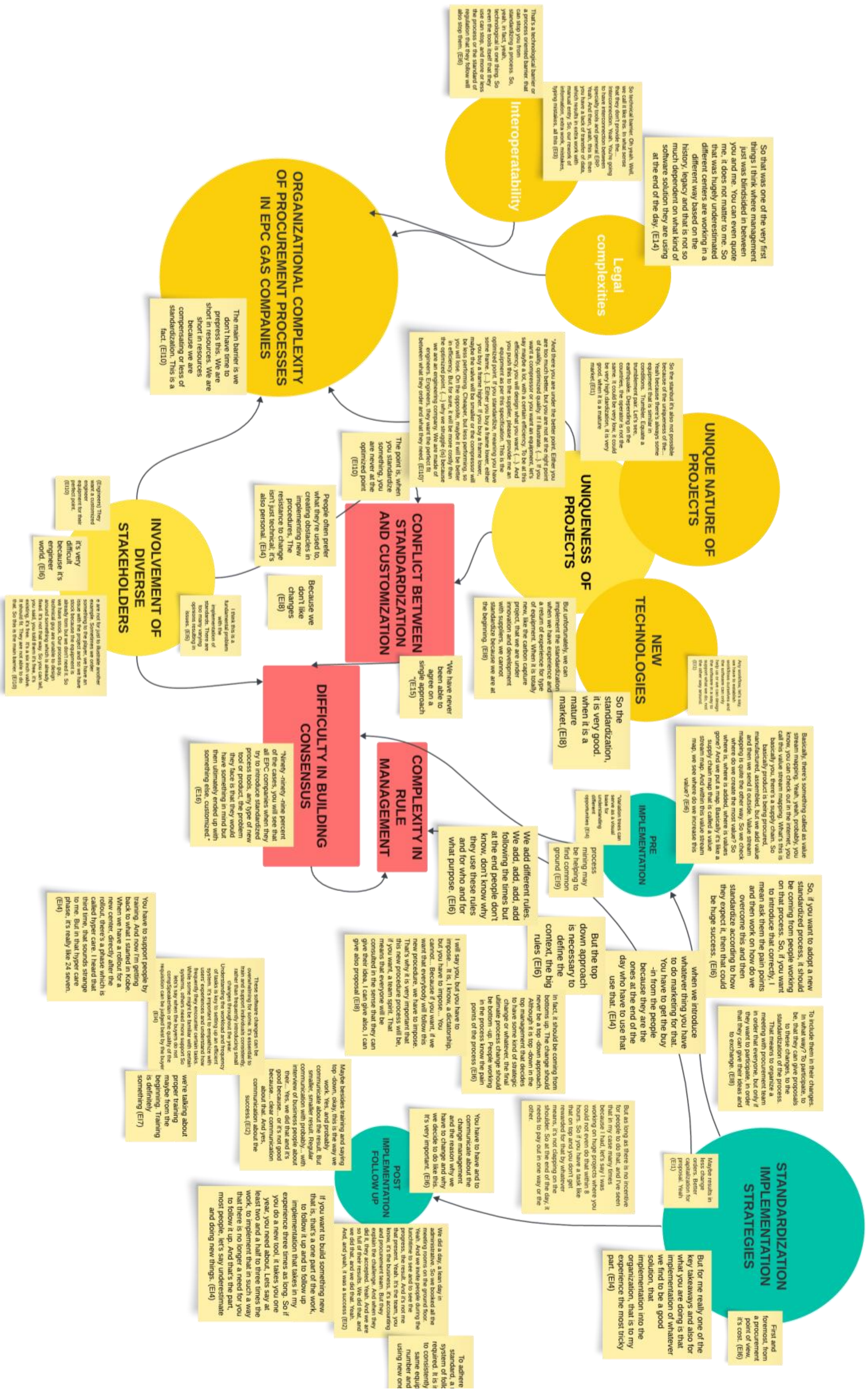


*Figure 7. Mind map Overview of selected Interview Quotes*