Optimizing the xyz process for Project Procurement at Company X

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ABSTRACT

The xyz process within the department of Project Procurement at Company X was introduced as a tool for monitoring and tracing schedules and timelines for construction parts of car architectures. Based on insights received during an internship at Company X in 2019, the process is not applied or applied insufficiently. Core issues, such as deviations in degrees of application and cooperation with suppliers created the starting point for this bachelor thesis targeted at revealing problems disrupting the application of the xyz process of Project Procurement at Company X in City Y and the generation of a potential solution design. A modified version of the Field Problem-Solving Project of Van Aken and Berends (2018) was applied combining theoretical aspects of Project Procurement and the Stage-Gate methodology with practical insights gathered through 5 semi-structured interviews within Project Procurement at Company X. Besides verification and extension of problems and solution proposals from experts, the interviews served to validate or criticize a developed solution model based on findings received from the literature review. Results after analysis of the interviews question the necessity of the xyz process, as it demands tasks and responsibilities for effort and information, which are already covered in other systems leading to redundant work. Based on the initial purpose of the xyz process, a lack of milestone tracing for software, legal aspects and licenses were identified as gap, which is neither covered in daily business activities nor within the process. Furthermore, the study reveals redundancy of information and manual effort. It stresses the request of employees for centralization of data and automation of processes. The validated solution model is based on a comprehensive platform which replaces existing systems and connects Company X internal as well as external to tackle these issues.

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Keywords

Project Procurement, Project Management, Problem and success factors in projects, Stage-Gate, Process optimization, Technological development, Tailored systems, Radical innovation

1. PROBLEMS OF XYZ – A STAGE-GATE PROCESS

1.1 The xyz process causes problems instead of solving them

During the last 30 years, several changes in different economies, sectors or businesses, based on globalization and increased technological development, altered the nature and associated requirements of projects (Walker & Rowlinson, 2007, p. xiii). Dynamic trends and innovative, fast paced developments demand for high degrees of responsiveness and adaptability to realign with unexpected occurrences or disruptions evolving during the project life cycle. In 1990, Cooper introduced the Stage-Gate framework guided by the need for faster innovation processes with fewer mistakes in production industries, reduced cycle time and improved development of new products (Cooper, 1990, p. 44). To cope with rising challenges associated with managing and controlling projects, Cooper constantly refines and adapts the Stage-Gate model to provide a state-of-the-art framework for business optimization. Neglecting new developments by using obsolete models within modern projects will lead to failure and decrease in product sales (Cooper, 2003, p. 1). Scalable Stage-Gate configurations suitable for different types of projects evolved and a shift from sequential to parallel work activities opened up the framework for a fusion with agile , stressing adaptability, agility and acceleration of the process (Cooper, 2008, p. 223; 2014, p. 21). Disadvantages of the Stage-Gate framework, such as unresponsiveness, should be counteracted by the implementation of iterative development cycles allowing for the generation of hybrid models to provide the opportunity for constant realignment, depending on environmental or internal factors affecting the project (Cooper & Sommer, 2018, p. 19). Furthermore, influential factors, such as early customer involvement, broad customer bases and market research for product design generate a basic fundament for the Stage-Gate process to drive success in new product development (Cooper, 2019, p. 38).

At the department X, project management is a main activity where every purchaser is involved in procuring required parts for different projects within a specified time to meet the target start of production (SOP). The parts required for a project could be regular carry over parts (COP) from cars already produced in series or new parts according to projects' requirements. Dealing with serial parts mostly represents a standard COP process with comparatively less effort. Requirements for new parts are increasingly volatile through conduction of trial and error prototyping series revealing necessary alterations, detected by the technical team, and transferred to Project Procurement via drawings and new specifications. The purchaser gets in touch with the nominated supplier for the part development activities. Criticality in part development, time, or tooling is dependent on the type of part and necessary alteration. Certainly, critical parts have critical tooling and therefore require long lead times for development. Every part in every project has some development time and target to reach the SOP timeline of that project, but there could be some delays in the system or in the process either from supplier side or from concerned teams of Company X. There is a chance of risk in not meeting the SOP, thereby leading to delays in the project or in the worst-case entire disruption of SOP. In order to avoid these potential consequences, Company X implemented the xyz process in 2018, which is applied by Project Procurement in cooperation with suppliers. It should ensure the reception of planned and ordered components on time and align services such as development or alteration of goods through information sharing and reactivity.

The xyz process consists of control checkpoints (Gates) including forms to be filled out by suppliers for reception of state-of-the-art information about development of construction parts or unexpected circumstances that might have emerged. These Gates are represented by milestones and project timelines which need to be achieved for continuous planning and conduction of business. Stages represent development activities performed by suppliers on behalf of Company X. Consequently, the xyz process serves as an observative Stage-Gate information system to enhance communication, realign planning schedules if needed or prepare troubleshooting in case milestones and SOP are threatened through unexpected disruptions, to ensure that development activities are performing on planned timelines towards milestones.

Since the xyz process was launched, several obstacles emerged which need to be further analyzed within this paper. The following problems were detected through informal interviews conducted during an internship within Project Procurement at Company X in 2019:

- Issues in perception, understanding and value of the process (at Company X employees and suppliers) lead to deviating performance and effort priorities
- Suppliers in Germany and especially abroad use different systems and templates, therefore xyz involves high amounts of effort by filling out manually
- Requested information during xyz need to be more target oriented (what information do we need / not need? what should we monitor / not monitor? when do we need data?)
- Bias – some suppliers only fill in parts of information leading to invalid outcomes
- Milestones for software projects are currently not in tracing

Consequently, the xyz process fails in practice and bears costs and effort. It is missing to realize its main purpose leaving Company X in a threatened position by potentially unexpected delays or disruptions.

The topic of this thesis emerged from a real business problem threatening entire supply chains and having potential to cause severe consequences for its stakeholders. Therefore, the following research question emerged:

Which problems disrupt the application of the xyz process of Project Procurement at Company X in City Y and how can these be solved?

Application of the Stage-Gate process in contrast to its developments during the last 30 years is analyzed within the automotive industry, at Company X. New developments in theory are tested in terms of added value or potential for improvements. Insights made at Company X contribute to the framework of process optimization with a focus on projects and help other businesses with similar problems to optimize cross-boundary communication, alignment, cooperation, and prevent breakdowns. Furthermore, the creation and validation of a solution model reveals additions or limitations to models analyzed during the review section of this thesis and contributes to scientific theory.

1.2 A Field Problem-Solving Project of Van Aken determines the structure of this research

Problems of the xyz process at Company X represent a practical business problem which needs to be solved, therefore, the design of this thesis is determined by a Field Problem-Solving Project (FPS), following the logic of the problem-solving cycle by Van Aken and Berends (2018, p. 13), which can be seen in Figure 1.

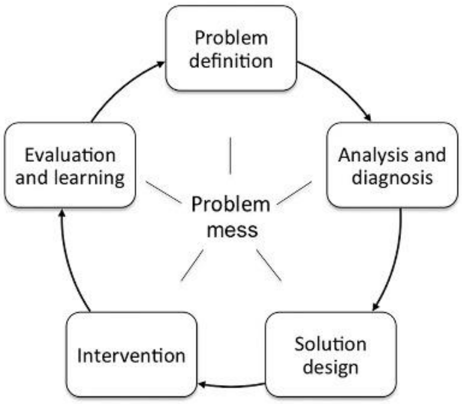

Figure 1: "The problem-solving cycle" (Van Aken & Berends, 2018, p. 13)

Following the description of Van Aken and Berends (2018, p. 12), the problem-solving cycle is driven by a certain business problem which is not given but chosen by stakeholders. The design is targeted at specific organizational problems analyzed from a theoretical and practical perspective (Van Aken & Berends, 2018, pp. 12-14, 37-39):

- Th*e problem definition* serves for identifying and structuring the problem, starting with a definition of the initial issue from the perspective of Company X. This issue might be a symptom of a larger problem and needs to be transferred into a broader context for the generation of a thorough scoping process. A project plan and an approach to subsequent analysis, diagnosis and design needs to be organized.
- In *analysis & diagnosis*, causes of the problem and its context are examined based on qualitative or quantitative research. Literature on the type of business system and the type of problem are used to interpret the results of the analysis, support the diagnoses of the causes of the problem and produce specific knowledge.
- The *solution design* has to tackle the most important causes and the implementation process for the solution has to be designed based on use of valid knowledge from research consisting of theoretical and practical components. A systematic literature review combined with solution concepts of employees should result in a range of solution concepts to solve the business problem.
- *Intervention* and *evaluation & learning* are out of scope for this thesis.

In chapter 1.1 problems surrounding the xyz process were presented based on informal interviews collected during an internship at Company X in 2019. Furthermore, literature creating the starting point of the theoretical part of this thesis was exhibited, with a focus on the Stage-Gate framework and influencing factors according to business type, in the case of Company X, Project Procurement in the automotive industry. The literature review presented in chapter 2 is split into 2.1, targeted at projects and Project Procurement, and 2.2, dedicated to the Stage-Gate framework. Chapter 2.1 illuminates alterations of Project Procurement triggered by new technologies, trends and environmental demands. Afterwards, associated problems and success factors based on these developments are extracted and lastly, compared to models provided by literature targeted at solving these problems and embedding the success factors. Chapter 2.2 describes developments of the Stage-Gate framework during the last 30 years and adaptations made to new requirements based on project needs. Similar to chapter 2.1.3, the application of solution designs and success factors, with practical examples from a company case, are presented in chapter 2.2.3. In chapter 2.3, insights received from both dimensions are combined and a solution model for Company X is presented.

Table 1: Implementation of the decision-making cycle in chapters of this thesis

Cycle-Part	Thesis-Chapter
1. Problem definition	1. Problems of 6 Gates - a Stage-Gate process
1. Problem definition	4.1 Problem definition from the perspective of Volkswagen
2. Analysis & diagnosis	2. Utilization of Project Procurement and the Stage-Gate proces is assessed by analysis of its sub-components
2. Analysis & diagnosis	4. Analysis and diagnosis
3. Solution design	2.3 Utilization of the Stage-Gate process in Project Procurement
3. Solution design	4.3 Expert feedback, added value and real-izability of the solution design

2. UTILIZATION OF PROJECT PROCUREMENT AND THE STAGE-GATE PROCESS IS ASSESSED BY ANALYSIS OF ITS SUB-COMPONENTS

2.1 Partnering in Projects and Project Procurement

2.1.1 Procurement develops a project focus

Nissen (2009, p. 247) describes effective procurement as critical ingredient for effective project management, as, depending on the type of project, over 50 % of the total project costs are attributed to procured services or goods. Project pathway and progress are mostly defined by procurement caused by lead times and development efforts. Fleming (2003, p. 1) describes benefits of outsourcing in terms of expansion of intellectual scope, acquisition of technical brainpower from other companies or the benefit of hiring educated personal external than recruiting and adding permanent employees. Furthermore, relationships with suppliers will bring resources, facilities, investments, and equipment to the project which one participant alone does not possess (Fleming, 2003, pp. 1-2). Procurement may be regarded as an organizational system that assigns specific responsibilities and authorities to people and organizations, and defines the relationships of the various elements in the construction of a project (Love, Skitmore, & Earl, 1998, p. 222).

Project Management Institute (2000, pp. 4-5) define a project as joint commitment targeted at the creation of a unique product, service or result within a limited scope of time. Projects are governed and monitored by project management (PM) which is defined as the application of knowledge, skills, tools, and techniques to project activities to meet project requirements (Project Management Institute, 2000, p. 6). Consequently, procurement for projects or Project Procurement may be described as acquisition within an organizational system assigning responsibilities and defining relationships within the context of a temporary agreement, conducted under project management guidelines.

According to Walker and Rowlinson (2007, p. xiii), today traditional limitations of a project start to blur caused by broad extensions of new product types challenging traditional methods, such as events or change management initiatives. As discussed in the previous chapter, value always lies in the perception of stakeholders participating in a partnership. Furthermore, the context of a project defines choice of procurement methods. In construction, for example, core focus lies in completion of the project within budget and time (Ujaddughe, Opawole, & Babatunde, 2010, p. 1). In public projects costs, benefits as well as both socio-economic and environmental impacts lie in the center of attention (Roumboutsos, 2010, p. 165).

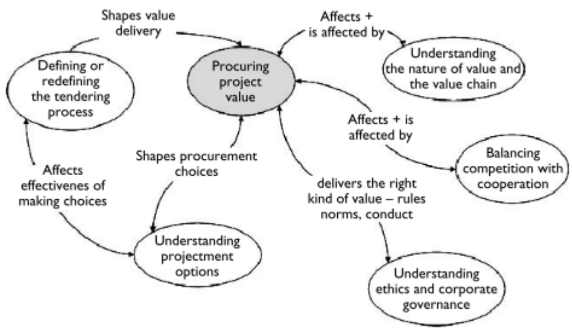

Figure 2: "Procuring project value" (Walker & Rowlinson, 2007, p. xvi)

Figure 2 illuminates the impact of different variables influencing and shaping the perception of procuring value within a project, such as the nature of value and the value chain, competition vs cooperation or ethics and corporate governance. Depending on the nature of the project, iterations, relationships, and value, suitable procurement methods have to be designed, starting with the causes of founding the project. Moving back to the example of the automotive industry, a project may consist of an agreement between a car manufacturer and suppliers for construction parts targeted at specific car architectures (projects). The nature of a project is based on outsourcing decisions generating the need for external supplies on basis of several car architectures. Iteration describes the relationship between both participants, as an ending project with a finished car will lead to a new project containing new architectures. Consequently, long-term partnerships evolve generating trust and a joint culture for an indefinite series of projects. Without agreements on projects, facilities and knowledge would be necessary in every discipline or construction part of the car. Regarding todays supply chain networks consisting of two or three tier suppliers, construction without project arrangements would be unthinkable. The theory of comparative advantages assessed by Costinot and Donaldson (2012, pp. 453, 458) delivers evidence about the benefits of production specialized in different economic activities based on their relative productivity differences. Consequently, a specialization in a discipline, may it be construction and assembly of cars or production of wheels, besides management of supply bases, will generate expertise and additional value. Therefore, a suitable procurement method needs to be aligned with the requirements of the project. In sustainable procurement, the process significantly affects successful delivery of a sustainable project as different bidders offer different schemes for the achievement of objectives (Wang, Hsu, Yu, & Cheng, 2018, p. 15). Wrong choices or combinations might therefore result in inefficiencies or even harm.

These methods are described through the generation of partnerships and tendering procedures, of which the latter goes beyond the scope of this thesis.

The shift in procurement from short-term, one-time projects towards collaborations on sequential project lines build upon project management principles led to further developments such as the model of Project-Based Organization (PBO), since the project is the main way to gain business value and benefits for the organization (Putri, Pratami, Tripiawan, & Rahmanto, 2019, p. 1).

Putri et al. (2019, p. 2) describe this development as follows:

"Organizations that invest in using project management practices are shown to experience higher project success compared to organizations that do not implement project management practices. This is evidenced by a 92% success rate while only 32% for organizations that have poor project performance. Over the past 10 years as many as 9.9% of organizations lost money due to poor project performance, of which $1 billion invested, the organization would lose $99 million."

From the example of the construction industry, development of procurement towards a project focus leads to new challenges in partnerships, strategies, and collaboration. New project designs emerge and the need for tailored project management techniques is rising with a focus on outsourcing and sustainability.

2.1.2 Communication and commitment as success factors for collaborative project execution

Increased globalization allows for cooperation and collaboration around the world and developments, such as the evolution of IT systems, computerization or means of transport through sophisticated supply chain networks decrease communication and trade barriers. As a consequence, strategic alliances emerged benefiting both sides of a transaction through commitment, communication, and trust for achievement of shared goals and optimal utilization of resources (Zou, Kumaraswamy, Chung, & Wong, 2014, p. 270).

Following the definition of Walker, Hampson, and Peters (2002, p. 84), partnering may be described through commitments and the generation of trust amongst people within partnered companies which work together towards shared project goals. Furthermore, alliancing is defined as a relationship between owner, client and other stakeholders on the basis of trust, commitment and competence towards collaborative project development. (Walker et al., 2002, p. 85). Consequently, collaboration and communication between different stakeholders is crucial to create and conduct a successful project for the benefit of each participant.

Besides owner and client relationships, potential stakeholders, such as individuals, groups, neighborhoods, organizations, institutions and societies participate and have interest in the project (Mitchell, Agle, & Wood, 1997, p. 855). Differing opinions or weight of criteria on aspects such as agency, behavior, institution, population ecology, resource dependency, and transaction cost theories between stakeholders might impact a project and disturb or maintain an equilibrium of collaborative working (Mitchell et al., 1997, p. 863). As a result, all variables need to be satisfied to the best possible degree to prevent disruptions in the project process, ensure the fulfilment of expectations and generate strong external orientation to address performance criteria that affect other participants, especially clients as the major stakeholders, with emphasis on continuous improvement (Soetanto, Proverbs, & Holt, 2001, p. 547). Larson (1997) examines the relationship between specific partnering related activities and project success for 291 construction projects. The outcome of the study presents problem solving procedures and provisions for continuous improvement as linkages to controlling cost, meeting schedule, and technical performance besides a positive relation to the satisfaction of customer needs, avoidance of expensive litigation and overall results (Larson, 1997, p. 193). Covering these aspects will satisfy stakeholders of a project and ensure continuous project success. Complementary, Bygballe, Jahre, and Swärd (2010, p. 246) stress the importance of relationship management as critical success factor for achieving benefits of partnering in a combination of informal and formal processes. Bresnen and Marshall (2000, p. 233) describe the key to effective change within the industry as development of an appropriate culture of relations to support the contracting mechanisms needed for a partnering approach to work. Regarding increased blur of international barriers, different organizational and national cultures have influence on these relationships. The importance of cultural management bears additional effort, as organizational culture is not a unitary, consensual, or simple process orchestrated by top management for achieving results (Bresnen & Marshall, 2000, p. 234). Between various cultures perception of value and goals might deviate, as Ashnai et al. (2009) point out. Different viewpoints of Iran, Russia, China and UK were assessed based on trust, needs, integration, power and profit leading to diverse results and differences between benefits which managers seek from the relationships that they have to manage (Ashnai et al., 2009, pp. 92, 94, 95). This diversity of value perception, business conduct within different organizational or national cultures and stakeholder involvement gives rise to many core problems described by Chan et al. (2004, p. 188), such as little cooperation, lack of trust, and ineffective communication resulting in adversarial relationships between contracting parties. He describes commercial pressure, little experience with the partnering approach and uneven commitment among project participants as major problems leading to partnering failure (Chan, Ho, & Chan, 2003, p. 134).

Imagining Company X as an example, main actors might be Company X and suppliers of construction parts for car manufacturing. Besides this simplistic model, contributors of supply chains, which are crucial for ensuring transportation of these parts, providers of finance for acquiring them, technicians to align modules towards a working architecture of a car or outsourced activities, such as IT management and monitoring need to be taken into account and directed towards a common goal. Collaboration and commitment are based on differing perception and valuation of the project of each stakeholder affecting schedules, performance and in the end customer satisfaction. Therefore, management of relationships within different cultures, such as departments of Company X or international suppliers is crucial to achieve project milestones and successful outcomes. Without communication and joint perception of desired outcomes, internal as well as external relationships might follow an adversarial pathway potentially leading to opportunistic behavior.

To counteract these problems from evolving, Drexler and Larson (2000, p. 294) differentiate between four types of Owner-Contractor relationships and describe a desired mindset for every stakeholder. Project partners are described as follows:

"Participants treat each other as equal partners with a common set of goals and objectives. Every attempt is made to avoid litigation and to resolve disputes in a timely, mutually satisfying manner. Participants consider themselves part of the same team and work closely together to solve problems and make process improvements." (Drexler & Larson, 2000, p. 294)

Concluding this chapter, relationships and relationship management create a main necessity of sharing expectations, goals, and value perception. This is crucial in a business world consisting of global wide trade, collaboration, and sophisticated supply chain networks distributed amongst different departments, businesses or countries with different organizational cultures. Common goals and objectives need to be defined as well as comprehensive project planning and dispute resolution methods to improve commitment and communication for project success.

2.1.3 Problem and solution designs from a project perspective

Yeo and Ning (2002, p. 253) describe challenges based on unsatisfactorily performance, low profit margins, persistent project overruns in schedule and budget, and a plague of claims and counterclaims within the engineering and construction industry based on culture, process, and technology. An EPC (engineer-procure-construct) project is described as tightly coupled with and followed by the procurement phase (Yeo & Ning, 2002, p. 254). From a problem perspective, challenges are described as "…interdependence of activities, phase overlaps, work fragmentation, complex organizational structure, and uncertainty in accurate prediction of desired outcomes" (Yeo & Ning, 2002, p. 254).

A catalogue of different solution designs is presented for improving overall performance of project delivery, such as Fast-trace, Concurrent Engineering, JIT Logistics Management, Business Process Re-engineering and Partnering coupled with tailored procurement mechanisms (Yeo & Ning, 2002, p. 255).

Examples presented in their paper reveal the importance of procurement as a connecting function between engineering and construction, material costs, dependence on external companies, the need for more communication and negotiation with these external parties, time buffers to protect of uncertainties and superior project performance in overall project cost and delivery (Yeo & Ning, 2002, p. 255). Figure 3 shows the EPC model connecting and shaping engineering, procurement, supplier and organizational communication flows in a process of sequential as well as parallel intertwined activities within the overall project execution.

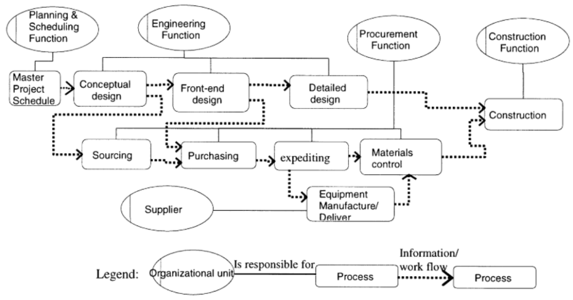

Figure 3: The EPC framework (Yeo & Ning, 2002, p. 255)

Yeo and Ning (2002) stress the unique nature of every project and adapted design, as new suppliers generate new requirements which in turn generates uncertainties, as illuminated in the previous chapters containing value perception and weighting criteria. Necessary instruments for improvement of a supply chain concept are based on real time information sharing, coordinated procurement process in the whole chain and collaborative attitude amongst all of the chain members (Yeo & Ning, 2002, p. 256). Further implications based on procurement in complex projects are described as follows, based on Yeo and Ning (2002, p. 257):

- Procurement needs to maximize stakeholder value by performing as a strategic link within the project delivery value chain
- Strategic and tactical plans have to be generated in order to follow deadlines and ensure delivery of materials
- A networked information system has to be installed for ensuring a state-of-the-art information flow amongst stakeholders for meeting the project schedule
- Paperwork and time-wasting activities need to be eliminated through process redesign and reduction of administrative delays
- These designs need to reduce the length of the procurement pipeline
- Supply and demand uncertainties need to be reduced for removing bottlenecks within the process while increasing project throughput
- Core items need to be purchased early in the process, non-core materials later

- Relationships within the supply chain need to be improved and partners with capabilities, commitment, joint interests, and sensitivity chosen

Building upon measures of communication, trust and perception Walker and Lloyd-Walker (2012, p. 877) present the concept of "Understanding Early Contractor Involvement (ECI) Procurement Forms" emphasizing various relationship-based Project Procurement (RBP) forms which are globally adopted and at times lead to misunderstanding amongst participants based on deviating expectations or perceptions in behavior, relationships and general content surrounding the project.

Walker and Lloyd-Walker (2012, p. 878) describe the aspect of relationship-based procurement, where all business transactions involve a relationship. Tailoring this statement to projects and the urge for comprehensive collaboration, it receives even more necessity for attention.

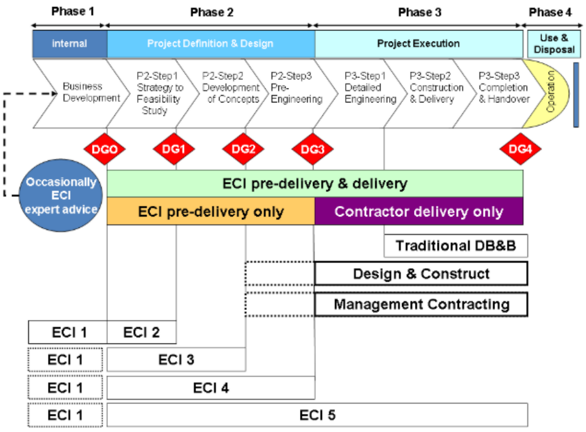

Figure 4: Project Life Cycle and ECI (Walker & Lloyd-Walker, 2012, p. 879)

In an adapted model of the project life cycle gateway (see Figure 4) concepts are combined with the idea of ECI to "…access valuable practical knowledge about project solution options, their feasibility and the direction in designing a solution that can be effectively executed" as well as improve situations, "…where the client needs specific delivery subject matter expertise when developing project ideas" (Walker & Lloyd-Walker, 2012, p. 883). Different ECI spots represent specific situations and an overall context, but early contractor involvement is possible within every Stage.

Concluding assumptions of Yeo and Ning (2002) and Walker and Lloyd-Walker (2012), the complexity of a project combined with procurement designs reveal core similarities causing problems based on communication, commitment, information, value and perception of participants within the project. The generation of networks, strategic links of procurement, business redesigns and early contractor involvement create tools to counteract issues and guide towards successful project execution.

For the improvement of project management, projects need to broaden their horizon and shift from fixed planning and target setting within a Staged process towards the generation of innovative solutions improving existing plans in a modified way (Lenfle & Loch, 2010, p. 49). To achieve this goal a practical model for process and production optimization, the Stage-Gate process, is described in the next chapter.

2.2 The roots of the Stage-Gate process and its development in a dynamic, globalized world

2.2.1 From manufacturing to service-centered gating processes

After describing problems, success factors and solution models, such as EPC and ECI, the Stage-Gate process describes a tool targeted at combining gathered assumptions from chapter 2.1 to provide a design capable of conducting successful projects. In 1990 Robert G. Cooper introduced the concept of the Stage-Gate process to stimulate innovation and sustainability for organizations based on demands from the environment, increasing internal and external competition, market maturity and technological advancements (Cooper, 1990, p. 44).

In construction the pressure for reduced cycle time and improved product "hit rate" led to the foundation of the Stage-Gate process as a tool to manage, direct, and control product-innovation efforts through a conceptual and an operational model for moving a new product from idea to launch (Cooper, 1990, p. 44).

Cooper (1990, p. 45) further extends that the key for sustainable competitive advantage lies in conceiving, developing, and launching new products as a core activity, not merely an extension or incremental improvement.

"Stage-gate systems recognize that product innovation is a process. And like other processes, innovation can be managed. Stage-gate systems simply apply process-management methodologies to this innovation process" (Cooper, 1990, p. 45).

The initial Stage-Gate model was targeted at manufacturing and consists of a model containing five Stages and five Gates (see Figure 5).

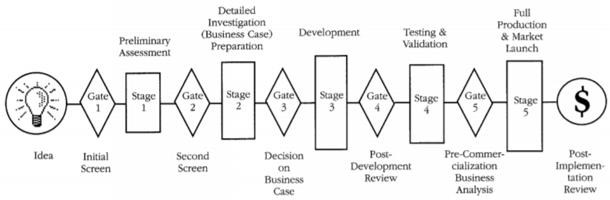

Figure 5: The first Stage-Gate model by (Cooper, 1990, p. 46)

Starting with the generation of an idea within a new process each Stage represents work output that will be assessed during checkpoints, namely Gates (Cooper, 1990, pp. 45-46).

Deliverables for each Stage need to be clarified as well as criteria for Gates which need to be fulfilled before proceeding to the next Stage, which is of high importance, keeping into account Coopers statement of each Stage usually being more expensive than the preceding one (Cooper, 1990, p. 46). At each Gate a Go/Kill/Hold/Recycle decision for the project is to be decided (Cooper, 1990, p. 46).

Stages might be conducted sequentially (as presented in the model) or parallel for counteracting the dilemma of time efficiency and project effectiveness as parallel processing compresses the development cycle without sacrificing quality (Cooper, 1990, p. 50). In the first model, parallelism is still in early stages. It rises in importance during the development of the Stage-Gate process and is illuminated at a later point in this thesis.

In a study of 203 new product projects Cooper (1990, pp. 47-48) examined different levels of commitment towards Stage-Gate application and impact on success or failure of the project.

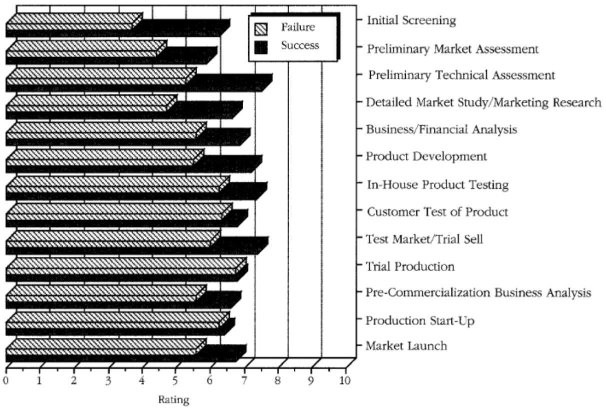

Figure 6: Failure and success in commitment of the Stage-Gate process (Cooper, 1990, p. 47)

As visible in Figure 6, within each of the 13 activities assessed, the application of the Stage-Gate process led to higher success rates, whereas Trial Production and Production Start-Up remain on the same level.

Cooper (2007, p. 67) extended his Stage-Gate methodology from a manufacturing towards a service centered focus with projects such as fundamental research projects, science projects and basic research, as technology development projects are crucial in terms of long-term growth or even survival.

As the average business's research & development portfolio has shifted dramatically to smaller, shorter-term projects (almost double as much as in 1990) using untraditional, new methods, the traditional Stage-Gate model must adapt to follow up, prevent harm and provide guidance (Cooper, 2003, p. 1). Figure 7 presents the altered version, namely TD model (technological development) within an IT context consisting of three Stages and four Gates.

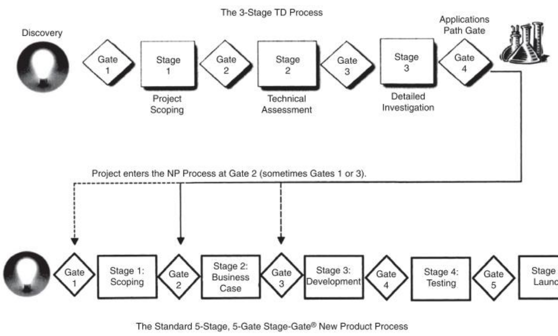

Figure 7: Comparison of TD and traditional Stage-Gate systems (Cooper, 2007, p. 72)

Cooper assures continuous monitoring, optimization, and alteration of the Stage-Gate process to fulfil the need of state-of-the-art developments within the environment. In Cooper (2008) challenges and solution designs, emerged during 18 years since launch, are addressed and future developments of the Stage-Gate process presented. Challenges are described as issues in governance, over-bureaucratizing or misapplication of methods to cut costs whereas solutions are proposed to improve governance by a clear definition of gatekeepers, rules and the inclusion of leaner Gates to counteract over-bureaucratizing (Cooper, 2008, p. 213).

Cooper (2008, pp. 223-224) stressed the need of a scalable Stage-Gate system to suit different risk-level projects which is more flexible and adaptable, as projects have different dimensions, size, reactivity to changing demands or time constraints. Figure 8 presents three different Stage-Gate configurations deployed after Gate 1 has been passed, named Stage-Gate (full), Stage-Gate Xpress and Stage-Gate Lite. Stage-Gate (full) represents the traditional model with five Stages and five Gates in total. In Stage-Gate Xpress these five Stages are distributed into three work packages consisting of parallel activities and separated by two further Gates after passing the discovery area. Stage-Gate Lite further deviates from linearity by splitting the five Stages into two work packages separated by only one additional Gate.

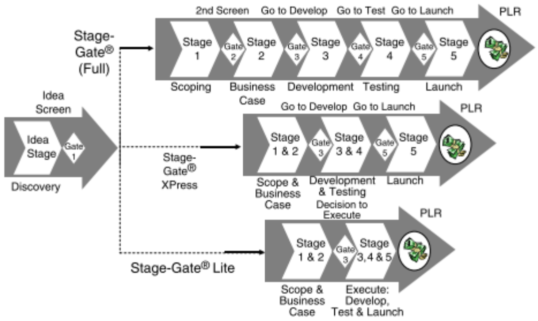

Figure 8: Scalable Stage-Gate configurations tailored for different projects (Cooper, 2008, p. 223)

Cooper and Edgett (2012) analyzed commitment to Stage-Gate methods revealing best performers by industry in terms of success and governance structures.

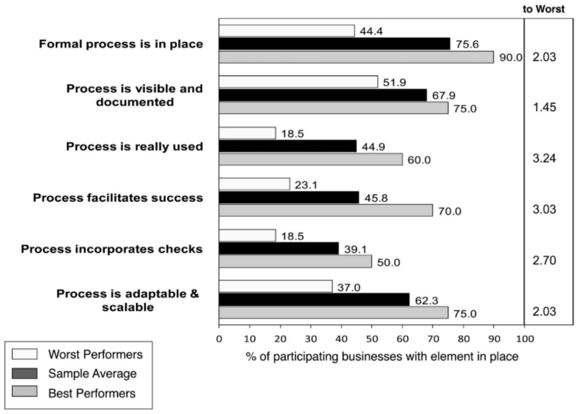

Figure 9: "Percentage of participating businesses with idea-to-launch processes meeting key criteria for success" (Cooper & Edgett, 2012, p. 49)

Figure 9 presents results of the study, conducted between 10 segments, such as consumer goods or software, describing best performers as visible and documented at an operational level, applying the Stage-Gate process, enabling project teams to access the resources they need to succeed, incorporating compliance checks to ensure that the process is followed and being adaptable and scalable (Cooper & Edgett, 2012, pp. 44, 48-49). Furthermore, it is necessary to clearly define gatekeepers and their responsibilities for go/kill project decisions at each gate (Cooper & Edgett, 2012, p. 50). Outcomes of the study reveal success factors based on application of the Stage-Gate framework, but as described in this chapter as well as in chapter 2.1.1, projects vary and not every business is capable of implementing a suitable Stage-Gate system, based on individual needs the framework cant satisfy.

After describing the initial Stage-Gate model, adaptations, such as the TD model within the IT industry and a review on factors of success and criticism revealing the necessity for more scalability and adaptability, the following chapter illuminates a major development within the framework. Regarding challenges and limitations associated with the Stage-Gate process, agile is introduced to counteract barriers and allow for hybrid systems applicable for every type of project in a business environment.

2.2.2 *Agile development and scrum – the evolution of the Stage-Gate process*

Since launch of the Stage-Gate process in 1990 the trend towards Agile development and Scrum is rising in literature and shaping the process. In the previous chapter first steps of these developments were detected as blueprints within early Stages. Cooper (2014, p. 20) describes this new evolving trend as an evolution of Stage-Gate or close to an evolution, based on best practice of companies adapting the initial Stage-Gate process towards success.

Problems of the traditional model, such as linearity and rigidity in a world that is now faster paced, more competitive and global, and less predictable were already examined in previous papers and countered by solution designs such as the TD model for IT service projects, but implementation is still problematic in some of the cases (Cooper, 2014, p. 20). As a result, The Stage-Gate process transforms to the Triple A System consisting of A1-Adaptive and Flexible, A2-Agile and A3-Accelerated (Cooper, 2014, p. 21):

A1-Adaptive: Spiral or iterative development with a series of build-test-revise iterations, adapting through new information

A2-Agile: Sprints, scrums, quickly and nimble moving from milestone to milestone within a lean system and waste removal

A3-Accelerated: Accelerating the development process, properly resources projects, dedicated cross-functional teams, enhanced parallelism in activities through overlapping of Stages and deviating from a classical view of Stages, and lastly, but important for our research:

"...robust IT support is provided to reduce work, provide better communication, and accelerate the process." (Cooper, 2014, p. 21)

Deviating circumstances and emerging trends combined with technological development, as described in Cooper (2007), inspired by lean and rapid production systems, direct the Stage-Gate process towards the framework of Agile leading parallel development procedures to a new level. Figure 10 provides insights on these alterations, such as spiral and iterative cycles within each Stage consisting of diverse parallel activities based on build-test- feedback-revise decisions.

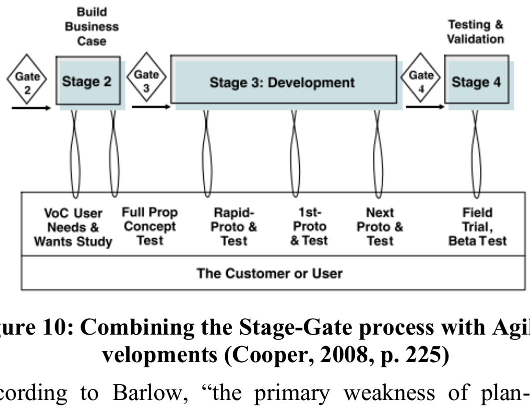

Figure 10: Combining the Stage-Gate process with Agile developments (Cooper, 2008, p. 225)

According to Barlow, "the primary weakness of plan-based methods is a lack of responsiveness to change" (Barlow et al., 2011, p. 26). The same can be concluded for the classical Stage-Gate system.

Furthermore, the requirements of a project change during initiation, execution and completion, increasing the necessity to be responsive and adaptable to changes which will occur within the process (Barlow et al., 2011, p. 26).

To answer new demands, Agile development comes into play containing the following principles and revealing strengths and weaknesses:

Table 2: Principles of Agile (Barlow et al., 2011, p. 27)

Agile Principle	Description
Customer collaboration over contract negotiation	Reduce formalities to start and finish faster, with a strong focus on the customer throughout the development process
Individuals and interactions over processes and tools	Enhance communication within teams and barrier removal
Working software over comprehensive documentation	Developers spend more time coding and testing than they do writing extensive documentation
Responding to change over following a plan	Give teams the freedom to make changes and adjust to project needs

Table 3: Strengths and weaknesses of Agile (Barlow et al., 2011, p. 28)

Strengths	Weaknesses
Focus on customer needs	Does not promote formal communication
Adaptable to changing requirements	Time and resources might be unknown initially
Fast development time	Requirements not well defined
	Lack of documentation

Regarding these weaknesses, such as lack of formal communication, unknown time and resources, lose defined requirements and lack of documentation, an add-on to Agile comes into place, named scrum, which is described as a framework allowing for the application of processes and techniques for continuous product improvement while enhancing relationships and communication within a team (Schwaber & Sutherland, 2017, p. 3).

Scrum may be used for product development as well as services and proved effective in knowledge transfer based on iterative cycles (Schwaber & Sutherland, 2017, p. 4).

Through formation of small, flexible teams operating in diverse networks, cooperation is allowed within development architectures and target release environments counteracting weaknesses based on communication and documentation (Schwaber & Sutherland, 2017, p. 4). At the heart of the scrum methodology lies execution in sprints. These represent a fixed period of time filled with activities, usually taking place over one month (Schwaber & Sutherland, 2017, p. 9). Sprints are regarded as small projects and within these projects no major changes are made, quality goals do not decrease, but scope may be clarified and re-negotiated between the product owner and development team (Schwaber & Sutherland, 2017, p. 9).

Cooper (2015, p. 6) illuminates that "…new-product success rates increase by 37-percent, projects hitting profit targets increase by 72-percent, and percentage of sales from new products more than triple with an effective gating system installed."

Challenges however, such as alignment of business with an Stage-Gate tailored system or the implementation of it still create a burden (Cooper, 2015, p. 6).

Differences between the Stage-Gate process and Agile in terms of type, scope, organization, and decision model are shown in Table 4.

Table 4: Stage-Gate process vs. Agile (Cooper, 2016, p. 22)

	Stage-Gate	Agile
Type	Macroplanning	Microplanning, project management
Scope	Idea to launch	Development and testing, can be expanded to pre-development
Organization	Cross-functional team (R&D, marketing, sales, operations)	Technical team (software developers, engineers)
Decision model	Investment model—go/kill decisions involve a senior governance group	Tactical model—decisions about actions for next sprint made largely by self-managed team

Moving back to the origin, the Stage-Gate process was conceived with a manufacturing focus, altered towards service segments and found a way combining both in a hybrid Stage-Gate / Agile model suitable and adaptable for each direction or an architecture consisting of both (Cooper, 2016, p. 21).

Benefits created through this model are described as adaptive and target oriented production process (through sprints), uncertainty accommodation (through predefined requirements and checkpoints at Gates), accelerated development (through target oriented sprints), dedicated and focused teams (combining best practice from both models) and lastly improved team communication (Cooper, 2016, pp. 26-27).

The implementation of agile in the software industry may be described as a revolution and combinations with the Stage-Gate process shape product development in the manufacturing industry (Cooper & Sommer, 2018, p. 25). In 2019, as described in chapter 1.1, Cooper summarizes assumptions presented previously within this chapter and extended the Stage-Gate model with two noticeable aspects, developed but not yet mentioned in 2017. Influencing factors, such as early customer involvement, broadening of customer base, integrated marketing research, rapid prototyping, customer tests and well planned launch execution were mentioned (Cooper, 2019, p. 38). Furthermore, a model combined of sprint iteration and spiral test was presented (Cooper, 2019, p. 45). As influencing factors are already covered in chapter 2.1 of this thesis and remaining aspects as well as in-depth scrum developments go beyond the scope of the paper, the reference is made for completeness in the interest of the reader. In the next chapter two case studies within companies suffering under misapplication of the Stage-Gate process is analyzed and methods leading to solutions of the problems revealed.

2.2.3 Problem and solution designs from a Stage-Gate process perspective

Karlstrom and Runeson (2005) present a case study targeted at large software product companies in a context of Agile methodology. In the example of ABB Automation and Ericsson Microwave Systems, both companies targeted the implementation of Agile methods through alteration of software management projects without changing the Stage-Gate model (Karlstrom & Runeson, 2005, p. 44).

Table 5 presents key characteristics of the companies within the study (SEPM = Software Engineering Project Management):

Table 5: Overview on ABB and Ericsson (Karlstrom & Runeson, 2005, p. 45)

Company	Product type	Customer type	Business model	Software engineering methodology	SEPM* model	Goal
ABB	Real-time industrial control and automation system	Industrial customers	Market	Normally traditional; pilot team using XP	Stage-gate	Agile software team integration into gate model
Ericsson	Embedded radar control and target tracking	Military	Product line with contracts	Normally traditional with some iteration, pilot team using XP	Stage-gate, iterative	Agile software team integration into gate model

The research was conducted applying qualitative analysis through semi structured interviews and archival analyses which resulted in the following outcomes visible in Table 6 regarding potential effects of Agile methods within the organizational structure where "+" indicates a positive effect and "!" indicates effects that might need attention.

Table 6: Effects of Agile methods at ABB and Ericsson (Karlstrom & Runeson, 2005, p. 46)

Area	Agile feature	Effect*
Planning and prioritization	Most important feature first	+ Early feedback on features + No delays of important features
	Micro planning	+ Avoidance of requirements' cramming + Fixed plans avoided ! Little support for long-term plans
Communication and follow-up	Coherent teams	+ Good internal communication ! Potential isolation of agile team
	Automatic testing	+ Means for communication of change + Higher quality
	Small, manageable tasks Continuous integration	+ Feeling of being in control + Higher quality + Progress measure for management
Process model and roles	Customer involvement	+ Continuous feedback + Relevant features + Technical product manager is a good candidate as customer representative
	Documentation as tasks	+ Priorities resolved between documentation and code ! Conflicts visible between different amounts of documentation
Project management	Engineering-level empowerment	+ Engineers feel motivated ! Managers afraid initially ! Management training needed
	Focus	+ Engineers focus on past and current release, managers on current and future release + (!) Technical issues raised (too) early for management
	Engineering-level initiative	+ Little resistance to change

Regarding ABB Automation and Ericsson Microwave Systems the question arises of how to alter the Stage-Gate model to achieve these benefits through Agile:

The application of Agile enables early feedback loops through continuous operation as engineering teams are focused prioritizing work packages on most important tasks without interruptions, whereas demands of extra features from a Stage-Gate process become trivial decreasing uncertainties and effort made during the process (Karlstrom & Runeson, 2005, p. 46). Furthermore, higher iteration frequency and a more adaptive style to fast-paced changing, environmental needs saves further time and work effort (Karlstrom & Runeson, 2005, p. 47). Another important aspect lies in demands of communication from Agile to the Stage-Gate process - which was not solely visible in Agile or the Stage-Gate process itself but also in chapter 2.1 (Karlstrom & Runeson, 2005, p. 47).

Therefore, communication needs to open up, distance from formality and person-to-person interaction needs to increase, realizable through the formation of small working groups and hands on work on the tasks (Karlstrom & Runeson, 2005, p. 47).

Summarizing, the distribution of work within smaller packages led to an increase of focus, decrease in confusion amongst team members and a stronger perception of control and responsibility (Karlstrom & Runeson, 2005, p. 47). A shift from traditional, linear models towards iterative, parallel process execution solved problems generally occurring through requirement changes, such as system re-planning, redesign, and recoding, which led to increased levels of quality of delivered product parts (Karlstrom & Runeson, 2005, p. 47).

Consequently, the introduction of Agile through alteration of existing Stage-Gate procedures created a model targeted at barriers hindering development processes, changed perception of employees and offered a solution design leading to remarkable benefits.

A further study of Ettlie and Elsenbach (2007, p. 20) aimed at exploring Stage-Gate processes connected to innovation and new product technology between radical vs incremental levels and new virtual teaming systems based on hardware and software developments. Core subjects of the study consisted of use of virtual teams, adoption of collaborative and virtual product development tools for supporting software, degrees of formalized strategies for guiding the new product development process and adoption of supporting processes to provide guidance (Ettlie & Elsenbach, 2007, p. 20).

The survey covering 72 automotive engineering managers involved in supervision of the NPD process revealed 30 % of respondents using a modified Stage-Gate process (Ettlie & Elsenbach, 2007, p. 27).

Companies who used modified Stage-Gates development processes were also significantly more likely to adopt advanced enabling systems for new product development, like collaborative engineering hardware software to enable virtual team implementation (Ettlie & Elsenbach, 2007, p. 22).

Furthermore, formalized new product development processes were likely to be able to allow companies to adopt a modified Stage-Gates regimen (Ettlie & Elsenbach, 2007, p. 23).

The most common types of modifications adopted by companies are backtracing and implementation of guidelines for continuous improvement from program or project management (Ettlie & Elsenbach, 2007, p. 28).

Summarizing, a higher degree of innovativeness within companies adopting modifications to traditional Stage-Gate models was observed (Ettlie & Elsenbach, 2007, p. 31). Furthermore, virtual teaming software tools are applied, and common goals and structures defined, allowing for a consistent Stage-Gate process decreasing the urge for reviews or improvements (Ettlie & Elsenbach, 2007, p. 31).

Comparing both cases within this chapter, ABB Automation and Ericsson Microwave Systems applied a more informal approach rooted in software development whereas the survey within the automotive industry relied on modified Stage-Gate processes with a formal and top-down guided approach towards new product development and innovation. Depending on the type of industry, company size, operating field, or business problem, different variations and pairings of the Stage-Gate process can be observed. A shared similarity evidenced by analysis within the recent sub-chapters stresses the need for suitable tailoring of strategy, goals and structures with a suitable Stage-Gate design to solve problems target oriented in an environment requiring strong communication and commitment, formal or informal to solve problems and improve business processes.

Moving back to the xyz process at Company X, challenges become visible. In both cases the applied Stage-Gate system was not aligned with the requirements of the project leading to inefficiencies. Low degrees of responsiveness and communication within ABB Automation and Ericsson Microwave Systems are comparable to issues in perception and lack of information regarding the xyz process. Furthermore, a shift from traditional models containing sequential activities towards smaller, parallel conducted activities decreased uncertainties and allowed for adaptability, comparable to over-bureaucratization presented by paperwork at Company X. In the second case the implementation of virtual teaming software further allowed to increase communication flow and decrease urge for reviews, which is again comparable to collaboration between Company X and its suppliers, information bias or general lack of information e.g. tracing procedures. In both cases the change towards a suitable Stage-Gate system led to solutions for the problems. In the next chapter these solutions will be combined with insights received during analysis of literature on projects, Project Procurement and the Stage-Gate methodology.

2.3 Utilization of the Stage-Gate process in Project Procurement at Company X

In chapter 1 the main problems of the xyz process were described. Literature on Project Procurement, the Stage-Gate process and application of solution designs illuminated from each perspective were presented in chapter 2. For the generation of a solution design for Company X the following ingredients will be combined:

- Engineer-Procure-Construct (EPC) framework
- Early contractor involvement (ECI) framework
- Stage-Gate framework / tailored Stage-Gate system

The xyz process at Company X shares similarities with an EPC framework, such as "…interdependence of activities, phase overlaps, work fragmentation, complex organizational structure, and uncertainty in accurate prediction of desired outcomes" (Yeo & Ning, 2002, p. 254).

At Company X, construction and procurement are not seperated from each other in a sequential pathway, as construction parts or architectures ordered from suppliers are tested during prototype series and analyzed for misfits or modular inbalances. In some cases parts which were planned to be built into a car may become entirely inapplicable and time scarcity arises as a substitute needs to be developed and produced to compensate for the loss. Collaboration may be described as an iterative cycle of build-test-revise application through spiral or iterative development in a Agile process, similar to the definition of A1-Adaptive in the Triple A framework of Cooper (2014) besides "Agile" and "Accelerated".

Following the guideline for procurement proposed by Yeo and Ning (2002, pp. 255-256), procurement needs to connect with construction, is highly dependent on suppliers, needs more communication and negotiation within these external parties and has the potential to benefit from superior performance in overall project cost and delivery.

The necessity for more collaboration and closer communication and relationships with suppliers is stressed, which, if neglected, leads to the problems detectable within the xyz process.

Another point to consider represents core issues within the xyz process, consisting of large degrees of work loads, as the process nowadays is applied through high amounts of paper work bearing additional effort to daily business activities and consequencing in employees and suppliers being reluctant to perform.

On the basis of an altered Stage-Gate system to counteract problems based on communication and perception, a model of early ECI could be introduced to coherently align knowledge with updates of the project and state-of-the-art developments, such as insights received during prototype series and consequencing alterations requird by suppliers without any need for paper work and sequencial inquiries within the supply base (see Figure 4).

In the example of Walker and Lloyd-Walker (2012), ECI marks every step during the process where involvement of suppliers is feasible, consequently, during all phases of the project.

Yet the degree of confidentiality has to be considered as several parts may be subject of a dual-sourcing etc. and information should be kept confidentially between the parties.

If contractor involvement is realized from the beginning of the project, backed up by a collectivistic structure of information sharing, paper work and filling of formulas would be largely decreased or even rendered unnecessary entirely.

Summarizing the findings received during this literature review, a hybrid Stage-Gate model is proposed (see Figure 12) consisting of elements of both Agile and Stage-Gate instruments to deviate from a sequential towards a parallel view of processing and align with the needs of the project. Suppliers and employees of Company X need to be involved right from the beginning to generate a common base of understanding towards perception of the importance in communication, trust, and commitment necessary for the project or upcoming projects. Additionally, the right information needs to be provided at the right time. This knowledge needs to be kept updated through usage of a systematic structure, such as a cross-company-boundary enterprise information system, where recent developments are reported, for example, by technicians, procurement departments, suppliers or the department for software projects. As visible in Figure 11, input generated by different departments of Company X involved in the project as well as suppliers are constantly flowing into a centralized system. Consequently, every other system which is used nowadays will be rendered obsolete and every participant enters and stores information within the new system. If total numbers of affected cars within a project are needed, Supplier A does not need to write an E-Mail to the technical department, as required information are presented within a personalized dashboard. If Project Procurement needs to increase volumes for a project containing parts already nominated years ago, and current prices are needed for calculations, these prices are visible within the system, based on a connection to suppliers.

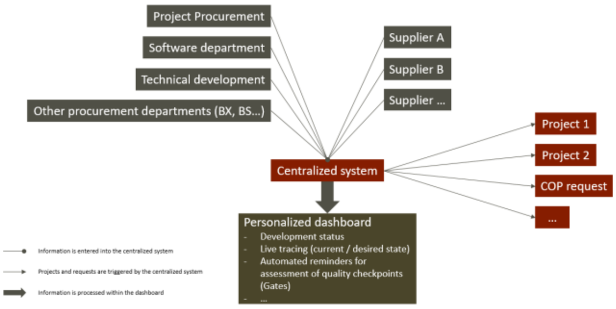

Figure 11: Solution model, a centralized platform connected to Company X and stakeholders

In the case of Company X, an entire realignment of project teams towards a structure consisting of sprints would not be feasible. Agile concerned with sprints rather refers to means of communication, build-test-revise iterations and milestone tracing in the context of the xyz process. The implementation of a centralized system would open up the currently misaligned gating structure and milestones would be visible on time, presented on a dashboard for state-of-the-art process tracing during every phase of the project. Therefore, Stages can be monitored on time and compared to deadlines, represented by necessary milestone accomplishments. Misalignment within the Stages is detected immediately, and iterations of product realignment can be planned and negotiated between customer and supplier.

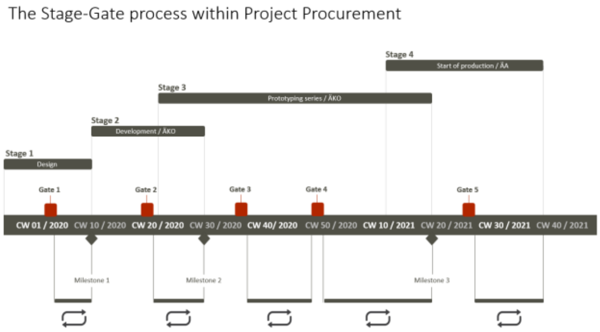

Figure 12: The Stage-Gate hybrid with Project Procurement as Company X

Activities, such as design, development, prototyping or SOP represent Stages within the new hybrid model (see Figure 12). After completion of every Stage, a milestone will be achieved. Gates might be determined by personal preference at the beginning of a project. Within the model, one Gate within smaller Stages or two Gates within prototyping, as the largest stage, are illustrated. When a Gate is reached, an automated message will be delivered to Project Procurement containing a reminder for reviewing the current process, which is visible within the dashboard. As the system will automatically alarm the purchaser in case of disruptions, this mechanism merely serves for the purpose of additional security. Imagining the possibility of system errors, a manual view of employees within fixed timeslots will additionally safeguard the project. If a disruption is detected at the Gate or in the time before arriving at the Gate, space between occurrence and milestone can be used to actively monitor the process on the dashboard on a daily bases, personally contact suppliers or in the worst case, conduct build/test/revise iterations to solve the problem. If a project progresses without any interruptions, no action in terms of monitoring or tracing is needed from the side of Company X.

Besides the main purpose of the solution design, targeted at milestone tracing, replacing the xyz process, it provides further benefits in associated areas, such as COP requests. Referring back to the example of increased volumes, a purchaser generally needs to constantly monitor, if negotiated capacities and demands of technical development for parts are in equilibrium. If capacities are insufficient, parts supply will be threatened, which consequently threatens the production of cars. In case of unalignment, several steps have to be undertaken. Imagining the current capacity of part A at Supplier A might consist of 500 parts per week, but 700 parts are needed based on the new demand. Acquired tools at supplier side based on investments made by Company X might be able to produce 1000 parts per week. Therefore, no additional investments need to be taken, as unused capacities can be utilized. Besides monitoring, the purchaser needs to inquire Suppler A and ask for utilization of the tool. Afterwards, the supplier needs to talk to its technicians to receive the inquired information before being able to send an E-Mail to Company X. He or she might verify free capacities, close the inquiry based on cost neutrality and enter the updated number of required parts into the internal system. Based on the implementation of a centralized system and state-of-the-art information input from Project Procurement, technical development and Supplier A, all of the aforementioned steps and associated effort could be abolished. The system will constantly monitor capacities. If unalignment is detected, current capacities will be compared to tool capacities. If the affected tool is still able to cover the change in volumes, the inquiry will be approved automatically and Company X as well as Supplier A receive an automated message, solely for informing purposes.

To prevent risks in terms of confidentiality, different degrees of permission need to be allocated inside of the platform to present the right information to the right person within personalized dashboards. Following such a design has potential to decrease threats concerned with failure of the xyz process such as delays or disruption of SOP process and additionally spares working hours or costs generated by a process which is applied insufficiently, leading to miscommunication and waste of effort. Besides Project Procurement, such a system may be applicable to other departments and processes within or outside of the company. In the next chapter, the methodology used to gather and analyze data will be described.

3. DISCUSSION AND CONCLUSION

3.1 Practical implications for Company X

Concluding on findings received during the analysis of the interviews, the xyz process was implemented as an additional tool to ensure safety in milestone tracing and monitoring of construction parts. Based on arguments received during the interviews, the process demands redundant work, unnecessary if an employee within Project Procurement follows assignments and responsibilities associated with the job profile.

This leads to the question, if the xyz process was founded on a problem which never existed, as every employee performs as expected. On the other hand, the only assumption, which would validate the existence of the xyz process, would consequently stress a misconduct of daily business activities, rendering another tool to safeguard deficiencies necessary. Illuminating the situation from this perspective, the xyz process does not present a problem, but a consequence based on another problem which should be center of attention.

If the problem is not based on internal deficiencies, effort in applying the xyz process out weight's minor benefits, such as an additional form of communication, which would be rendered unnecessary if processes work sufficiently. Furthermore, today, no employee is performing the xyz process on a regular basis leading to wasted capacities without realizing any of its benefits. Answering the research question with a narrow view would consequently result in an abolishment of the xyz process without any major sacrifices.

During the time at Company X and the progress of this thesis, especially after comparing literature with practical insights received during interviews, a broader problem was detected, covering a scope that extents issues related to the xyz process. Within Project Procurement a large variety of systems containing information exist. Some of these systems are already coupled with different suppliers and some information are generated automatically, whereas other systems need manual entries and are not aligned with both databases. Furthermore, information on categories such as capacities or schedules are present within multiple systems, giving rise to additional effort in entering and comparing received information. Extending this phenomenon on every department within procurement or even Company X, consequences of effort based on doubled and manual work are immeasurable based on the size of the company. Furthermore, milestone tracing for software, legal aspects and licensing increases steadily in importance, as boundaries between hardware and software, associated with a construction part, diminish. Today, no established process exists, counteracting the lack of control and coordination necessary within dynamically evolving environments and trends, such as automated driving or E-mobility.

The solution model, which was designed during the literature review, validated by employees of Project Procurement at Company X within interviews, and refined by feedback, might not be applicable in the narrow sense of the core issues underlying the xyz process, because, as already discussed, there is no necessity for the process at all, if every employee performs the job conscientiously. Instead, it might be applied to solve the broader problem by abolishment of extra effort for manual entries into systems and associated comparisons of double or multiple data sets. Replacing every existing system with an enterprise wide platform, connected to the supply base under allocation of different levels of permission would counteract these issues from the roots. Besides procurement, every department of Company X and every stakeholder can be connected, information would always be state-of-the-art, and redundancies eliminated. Additional milestones might be implemented in tracing, such as software or legal aspects. Software packages e.g. moving targets, that are too dynamic to be traced by an untailored tool, such as the current xyz process, would be traceable within the new model. Different parties, such as technical development, the quality department or logistics could be involved directly. Furthermore, it allows to automate processes beyond the scope of milestone or part tracing and generates a fruitful fundament for innovative ideas. Tracing might transform from an active activity containing effort based on work force towards a passive activity, as information do not need to be gathered and traced any more but retrieved on the platform to receive updates. If intervention is needed or problems are detected, purchaser, supplier or any other instance involved within the subject gets an automated message or an automated appointment for a telephone conference to solve the issue. If no deviation is observable, participants may decide to set individual milestones for manual tracing on own behalf.

The idea would benefit Company X as well as its stakeholders, such as suppliers, as core issues surrounding the xyz process and changes transferred by the solution design describe a framework of cooperation and commitment affecting every participant. Consequently, alterations in terms of simplification and communication will stimulate perceived value and business relationships. Every resource and information necessary to transform the idea into reality is available at Company X.

3.2 Theoretical implications for literature

3.2.1 Contributions of the research

To describe contributions of the research to the theoretical framework, a review on the steps conducted during this thesis and the position of literature inside of its design will be presented.

Within chapter 1.1, challenges concerned with the xyz process were described based on informal interviews, conducted during an internship at Company X in 2019. Based on these challenges, the topic of this thesis emerged, and a literature review was conducted, targeted at the detection of solution mechanisms for underlying problems of the xyz process. In chapter 2.1 changes in requirements of projects, due to environmental trends and globalization, coupled with conduct in procurement, revealed success factors and pitfalls. Relationships are rising in importance to combine different levels of perception in terms of project execution and achievement of goals between every participating stakeholder. To instrumentalize means of managing projects and stakeholder relationships, communication and early involvement of each stakeholders are required, generating commitment and stimulating progress. Models, such as the EPC framework stress the necessity of a strategic link between procurement and the project delivery value chain to maximize stakeholder value, reduce time wasting activities and ensure a state-of-the-art information flow based on a networked system (Yeo & Ning, 2002, p. 257). The ECI framework proposes early involvement of stakeholders, such as suppliers, within the project, to stimulate communication, commitment, information, value and perception of participants within the project (Walker & Lloyd-Walker, 2012, p. 877). After analyzing causes of problems and solution mechanisms to counteract these causes from evolving, triggered by the xyz process and compared to literature, a suitable design needed to be detected to enable required changes. As the xyz process is logically linked to the Stage-Gate framework (see chapter 1.1), a variant needed to be found, capable of realizing improvements. In chapter 2.2, the development of the Stage-Gate process was described from launch till today, considering changes based on influencing factors already mentioned at the beginning of this chapter. A shift from sequential to parallel execution of work-related activities in systems or tailored models for specific needs of industries and projects were presented. A combination of insights received from chapter 2.1 and chapter 2.2 led to the creation of a solution design for Company X, described in chapter 2.3. Within the interviews, in a first step, problem causes and effects of the xyz process were validated and further aspects, such as confusion concerned with project variety or waste of time, based on BEKOs rendering the process obsolete, were detected.

Within the design of this thesis, literature was used to solve a practical business problem. As described earlier in this chapter, the logical pathway of comparing challenges of the xyz process to literature based on conceptual rules, success factors, causes and consequences, in combination with a tailored Stage-Gate model, altogether applied in an automated platform, led to a beneficial outcome of this thesis project. In a practical sense, as well as a contribution to the theoretical framework. Literature and models gathered during the review added value to the solution design, but the solution design itself needed to be created from different theoretical modules. Combining means of communication and acceleration of processes in an automated way e.g. a suitable Stage-Gate system with a cross boundary platform, will consequently accelerate and improve its components. The main purpose of EPC, ECI and Stage-Gate lies in offering a perspective, but a combination within a model, such as presented in this thesis, will consequently enhance success of each ingredient. Embedded in a technological context concerned with stakeholder alignment and automation, added value will be stimulated in terms of agility and adaptability, as every participant is permanently connected. Regarding ECI, a contractor would not be solely involved, but an active part in controlling the project without major effort. In EPC, procurement strategies and linkages to suppliers could reach a new level, as minor activities, such as COP requests, are removed by automated structures, generating free capacities, while stimulating relationships. Summarizing, every aspect delivering input into the final solution model provides benefits, but if these aspects are combined and utilized, additional value will be generated. These combinations as well as limitations of this thesis need to be further examined, as described in the following chapter.

3.2.2 Limitations and future research

The study was conducted with a small scope targeted at solving a business problem in one company within one industry. Furthermore, only 5 out of 18 employees from Project Procurement were interviewed, using qualitative analysis in semi-structured interviews. Adding more employees to the analysis or using different methods, such as quantitative analysis e.g. questionnaires could reveal a deviating picture. It is imaginable, that a larger group of participants with a longer time span available for responding would present additional aspects not yet detected. In an interview, time to respond is constrained, but in a calm environment and respond times of a week, for example, employees might consider questions more intensive and answer differently. Furthermore, new problems might be detected, not solvable by the presented model, questioning its validity. Besides opinions of employees from Project Procurement at Company X, stakeholders, such as suppliers, or other involved departments, should be asked as well. If every stakeholder or at least a representative number of respondents would be implemented in the research and different tools for data collection and assessment were applied to create comparisons, the study would still only be valid and approved for Company X / one company within the automotive industry. Individual means of project execution, business conduct or perception of value might deviate within the industry, and one model might not solve problems of every company. Furthermore, Company X is a large company and the applicability of the model was not tested in medium of small sized companies. Consequently, in a next step, the model needs to be tested by other automotive companies and its stakeholders. To adapt it for different industries or departments, it is necessary to detect core components. As described in chapter 3.2.1, a combination of different models, such as EPC and ECI was created, coupled with the Stage-Gate process, further developed, and in the end verified by Company X. But another company within or outside of the same industry might require different components. In future research, success factors and boundaries need to be analyzed by business size, departments and industries before coupling them with a suitable Stage-Gate system. Afterwards, the connection to a platform, offering automation of processes and alignment of modules, should be implemented and the validity for each specifically tailored system can be tested. Lastly, the model is targeted at tracing milestones, increasing communication, stimulating relationships and decreasing effort for every participant. It is imaginable to extend this scope based on needs of different users. It is imaginable, that it could be used to replace additional activities, while saving more time and effort.

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