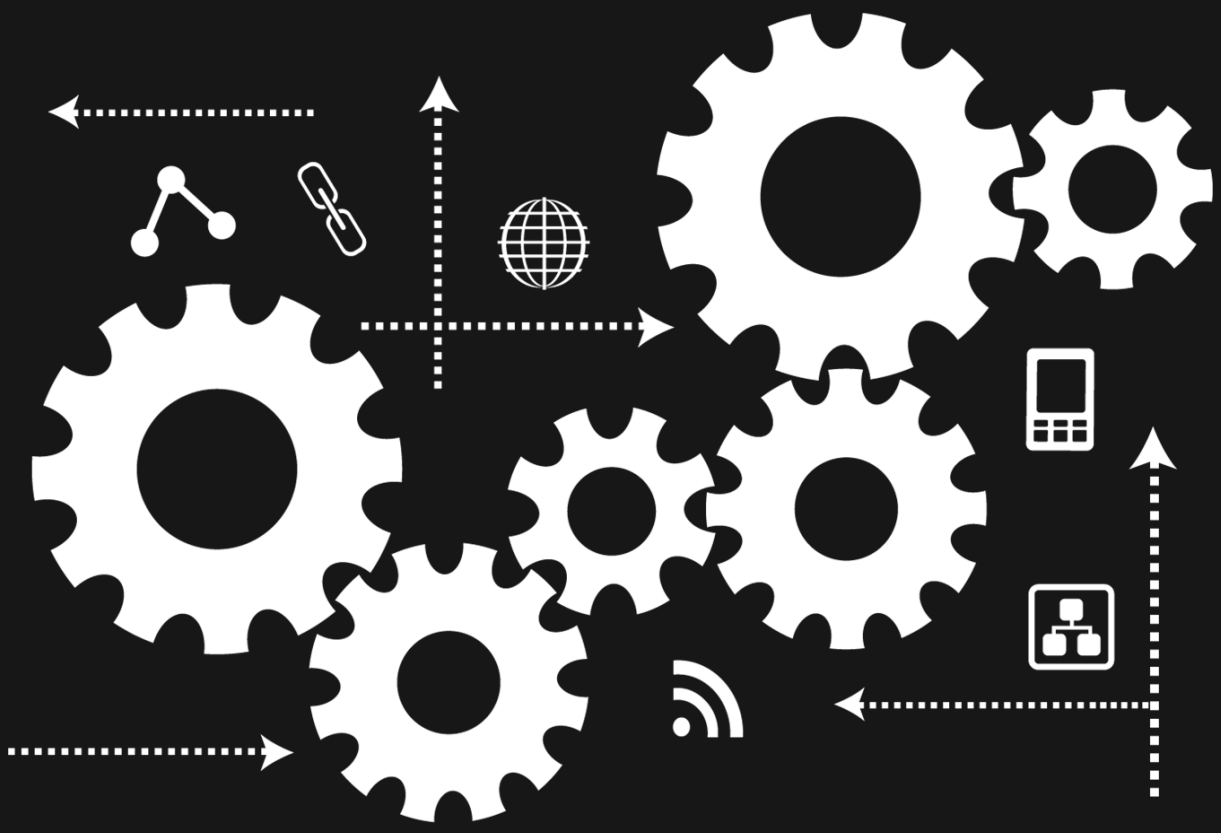
COMPANY X



''To what extent and in what way can an Integrated Business Planning contribute to the value chain of Company X within their multi-project environment?''

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Company	:	COMPANY X	*Submission date*	:	08-08-2019
Company supervisor	:	Manager Delivery Team			

08-08-2019

"Towards an Integrated Business Planning at Company X"

Master Thesis Business Administration
University of Twente
Faculty of Behavioural, Management and Social sciences (BMS)

Master Thesis

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Management summary

Company X is a specialized, international player in the area of storage systems, from manual to fully automated storage systems. At this moment, the organization deals with scattered and not linked planning processes. Each department has their own planning process and system. Since these do not interface with each other, the likelihood of introducing mismatches and planning mistakes is big. The planning processes are labor-intensive, not linked to an overall process and difficult to understand. This situation makes the management of a project difficult. There is no overall tool in use to harmonize the planning data. This makes forecasting and reporting a difficult and labor-intensive activity. Therefore, it is necessary to examine the contribution of an integrated business planning in their multi-project environment.

The goal of this research is to provide Company X with an advice and conceptual framework. With this, we provide Company X a solid base of how to integrate their business processes into one integrated business planning. To give a solution to the problem and realize goals, we formulated the following main question:

''To what extent and in what way can an Integrated Business Planning contribute to the value chain of Company X within their multi-project environment?''

To answer the main question, we formulated five sub questions. Figure 1 shows the research design including the five questions divided into three phases. In the *current situation*, we analyzed the value chain and planning processes. We identified planning-related risks in the *bottleneck phase*. In the *desired situation*, we designed a conceptual framework to illustrate the contribution of an integrated business planning towards the value chain of Company X. In addition to the data collection methods from figure 1, we examined relevant literature for each sub question.

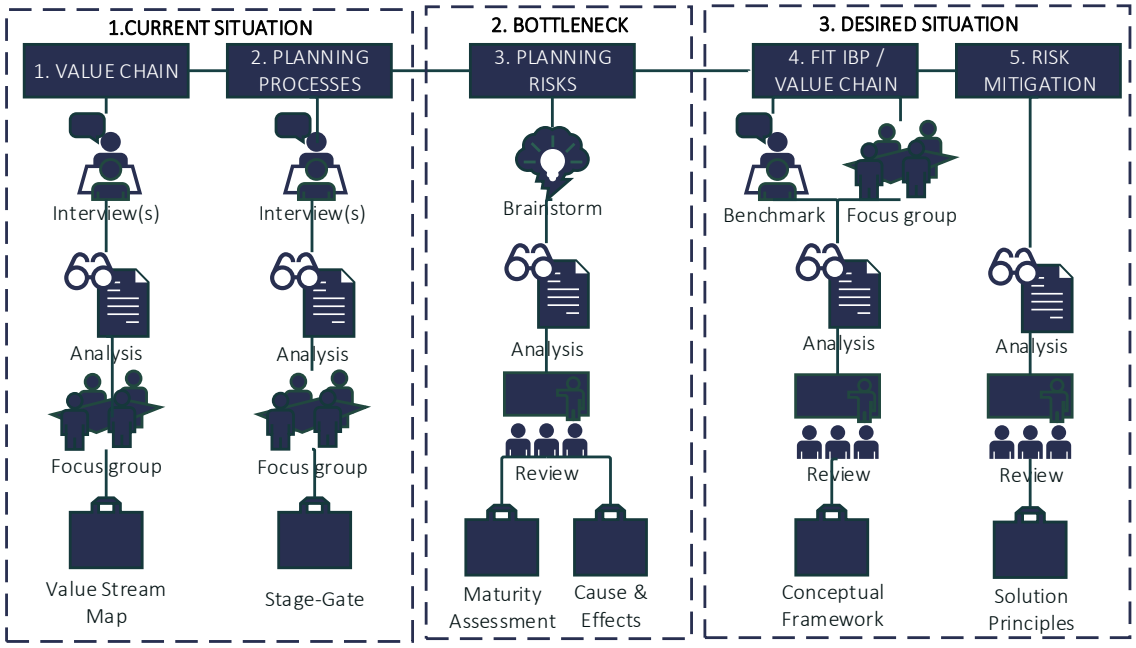

Figure 1. Research Design

In the current situation, there is limited alignment between the various value chain processes. There is a lack of consideration for all aspects of the process. Departments are not fully aware of their dependencies and process boundaries lack formalization. The result is leading; departments consider rules and procedures as less important. There is limited consistency due to the different use of terminology and way of sharing/using information. The current situation leads to misalignment of processes, limited involvement and different ways of working.

Company X has scattered and loosely connected planning processes. Planning takes place on two levels. Departments manage resources and capacities on the tactical level and schedule detailed activities on operational level. Planning data comes from different sources; there is no ''single truth''. The current way of planning is not suitable for changes. Consequently, a lot of manual operations, translations and interfaces, resulting in a communication-driven planning process. Milestones connect the current planning processes. Currently, Company X coordinates milestones decentrally, where changes have different consequences. Besides, there are no uniform milestone definitions. In line with this, milestones are not always correctly followed up. Subsequently, the current situation results in challenges with resource allocation, prioritization and decision-making.

Company X has a ''reactive'' planning landscape. Planning processes lack formalization and are not consistent. Planning processes are often self-organised and not part of a broader system. There are limited formalized rules when and how for example to allocate resources. Each planning process uses several information channels, which are subject to change. This results in mismatches and frequent re-planning. At the operational level, departments schedule detailed activities on an ''individual'' basis, often on experience, with limited alignment to other processes. Subsequently, 70% of the identified planning risks relate to ''process effectiveness'' and ''process efficiency''. Specifically, many risks relate to the degree of formalization, alignment and way of preparing and sharing information. The other 30% concerns risks related to people & organization and IT.

In the desired situation, we observe that an integrated business planning fits towards the value chain of Company X on different levels and supports in mitigating planning-related risks. Generally, we see in the bottleneck phase similar risks as described by the literature on integrated business planning and the situation at Company X. From this, we observe that an integrated business planning is a feasible way to improve the current situation by mitigating risks. Therefore, we designed a conceptual framework to illustrate the fit towards the value chain of Company X (figure 2). With this framework, we provide guidance for integration, coordination and improvement.

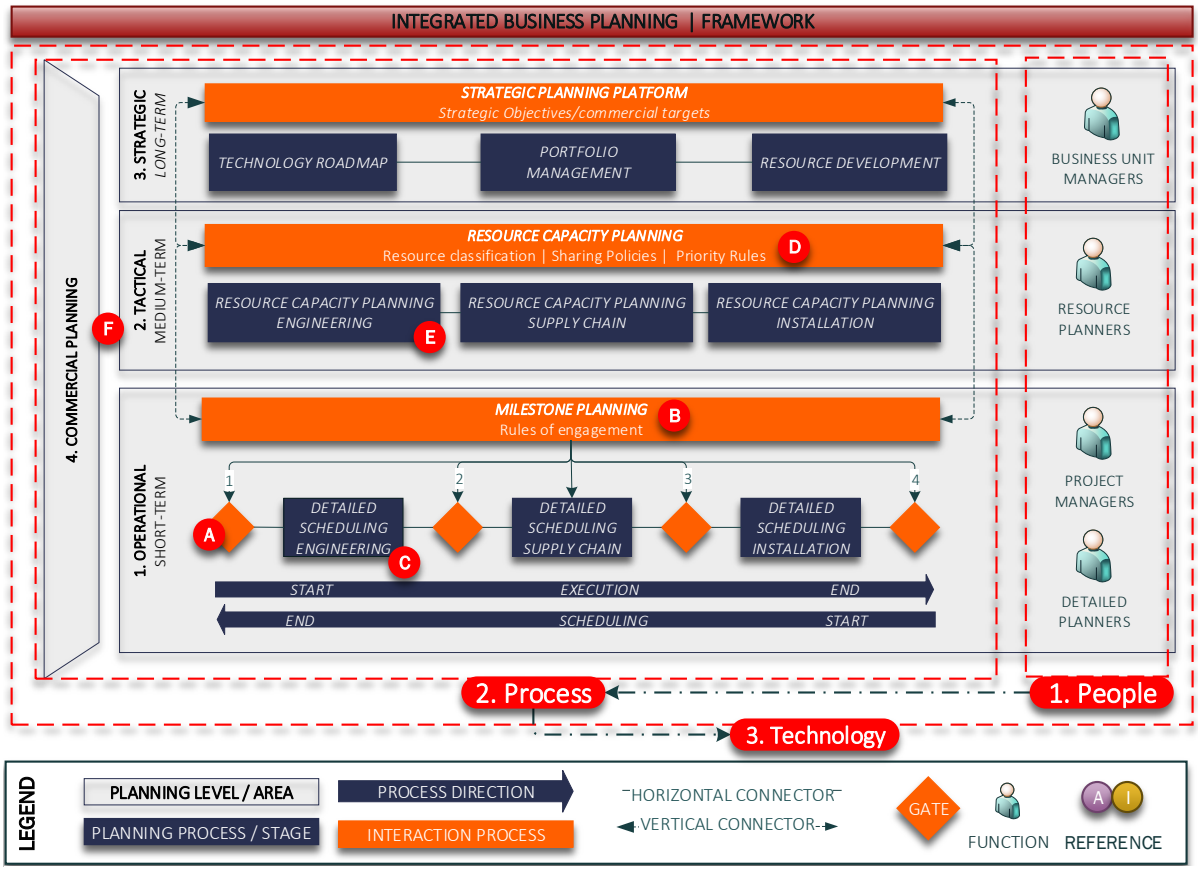

Figure 2. Integrated Business Planning Framework

With the framework, we give Company X practical recommendations *in what way* to improve the current situation, mitigate planning-related risks and work towards the desired situation:

1. ***Operational,*** on operational level an integrated business planning fits to Company X using the stage-gate process. This process aligns the operational processes and serves as coordination mechanism for project managers. We recommend backward planning, as sales specifies the installation period.
   A. Company X needs to set up a ''stage-gate'' process to improve integration and coordination.
   B. Use ''rules of engagement'' to ensure the quality of the stage-gate process. Rules can improve the consistency and transparency of their processes.
   C. Define a standard way to create detailed schedules (templates, input-transform-output). Important here is to integrate with the other processes using the gates.
2. ***Tactical,*** the stage-gate process creates also a link to the tactical level. On this level, resource classifications, sharing policies and priority rules guide resource managers to improve resource allocation.
   D. Company X can classify resources using a matrix, set up sharing policies and priority rules to structure the process of resource allocation.
   E. For the resource capacity planning, we propose to define a standard for each planning. Specify the input, define the process of monitoring and matters such as capacity levels and KPIs.
3. ***Strategic,*** the resource capacity planning provides the interaction to the strategic level. The output of the tactical level serves as input for the strategic level to perform portfolio management, develop resources and create a technology roadmap.
4. ***Commercial planning,*** to ensure that Company X is ''doing'' the right projects and ''can do'' the project right, Company X needs to align projects with processes.
   F. Therefore, we recommend to create an ''up-to-date'' project classification that considers process characteristics and the external environment.

To show in *what way* to benefit from the contribution of IBP, Company X needs to start with the ''people'' ((1) figure 2) to have understanding, leadership and commitment. Afterwards, Company X must focus on the ''processes'' (2) using a bottom-up approach. Therefore, the operational level is the starting point.

Finally we propose to focus on the role of ''technology'' (3). An integrated business planning is primarily about people and process; it requires understanding of processes and alignment of people's behavior. However, technology tools do play a major part in ensuring data and information is available to the process, and in helping to drive improvement in processes that are more sophisticated.

Besides recommendations regarding the *desired situation*, we have a few recommendations for further research in the near future:

- Finance was out of the scope. However, the literature addresses in many areas the role of finance within IBP. Therefore, we recommend further research into the role of finance.
- There is a late involvement of purchasing into the process of engineering. Therefore, we propose the following:
  - Perform a maturity assessment on the purchasing department. An assessment provides practical insights into the maturity of the purchasing department.
  - Explore the applicability of value engineering to create early involvement of purchasing. With this, organizations eliminate unnecessary costs, in order to achieve value for money on a project.
- Within this research, we had a focus on the macro process. Therefore, methods such as critical path method and program evaluation and review technique were out of scope. We recommend using one of these methods to assess micro processes when analyzing ''operational'' processes.

Preface

This master thesis is written to conclude the master of Business Administration at the University of Twente. Within this master program, I followed the ''International Management'' track. This research, at Company X, was a perfect opportunity to put knowledge into practice. It was very interesting to approach a subject like integrated business planning from a theoretical and practical perspective.

I thank my supervisors at Company X, the manager of the delivery team and manager PDAM by providing me the opportunity to perform this research. Furthermore, I want to thank the people of Company X for their support, commitment and enthusiasm during this research. They gave me many valuable insights.

I am grateful to my supervisors from the University of Twente, Peter Schuur and Petra Hoffmann. The feedback sessions were very helpful and gave valuable insights in to order to improve the end-result.

Finally, I hope you all enjoy reading this report and hope this research will help Company X to remain a unique and healthy organization.

After having started on the secondary vocational education, then higher professional education and now a university education, I can say:

Where there's a will, there's a way!

Bram te Woerd
Enschede, August 2019

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1. Introduction

In the framework of completing the master study Business Administration at the University of Twente, I conduct research at Company X into the field of integrated business planning and multi-project environment. In section 1.1, we give an introduction of Company X. Section 1.2 shows the motivation of the research. Section 1.3 describes the research goals, questions and scope. We describe the research design in section 1.4 and the contribution in section 1.5.

1.1 Company description

Company X

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Company Z

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Organizational structure

Company X works according to a matrix structure. There are three commercial units. In the execution, they have a project execution and supply chain department. Figure 1.1 shows the structure including various staff departments. The red line indicates the focus area of the research.

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Figure 1.1 Organizational Structure Company X, Country A

Besides the departments of Company X NL, figure 1.2 shows the focus area of Company X, country B. The entire supply chain and production department are part of the research. Below, the author introduces each departments briefly.

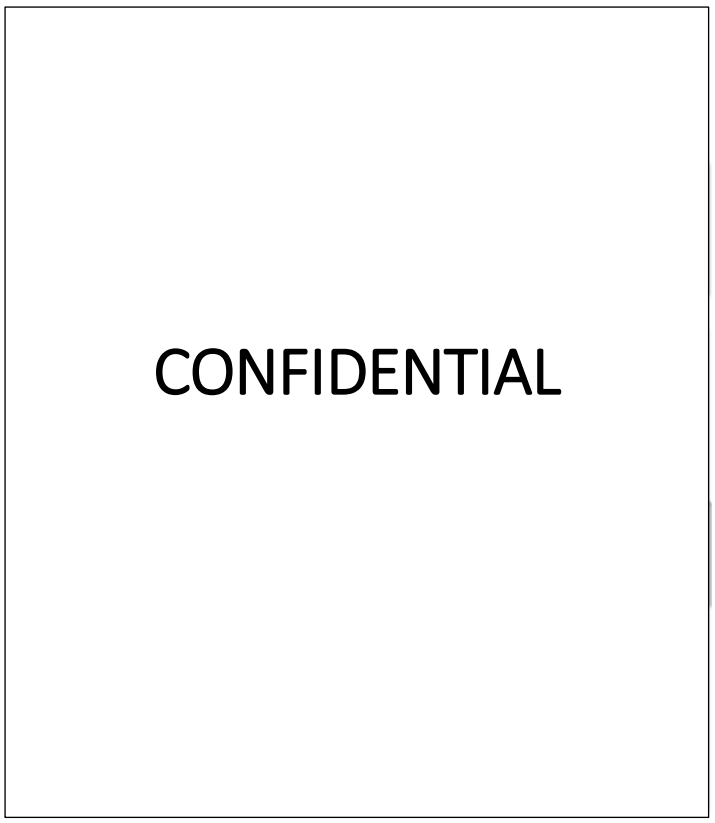

Figure 1.2 Organizational structure Company X, Country B

SALES

Company X has three commercial units, operating from Country A. Figure 1.3 shows the difference between the commercial units.

Resellers

The resellers unit components and manual solutions through a dealer network. Focus on standard products. They offer a service for inspecting storage solution. Price is more important than capability (COMPANY X, 2018)[1]. Unique selling points are their local presence through their dealer network and the quality of the products.

Key Accounts

Key accounts sells manual and semi-automated solutions to end-users. Key account managers are responsible for a certain market segment. This department has engineering capacity so that, in addition to standard solutions, it can also offer customer-specific solutions. Price equals to capability. Therefore, customers find price an important aspect, but also appreciate the offered capabilities.

System Integrators

The system integrators unit sells automated solutions. The projects are customer-specific with a lot of engineering work. It concerns ''engineering-to-order'' (ETO), where the customer sets the requirements. The main driver of this business are the custom-made solutions, where capabilities are more important than price. Technical capabilities and reputation are crucial in this type of business.

Figure 1.3 Price-capability focus.

REALIZATION

Engineering & Structural Engineering

The engineering department converts customer requirements into technical specifications. Engineers create the technological design and structural engineers perform the statistical check. This department designs the solution and determines the follow-up process with their solution.

[1] Source derived from the intranet (not publicly available) of COMPANY X

Project Management
The project managers are responsible for the project realization from order until installation. They are responsible for the cost, time and quality of the solution. Project managers are the link between Company X and the customer in the execution phase.

Installation management
Installation managers perform the preparations before the start of the installation. From the start of the installation, they have a supporting role towards the supervisors on site. With preparations, we refer to activities such as contracting a subcontractor, preparing the installation planning and safety concerns. Safety has top priority in their role.

Supervision
Supervisors are the link between the subcontractor, who executes the installation and Company X on site. They work according to a fixed installation method and follow strict procedures for safety. As mentioned, installation managers support them in case of training and advice.

SUPPLY CHAIN

Central Planning
Central planning has a coordinating role between different departments. They are the chain between sales and engineering, engineering and supply chain and supply chain and installation. Central planning ensures that engineering, production, procurement and installation align with each other, so that there can be delivered on the promised delivery times.

Production planning
Production planning determines when what to produce. They convert the capacity planning into detailed schedule. With this, they indicate when they need which goods from warehousing. Production engineering supports production planning in case of tooling and testing.

Warehousing
Warehousing is the input channel for the incoming goods. They check all goods on quantity and quality according to purchasing specifications. Afterwards, they place the raw materials and semi-finished goods on stock or prepare it for production. They transfer finished goods directly to shipping and delivery.

Purchasing
Purchasing takes care of the purchase of raw materials, semi-finished goods and finished goods. In the Netherlands, they perform the purchase for mainly finished goods of certain segments with a direct delivery to site. Purchasers in Country B take care of the purchase of raw materials and semi-finished goods. These materials require an additional production step such as coating. Together they make sure that the factory and installation have always access to the right materials at the right time.

Shipping & Delivery
Shipping and delivery ensures the timely delivery of goods on site. As mentioned, they receive the goods from production or warehousing, prepare delivery and arrange the transport to site. Compared to warehousing, they are the output channel.

MANUFACTURING

Production
Production ensures the production of materials according to the right quantity and quality. The production converts the rack design of the engineers into steel products. Three production steps follow in sequence, concerning: 1) profiling, 2) welding, and 3) coating. Afterwards, packaging take place before transport to shipping and delivery.

Product Portfolio

Company X has a broad and varied portfolio of projects. As mentioned earlier, from components to complete systems. In each situation, Company X delivers the ''steel'' product. In case of automated solutions, software and hardware come from other suppliers. Company X offers the following segments (see figure 1.4, including numbering) (Company X (n.d.), 2019):

- Products for storage of pallet goods
    1. Pallet racks
    2. Drive-in racks
    3. Pallet shuttle
    4. Automatic pallet storage
- Products for storage of small goods
    5. Shelving systems
    6. Open face miniload
    7. Beam type miniload
- Specials and storage racks protection
    8. Mezzanine floors
    9. Defenders
    10. Stiffener
    11. Frame protectors

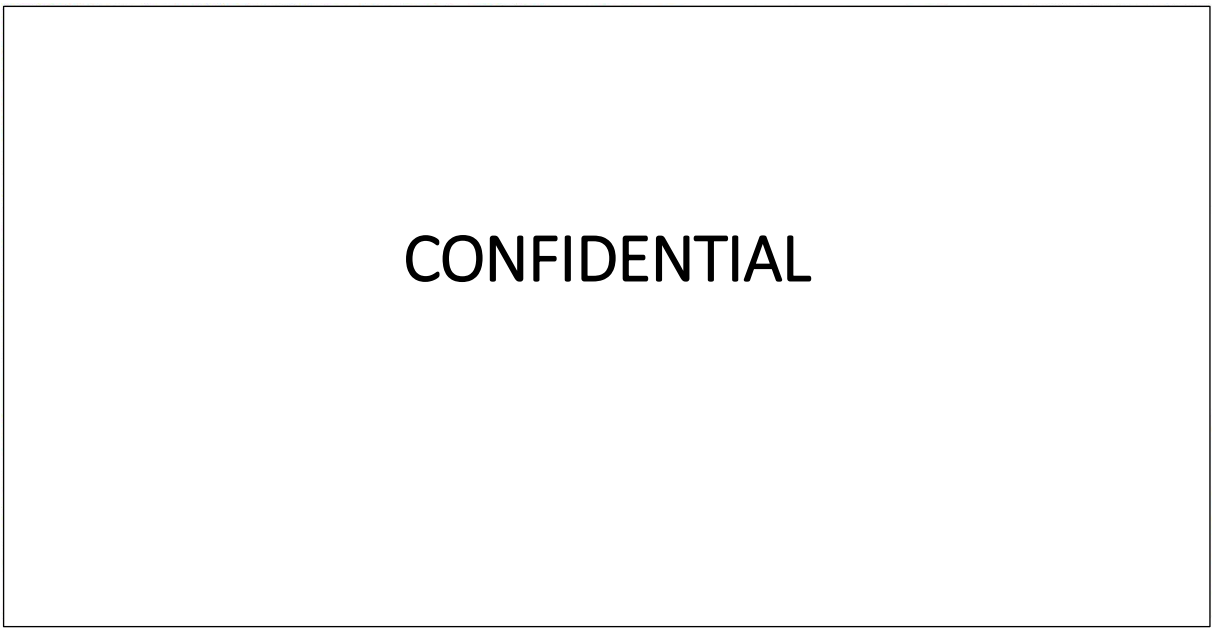

Figure 1.4 Product portfolio (Company X, 2019)

The projects of Company X contain often a number of the products. To highlight this, we describe two projects to illustrate the complexity and size of a project. In section 5.1.2, we use the projects again to illustrate the impact on Company X.

Project I: Company A

On behalf of Company A, key accounts realized this project. This project includes a range of different products such as pallet racks, shelving systems, mezzanine floors and defenders. The warehouse consists of three floors with pallet racks and shelving systems (Company X (n.d.), 2019). Company A asked for an order pick environment with a maximum of storage capacity available. This resulted in a warehouse with storage capacity of more than 220 kilometers of shelving. Figure 1.5 shows the solution in which the picture on the left shows the total solution and the right shows the shelving system.

Properties:

- Installation lead time of only 20 weeks
- More than 220 kilometres of shelves for storage capacity available
- Specific customer solution developed
- Pallet racks store package materials
- Shelving systems store small goods
- Mezzanine floor and stairs

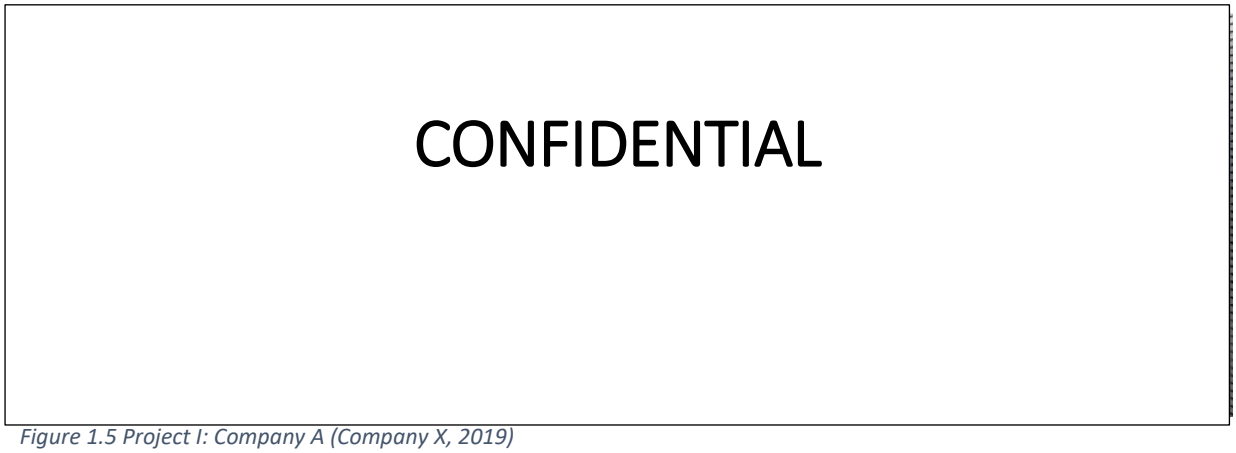

Figure 1.5 Project I: Company A (Company X, 2019)

Project II: Company B

This project includes pallet racks and floors (figure 1.6). It concerns a fully automated pallet system of 34 meters high. More than 12,500 pallet spaces, suitable for heavy loads (1000 kg per pallet location) (Company X (n.d.), 2019). Fully customized storage racks and customer specific tests in the test centre of Company X shape this project.

Properties:

- Fully automated pallet system
- Double deck pallet system, single-sided access
- 34 meters high
- Suitable for a heavy load of 1,000 kg per pallet location
- More than 12,500 pallet places
- Warehouse racks are completely tailor-made
- Customer-specific tests carried out in-house

Figure 1.6 Project II: Company B (Company X, 2019)

1.2 Situation and complication

Current situation

Scattered and a not linked planning processes shape the current planning processes at Company X. At this moment, each department has their own planning process and system. Since planning processes do not interface with each other, the likelihood of introducing mismatches and planning mistakes is big. The planning processes are labor-intensive, not linked to an overall process and difficult to understand. This situation makes project management difficult. There is no overall tool in use to harmonize the planning data. This makes forecasting and reporting a difficult and labor-intensive activity. Recently, Company X received an order for a big project that requires a lot of production capacity. At the same time, sales negotiated about a new project with a comparable size and installation period. Sales did not request a delivery time for this potential project. At the end, if Company X also receives this project, major capacity problems arise. This is a typical example of not following procedures. There is in fact an agreement that sales request a delivery time 10 working days prior to the negotiation. Another example, at this moment central planning manages the capacities of the production and production planning the detailed schedule. This happens in two different systems. Frequently the situation occurs that there are planning differences, since production planning receives an update of the capacity planning once a day. Production planning and central planning fix this kind of issues through consultation. Ideally, there is overall systems which prevents planning differences. Due to this kind of issues, the current process is communication-driven. Appendix A contains the initial description of the project.

Towards the future

Business strategy

Company X established a digitalization strategy in 2018. With this, they refine their business strategy in order to align business objectives with digitalization objectives. They refined this with the vision statement ''be the easiest to work with''. The key words speed, transparency and consistency shape this business strategy (Company X, 2019)[2]. To be consistent, there should be one ''single source of truth''. Transparency requires clear and uniform processes. Finally, speed needs optimal collaboration.

Digitalization strategy

Within this strategy, Company X works with ''principles'' that guide the organization into a certain direction. Figure 1.7 shows an overview of the principles related to the research. As result of these principles, Company X defined several improvement projects. This research relates to the following principle: *''create, assign and prioritize tasks in real time, track progress online and immediately delivers work plan and schedule to all workers''* (COMPANY X, 2018)[2]. The next page provides a detailed description of the urgency and priority of the research.

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Figure 1.7 Related digitalization principles (Company X, 2019)

[2] Source derived from the intranet (not publicly available) of COMPANY X

1.3 Research goal, questions & scope

Goal & questions

The goal of this research is to provide Company X with an advice and conceptual framework. This advice and conceptual framework provide Company X a solid base of how to integrate their business processes into one IBP. To give a solution to the problem and to realize the research goals, we formulate the following main question:

''To what extent and in what way can an Integrated Business Planning contribute to the value chain of Company X within their multi-project environment?''

To avoid misunderstanding about critical parts of this question, we define the following aspects:

- *IBP:* An IBP strives towards horizontal and vertical integration by linking the different disciplines and translating strategic plans into an operational way of working focusing on the processes, technologies and people.
- *MPE*: In an MPE, several projects accomplish side by side, while drawing, at least some, resources from a common resource pool.
- *Value chain:* In this case, the focus relies on ''project execution and supply chain'', as marked in section 1.1 and 1.2.

A literature review in the field of IBP and MPE follows in chapter 2. The sub questions below will contribute to answer the central research question:

Ch. 3. Current situation

- 3.1 What is the value chain of Company X?
  - *3.1.1 What is the role/function of the (sub) processes, people and technology?*
  - *3.1.2 How do coordination and decision-making take place?*
- 3.2 What is the current planning process of Company X?
  - *3.2.1 Which planning methods and systems are used?*
  - *3.2.2 To what extent are the planning processes interdependent?*
  - *3.2.3 How do projects influence the planning processes?*

Ch. 4. Bottlenecks

- 4. Which risks are there in the current planning processes of Company X?
  - *4.1 Which risks are present in the current planning processes?*
  - *4.2 In which way can we categorize planning risks?*
  - *4.3 What are the causes/effects of planning risks?*

Ch. 5. Desired situation

- 5.1 How can an IBP fit towards the value chain of Company X from a strategic, tactical and operational perspective?
- 5.2 What are the options to mitigate planning risks?

Within this research, we make a distinction between three phases: 1) current situation, 2) bottleneck, and 3) desired situation. The current situation is there to get an understanding of the value chain and planning processes. To show the value of an IBP, the bottleneck phase describes the risks. With the desired situation, we show how to mitigate the risks of the bottlenecks phase by describing the contribution of an IBP.

Scope

This research focusses on *to what extent* and *in what way* an IBP contribute to the value chain of Company X within an MPE. To avoid misunderstandings and manage expectations, we define various boundaries to frame this research:

- As mentioned, this research starts with the value chain of Company X. This research focusses on the processes from order until completion.
- Sales is out of the scope of this research. Because Company X experiences most planning problems after sales receives an order. Additionally, a student examined the structure of the sales process recently. At this moment, the Request for Delivery Time (RDT) serves as link between sales and execution. The RDT is part of the research, since it is one of the planning tools of central planning. Finally, the management has also explicitly stated this scope.
- Finance is out of scope. The initiators of this research have a preference to first research the main disciplines as described above.
- As noted, the central research question focusses on ''to what extent and in which way…''. Therefore, this research focusses more on the ''why'' and not on the ''how'' to implement a system or such.
- In this research, we focus on the macro level by using the stage-gate model of Cooper (2008). Thereby, we focus not specifically on the detailed activities. This stage-gate is suitable to frame the macro process.
- Methods such as critical path method (CPM) and program evaluation and review technique (PERT) are therefore out of scope, as such, methods focus on the micro level, on a single stage.

Table 1.1 shows the involved persons in this research.

I/E	*Name*	*Job title*	*Role*
INTERNAL	----	Management Team Delivery Team	1st Supervisor, responsible for the overall project.
	----	Management Team Delivery Team, PDAM	2nd Supervisor, responsible for the overall project.
	----	Process Supervisor	Sponsor
	B. te Woerd	Trainee	Project Manager
EXTERNAL	Dr. P.C. Schuur	Associate Professor	1st Supervisor University of Twente
	Dr. Ir. P. Hoffmann	Assistant Professor	2nd Supervisor University of Twente

Table 1.1 Project team

Deliverables

With this research, we deliver the following products:

- *Advisory report,* a report that provides an answer to the central research question.
- *Conceptual framework*, a visual representation/fit of an IBP applied to Company X based on practical and theoretical knowledge. This framework shows the contribution of IBP from a strategic, tactical and operational level. The framework gives Company X an idea and direction of how to apply IBP considering the MPE.

1.4 Research Design

This part shows the research design. The first part describes the research setting. Part two describes the data collection and analysis. The final part addresses the reliability and validity of this research.

Research setting

The method used in this research is a qualitative case study design. This case study entails the detailed and intensive analysis of a single case. As Stake (1995) observes, case study research is concerned with the complexity and particular nature of the case in question (Bryman & Bell, 2015). Therefore, the research entails an in-depth study to explore *to what extent* and *in what way* an IBP can contribute to the value chain of Company X within their MPE. The case study has an exploratory character, which means that researcher aims to get a feeling for potentially important dimensions and to describe a phenomenon in the appropriate contextual setting.

Data collection & analysis

We follow several steps in order to examine *to what extent* and *in what way* an IBP can contribute to the value chain of Company X. As mentioned, section 1.3 provides a set of sub questions in order answer the main question in a systemic way. Figure 1.8 shows the methodology per sub question.

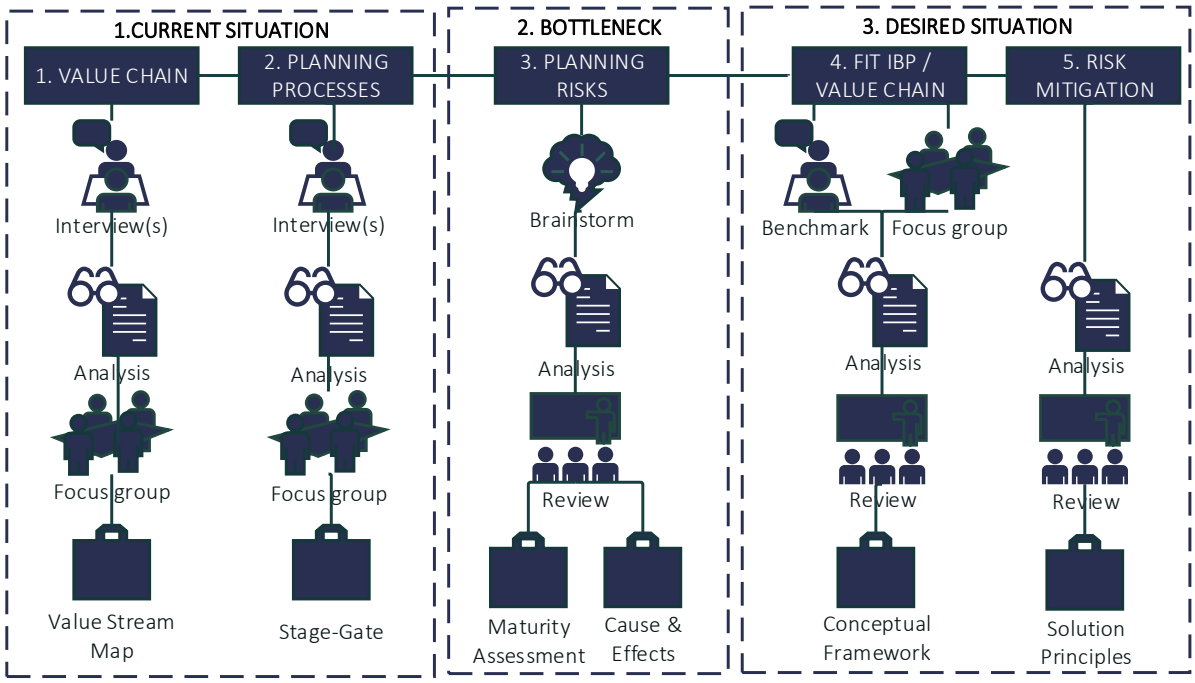


Figure 1.8 Research design

Before we describe each sub question, we first highlight each data collection method. Data collection and analysis took place through content analysis, semi-structured interviews, focus groups, observations and benchmarking. To get a first understanding of the processes, we examined existing content. To gather relevant information, we conduct interviews with all internal stakeholders, which involve or influence the planning processes (see figure 1.1 and 1.2). In case of semi-structured interviews, we use an interview guide, referring to a list of questions/topics on specific topics (Bryman & Bell, 2015). Questions may therefore not follow on exactly in the way outlined on the schedule. To collect more details about certain topics, we use observations. We use focus groups to verify the findings. Finally, we visited benchmark company to compare methods and look at a system.

In first sub question, we describe, analyze and visualize the value chain of Company X. Therefore, we focus on three dimensions processes, people and technology. Besides this, we look at basic aspects such as collaboration, coordination and decision-making. First, to get a first understanding of the processes, we analyze content such as the ''Project Management Handbook of Company X'' and several other documents/ workflows. After this, we collect data through interviews with all internal stakeholders and verify/review the findings within a focus group session including all stakeholders. With this sub question, we deliver a value stream map and stage-gate model. The value stream map contains processes in detail. The stage-gate model shows a simplified overview of all processes using stages and gates. The theoretical framework provides an explanation of the stage-gate process.

Q1: *What is the value chain of Company X?*

In the second sub question uses interviews, observations and a focus group in order to describe and verify all planning processes. First, we look at all planning methods and systems. Secondly, we analyze the interdependencies between the different planning processes. Thirdly, we describe the critical parameters of the current planning processes. With this, we deliver a summary of all processes using a planning framework from the literature.

Q2: *What is the current planning process of Company X?*

In the bottleneck phase, we describe the planning-related risks of the current situation. We describe the risks in order to show the contribution of IBP in the desired situation. With these risks, we can show how IBP mitigates the risks in the desired situation. First, we use a maturity model to assess the current planning processes. Afterwards, we categorize planning-related risks based on the dimensions and sub dimensions of the maturity model. Finally, we show the causes and effects of three risks. To provide an answer on this sub question, we use input from the current situation and a brainstorm session. From a functional perspective, we identify many risks in the current situation. We used the value stream map during the brainstorm session to identify risks from project perspective involving several project managers.

Q3: *Which risks are there in the current planning process of Company X?*

With the fourth question, we provide Company X with a conceptual IBP framework, which combines aspects of IBP and MPE. This framework gives Company X an idea how they can work towards an IBP. Thereby, we combine practical insights from previous sub questions and theoretical insights from the literature in order to create a fit between IBP and MPE. In addition to the conceptual framework, we show a three-dimensional cube to emphasize the importance of projects in relation to the processes. Afterwards, we describe in what way to benefit from the contribution of an IBP.

Q4: *How can an IBP fit towards the value chain of Company X from a strategic, tactical and operational perspective?*

In order to show the contribution of IBP, we describe in the last sub question three planning-related risks with a solution principle. The idea behind solution principle is to indicate in which direction to mitigate a planning-related risk. Thereby, it is not the intention to formulate ''functional requirements'' for a potential system, as we approach it from a ''process'' perspective. We use input from the literature and benchmark visit to provide solution principles. Afterwards, a review with several stakeholders follows to verify the results.

Q5: *What are the options to mitigate the planning risks?*

Reliability & Validity

Reliability

The reliability of research concerns the extent to which an experiment, test, or any measuring procedure yields the same results on repeated trails (Carmines & Zeller, 1979). The higher the consistency of the results, the higher the reliability of measurement is. To ensure the reliability of this research, we consider several aspects. For example, in case of several interviews we use a certain structure to have consistency and introduce the objective to create mutual alignment.

Validity

Validity refers to the relationship between concept and measurement. In other words, a researcher should ask whether he/she is measuring what he/she intends to measure. Nevertheless, it is possible to have a reliable measurement, but still the validity of the indicator can be poor. We cover the validity of this research through member checks and focus groups. For instance, we show the findings after each interview or focus group to verify if the findings are in line with the view of the respondent(s). By several sub questions, we use a focus group after several interviews as verification method. Subsequently, in each sub question we use three perspectives. First, we look at existing content. Secondly, we perform interviews and focus groups. Thirdly, we obtained insights from the literature. Figure 1.9 shows the combination of the three perspectives.

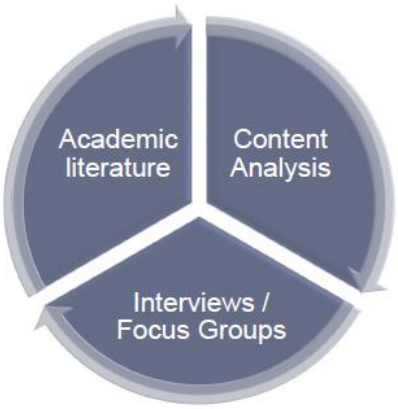


Figure 1.9 Data collection triangle

1.5 Contribution

Theoretical

In this research, we make important contributions into the field of IBP and MPE. First, this research supplements and enriches the knowledge about IBP by demonstrating the contribution in a specific case. Therefore, Noroozi and Wikner (2017) argue that practitioners in industry have largely developed IBP. However, despite the growth of scientific literature in the field of IBP during recent years, gaps between industry needs and scientific literature still exist. Bower (2012) supplements this and argues that the academic, business and supply chain world of IBP is not organized and governed well. There are no common agreements, definitions, metrics or certifications. This research shows in what way the different aspects of IBP contribute to the value chain of Company X considering the MPE. Thereby, Company X operates in a complex, dynamic and uncertain environment. At Company X, we speak about an MPE, as there are about 75 to 90 in progress at the same time. Subsequently, the unique character of this research is the combination of IBP and MPE.

Practical

From a practical perspective, this research contributes to different levels of the organization. First, this research provides the management of Company X with insights about IBP towards their business. Therefore, we identify planning-related risks, use best practices from the literature and reflect it on Company X. Secondly, from a tactical perspective, it provides Company X guidelines by introducing IBP and considering different aspects such as people, process and technology. It shows how IBP and MPE can mitigate risks. It provides background information why to enhance their way of working and best practices how to apply it. On operational level, it gives employees insights by comparing the current situation with the desired situation.

2. Theoretical framework

In the theoretical framework, we examine the literature about IBP and MPE. Section 2.1 shows the approach and methodology. Section 2.2 gives the literature in the field of MPE. Section 2.3 shows the literature about IBP. Section 2.3 describes how Company X structures certain aspects and where we apply the literature. Finally, section 2.4 provides the conclusion of the theoretical framework.

2.1 Approach & methodology

Only a few literature reviews offer clarity about how and why they obtained specific samples of literature. Without a methodology part it is difficult whether the conclusions are scientific responsible. Therefore, we make use of the Grounded Theory approach in this research. The aim of using a Grounded Theory approach to literature reviewing is to reach a thorough and theoretically relevant analysis of a topic (Wolfswinkel, Furtmueller, & Wilderom, 2013). We use the five-stage process of the Grounded Theory approach to give transparency about the review process. Table 2.1 shows the five-stage process.

No.	Task	This research
1. DEFINE		
1.1	Define the criteria for inclusion/exclusion	
1.2	Identify the fields of research	Integrated Planning Approaches, Multi-project
1.3	Determine the appropriate sources	Scopus, ScienceDirect, Scholar
1.4	Decide on the specific search terms	Integrated Business Planning, S&OP, Advanced/mature S&OP, S&OP 2.0 Multi-project Environment/management/organization/Planning
2. SEARCH		
3. SELECT		
3.1	Refine the sample	Year : Depends on search criteria/area. Document type : Article, Review Key word : Based on search criteria
4. ANALYZE		
4.1	Open coding	
4.2	Axial coding	
4.3	Selective coding	
5. PRESENT		
5.1	Represent and structure the content	
5.2	Structure the article	

Table 2.1 Five-stage process (Wolfswinkel, Furtmueller, & Wilderom, 2013)

To perform efficiently a systematic literature, we defined a scope to determine the criteria for inclusion and/or exclusion. The objective, research questions and scope serve as basis for inclusion or exclusion of criteria. In step two, we use the sources of 1.3 and terms of 1.4 to search for relevant articles. Thereby, we use several filters such as the year of publication, document type and key words to refine the search results. The snowball method served as a method to find more literature. With the snowball method, we analyze the reference list of relevant papers to identify additional scientific literature. After the search phase, we used the fourth step to analyze each article. Within each article, we marked the relevant parts and merged it together in one document. Finally, the next sections present the results of the literature review. Appendix F provides the assessment matrix.

2.2 Multi-project environment

This part of the literature review examines the literature on MPE. Section 2.2.1 addresses literature about the management aspect. Section 2.2.2 shows literature about the organizational aspect and section 2.2.3 about the planning aspect.

2.2.1 Management

Project management

Hans, Herroelen, Leus, and Wullinka (2003) define a project as a unique undertaking, consisting of complex set of precedence-related activities that have to be executed using diverse and mostly limited company resources. In other words, a project is a temporary endeavor undertaken to create a unique product, service, or result (PMI, 2013). The temporary nature of projects indicates that a project has definite start and end, whereby a project ends if it fulfils project's objectives. In the past, a significant number of projects failed on the dimensions time and budget. Therefore, several undesirable characteristics are associated with failing projects like budget overruns, compromised project specifications, and missed milestones. Moreover, the three basic dimensions concerned with each project: 1) time, 2) cost and 3) quality. To avoid these issues, a proper project planning is required. A description of the scope and general approach of the project, its resources and personnel, evaluation methods, and a project schedule as well as a description of potential problems that may be encountered (Hans et al., 2003). Project management is the activity of defining, planning and controlling projects of any type (Slack, Brandon-Jones, Johnston, & Betts, 2012). Moreover, Tonchia (2008) refers to the management of quality, time, costs and resources. Therefore, the first three variables relate to performance and the last represents the (human and technological) restraints limiting the activities needed to execute a project.

Multi-project management

When organizations manages multiple projects simultaneously, one speaks of a multi-project context. This concerns matters such as prioritizing, accepting and allocating of projects (Twynstra Gudde (n.d.), 2019). These projects and multi-project companies emerged in the late 1990s as innovative concepts to deal with global, uncertain, ambiguous and dynamic environments faced by many companies today (Geraldi, 2009). Many authors describe it as a key dimension as an advantage but at the same time as a challenge when it comes to the coordination of a variety of contradictory demands, from a high uncertainty to a high structural complexity (Geraldi & Adlbrecht, 2007). According to Engwall and Jerbrant (2003), a multi-project organizational setting, as define here, constitutes by an organizational unit that executes substantial share of its operations as projects. In a multi-project setting, several projects accomplish side by side, while drawing, at least some, resources from a common resource pool. In addition, Payne (1995) argues that projects integrate into the management control and reporting systems of the resource pool owner. Evaristo and Fenema (1999) created a typology of projects based on two criteria, number of projects and locations (figure 2.1).

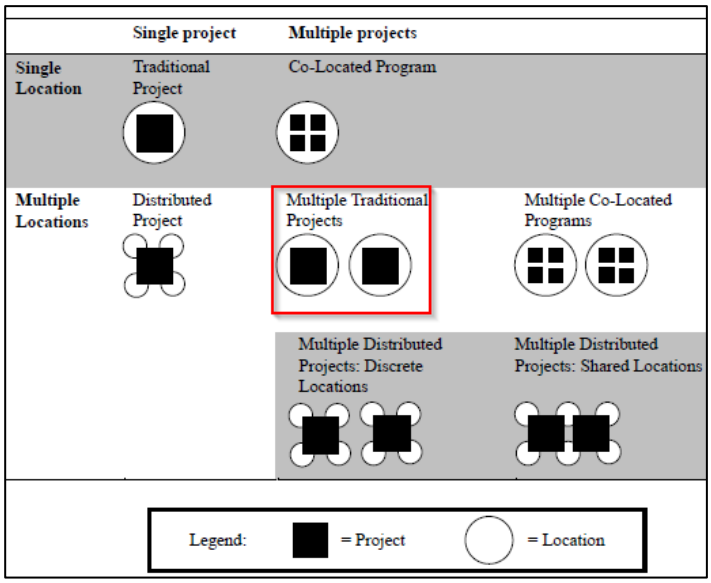


Figure 2.1 Typology of MPE (Evaristo & van Fenema, 1999)

Project life cycle

Every project goes through a number of stages, which together constitute its life cycle. Therefore, we use stages as described by the research of de Boer (1998), since he uses planning-related stage definitions.

1. Order acceptance. Basis for this stage is a quotation of a tight, yet reliable due date. Result of this stage is a contract that specifies the objectives of the customer.
2. Engineering and process planning. Objective of this stage is to generate input for material and resource scheduling by translating functional specifications into an activity network with resource and material requirements.
3. Material and resource scheduling. Allocation of activities to resource by determining the start and completion times. The objective is to meet due date's as much as possible, taking into account resource constraints, material availabilities, precedence relations.
4. Project execution. This stage contains the execution of each activity.
5. Evaluation & service. Evaluation of end-result.

Project categorization

In many organizations, the categorization system becomes so ingrained that people are not aware they use one until someone describes what it might look like. Therefore, organizations that undertake many projects need to identify the type of projects they undertake, and use labels to name them. The labels form the basis of a project categorization system. Therefore, Crawford, Hobbs and Turner (2006) recognize the need to align project delivery capability with business strategy. These authors describe two reasons why organizations need to categorize projects. First, the development and assignment of appropriate competencies to undertake projects successfully (do them right). Secondly, to prioritize projects within an investment portfolio to maximize return on investment (do the right projects). They argue, in order to make best choices, organizations need to assign labels (attributes, characteristics) to their projects, so they can categorize them and create a shared language. Crawford et al. (2006) describe three challenges for developing a categorization system for a work environment: comparability, visibility, and control. First, to provide a system to make comparisons between projects, and this requires some standardization of the language. Secondly, categorization systems enhance visibility. Thirdly, to control a system once an organization chooses to adopt a categorization system.

Project characteristics

Payne (1995) describes three criteria to highlight the differences between projects. Differences of size, urgency, and variety of required skills. Firstly, differences among size become important when there are multiple projects to be performed, but the largest projects are not enough to stand-alone. Projects have still common resources. Secondly, when projects include more technological developments, the variety of skills involved becomes greater. Thirdly, the urgency of projects are of different degrees of urgency. Subsequently, the same organization still executes the projects.

Therefore, Youker (2017) argues since the project management deals more and more with many different types of projects. Therefore, a new level of project management is developed, which requires a different approach in areas like construction, product development and information systems. Youker (2017) describes a number of characteristics, which define the difference between projects (see figure 2.2). Subsequently, Youker (2017) concludes the product of the project is the most useful characteristic in order to classify.

Figure 2.2 Project Characteristics (Youker, 2017)

Stage-gate

Many projects fail due to poor organizational design and leadership, inadequate quality of execution, unreliable data, and missed time-lines (Cooper, 2008). Therefore, organizations need help in the form of a playbook based on what winning team do. Stage-gate is simply that playbook. A stage-gate, in its simplest format, *''consist of a series of stages, where the project team undertakes the work, obtains the needed information, and does the subsequent integration and analysis, followed by gates, where go/kill decisions are made to continue to invest in the project''* (Cooper, 2008, p. 34). Figure 2.3 shows these steps. The design of stage-gate enables project teams and team leaders to get the best resources for their projects and then to speed them to market using the best possible methods to ensure success. Stage-gate is a macro-process, overarching process that combines project management methods in the stages of the stage-gate process. By this contrast, project management is a micro process. For instance, project management apply tasks such as a ''team initiation'' or ''critical path plans'', and ''milestone review points''. Specifically, organizations apply project management methods within the stage-gate process. Organizations apply methods such as critical path method (CPM) and program evaluation and review technique (PERT) in the stages of stage-gate process. Hence, some organizations continue deal with certain problems and pitfalls after implementing the stage-gate model. With this, Cooper (2008) refers to problems related governance and portfolio management and too much bureaucracy and reliance on software.

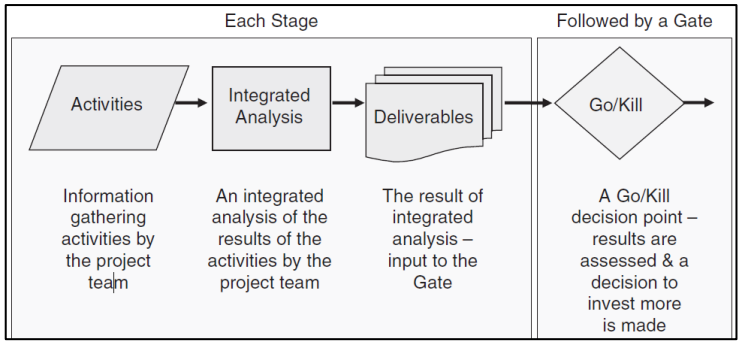


Figure 2.3 Stage-gate (Cooper, 2008)

Nowadays, progressive companies evolved and accelerated their stage-gate process in some ways. Resultsing in a ''Next-Generation Stage-gate'' with developments, such as:

1. *Scaled to Suit Different Risk-Level Projects*, it has become a scalable process, scaled to suit very different types and risk levels of projects.
2. *A Flexible Process*, no activity or deliverable is mandatory, the project team presents its proposed ''go-forward-plan''. Stage-gate is a guide that suggest best practices, recommended activities and likely deliverables.
3. *An Adaptable Process*, Stage-Gate has also become a much more adaptable process that adjusts to changing conditions and fluid, unstable information.
4. *An Efficient, Lean, and Rapid System,* smart companies made their next-generation stage-gate process lean, removing wast, and efficiency at every opportunity.
5. *More Effective Governance*, organizations use definitions for go/kill decision, gatekeepers and rules of engagement to improve governance.
6. *Accelerating the Gates*, the use of leaner and simpler gates.
7. *Accountability, the Postlaunch Review, and Continuous Improvement*, organizations create with the next-generation stage-gate a culture of continuous improvement.
8. *An Open System*, organizations move to a open to built-in flexiblity, capability and enable a network of partners.

A stage-gate process can provide a number of advantages. It reduces errors, ensures internal focus on projects, good communication between different departments and clarity about project planning. Subsequently, it offers good communication between stakeholders, including customers, partners and suppliers. Especially, with the next-generation stage-gate process organizations become more flexible, adaptive, and scalable and incorporate accountability and continuous improvement (Cooper, 2008).

Challenges & drivers

In order to highlight the dynamics of MPE, we describe the main challenges and drivers, which organizations experience in an MPE. Two challenges are of main importance and emphasized by many authors. This concerns the resource allocation and complexity of an MPE. Besides this, we provide a categorization of the main challenges.

Complexity

In general, projects are and have always been complex. As complexity refers to concepts like uniqueness, variety, and unpredictability, the definition of complexity deemed in itself to "kill" the soul of complexity (Geraldi & Adlbrecht, 2007). According to them, complexity serves as an umbrella term associated with difficulty and inter-connectedness. The authors use three dimensions for describing complexity. First, complexity of ''faith'' refers to the complexity involved in creating something unique, solving new problems, or dealing with high uncertainty. Secondly, complexity of ''fact'' refers to the complexity in dealing with a huge amount of interdependent information. Thirdly, the complexity of ''interaction'' emerges between two or more locations. Figure 2.4 shows a set of characteristics used to unravel complexity, and the correlation between the complexity of faith, fact and interaction.

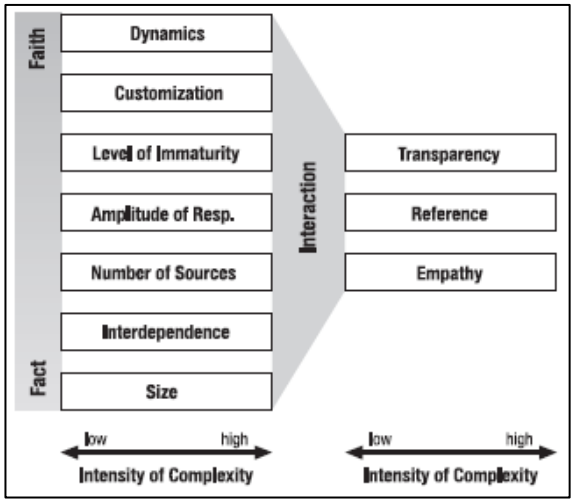


Figure 2.4 Characteristics of complexity (Geraldi & Adlbrecht, 2007)

The five Cs

Payne (1995) provides insights in the problems of MPE based on a classification of five categories. Payne (1995) describes the categories complexity, capacity, conflict, commitment and context. Complexity relates to aspects concerned with multiple interfaces between projects, the organization and external parties. The second category capacity refers to the ability of an organization in providing resources. Conflict referring to people issues, systems issues and organizational issues. Fourthly, commitment relates to the importance of projects and the fifth category is the context of projects, which considers culture, procedure and behavior.

Organization inputs process and outputs

Hashim and Chileshe (2012) use three domains to identify and categorize MPE challenges. Their research results in 22 challenges divided over 11 categories (see table 2.2). The mostly identified categories were associated with organizational culture, resource allocation and competencies of project managers. This refers to challenges as commitment, leading projects, planning, conflict and communication, availability of resources and feedback.

Organization Inputs	Organization processes and output
Project assignments	*Project location*
Human resource allocation	*Project management processes*
Resource availability	*Inter-project interactions*
Project location	*Organization culture*
	Problem solving
	Information sharing
	Management of single projects

Table 2.2 11 categories of MPE challenges (Hashim & Chileshe, 2012)

Resource allocation

According to Engwall and Jerbrant (2003), the primary theme of multi-project management is the issue of resource allocation between different projects. Most literature addresses multi-project resource allocation as a problem of a priori portfolio composition, planning, and scheduling. Besikci, Bilge and Ulusoy (2011) call this the Resource Dedication Problem. They use the following definition: *''the optimal dedication of resource capacities to different projects within the overall limits of the resources and with the objective of minimizing a predetermined objective function''* (p. 1). Sharing of scarce resources makes the allocation problem complex, as it creates dependencies between projects (Ponsteen & Klusters, 2015). They argue that managers not know how to deal properly with resource allocation under uncertainty in an MPE. Ponsteen and Klusters (2015) reviewed the literature on multi-project management from 2000 until 2013. Figure 2.5 shows an overview of multi-project resource allocation methods based on two dimensions. The first dimension refers to human or automated dimension. In other words, the question is whether a human or an algorithm takes the decision. The second dimension distinguishes central or decentral decision-making.

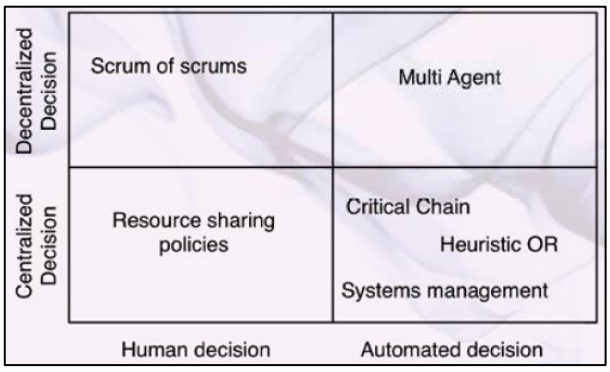


Figure 2.5 Multi-project resource allocation classification (Ponsteen & Klusters, 2015)

Pakgohar (2014) argues for an efficient project planning, it is necessary to distinguish resources based on the risk they expose. Figure 2.6 shows various criteria related to this risk. For example, renewable means that a pre-determined number of units of a resource is available for a specific planning period, while non-renewable are available for the entire planning horizon.

Criteria	Specification	
Renewability	Renewable	Non-renewable
Technology/Know-how	Common technique / low skilled	Highly specialized / high skilled
Value	Low value / cost insensitive	High value/cost intensive
Mobility	Immobile	Mobile
Type of supply	In-house	Third parties (lease, rent, buy)
Supply variance	Steady	Variable
Demand variance	Steady	Variable
Procurement pattern	Time independent	Time dependent

Figure 2.6 Criteria for resource categorization (Sunke, 2009)

Pakgohar (2014) classifies these criteria using a matrix (figure 2.7). Although, this matrix focusses mainly on tangible goods, it provides also possibilities to apply it to human and technical resources. With this, organizations can ensure the availability of critical resources by classifying each resource.

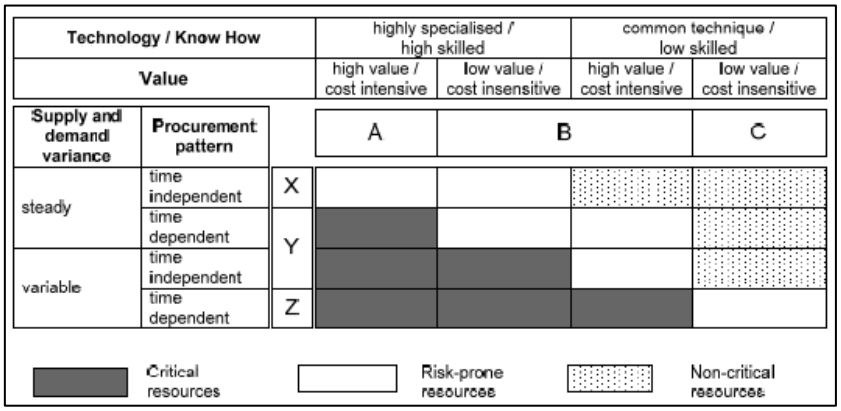


Figure 2.7 Resource classification (Sunke, 2009)

Drivers

Success of projects plays a crucial role in managing overall business of a project-based company. Dietrich, Järvenpää, Karjalainen and Artto (2002) describe the challenges and characteristics of a project-oriented organization. These relate to issues such as linking projects to strategy and business objectives, determining power and authority in the organization, managing risks and resources, sharing

information, and enhancing organizational learning. Based on previous research, Dietrich et al. (2002) conclude that the success in an MPE relate to three different areas. First, results including both financial and customer perspectives. Secondly, project performance and resources aspects. Thirdly, learning and communication at individual and organizational level. With their own research, Dietrich et al. (2002) categorize the success in an MPE into three areas concerning result-related, process- and resource related. Table 2.3 shows the different aspects. Thereby, results-related contribute directly to project business success where process- and resource related success factors are more enablers of success.

Results related success factors	Process- and resources-related success factors
Link to business (strategy, products, markets, environment, trends)	Commitment
Need and importance for project deliverable	Resources
Novelty: new product, technology, service	Time
Alternative solutions	Responsibilities
Achievement of strategic objectives, strategic alignment	Feedback
Impact on stakeholders and interfacing parties	Learning
Customer requirements	
External factors and environmental changes	
Risks	
Benefits	

Table 2.3 Success factors MPE (Dietrich et al., 2002)

2.2.2 Organization

Hans et al. (2003) describe three major organizational forms used in MPE. Firstly, the functional structure where all activities particular to the project strongly tied to the function performed by the functional division. Secondly, a pure project organization, where the project separates from the rest of the system and becomes a self-contained unit with its own dedicated staff and other resources. Thirdly, the matrix structure, a combination of the functional structure and pure project organization, attempting to combine the advantages of both and to avoid some of the disadvantages of each form (see figure 2.8). In this case, resources associate to functional departments but assign to different ongoing project throughout time. In a matrix structure, functional departments operate as workstations executing the work and projects are jobs that flow between the workstations.

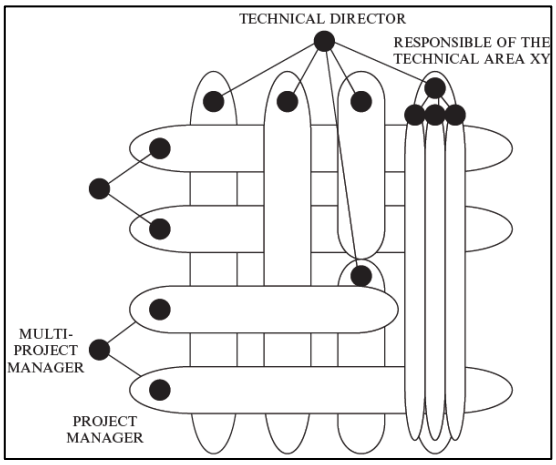


Figure 2.9 Differentiated matrix organizational structure (Nobeoka, 1993)

According to Tonchia (2008), there are two different types of manager in a matrix organization, the line and project manager. The task of the former is to preserve the standards of efficiency characterizing a given functional unit, as well as managing, preserving and cultivating similar resources and competencies, and making them available for a variety of projects within the firm. The task of the latter manager is to exploit all available resources in the best possible way, allocating them to achieve the project goals, and manage extra resources brought in if needed. Inevitably, the two-dimensional structure is anything but simple to achieve in practice, since it goes against the Taylor principle of uniqueness of command. Referring to the fact that an employee should receive orders from one supervisor only (Marume & Jubenkanda, 2016). In case

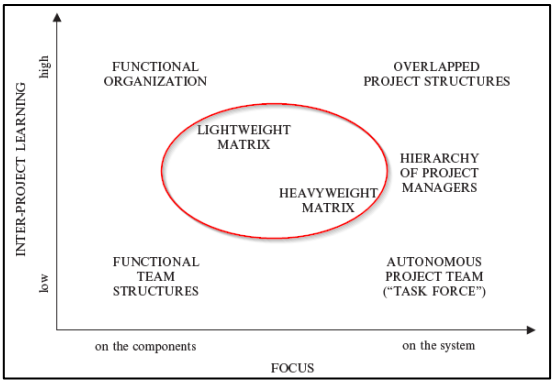


Figure 2.8 Multi-project organizations (Aoshima, 1993)

of limited resources and when there are conflicting demands made by various managers, priority and decisional power issues occur. Aoshima (1993) distinguishes two matrix structures, lightweight and heavyweight (see figure 2.9). In the lightweight matrix, the line manager retains the authority, whereas the project manager has the authority in the heavyweight matrix. Aoshima (1993) classifies types of organizations according to inter-project learning (linked to the transfer of knowledge among projects) and the project's focus (single components or on the system and its connections). Nobeoka (1993) argues that both is possible, where the line and project managers are either light- or heavyweight, while the functions can serve projects in different levels of intensity, distributing their resources among them.

2.2.3 Planning

This section introduces the framework of de Boer (1998) in order to describe the framework of Hans et al. (2003). We use both frameworks since they consider various vertical and horizontal levels and processes.

De Boer (1998) argues that a hierarchical decomposition is required to come to manageable planning processes. He argues that it makes no sense to plan all work at one level, since data collection take too much time. Information would be inaccurate since uncertainty plays an important role. Therefore, he argues that is more appropriate to work with aggregate data for long-term, high-level decisions. De Boer (1998) argues that information becomes available when time goes by, *''thus the longer the period on which decisions must be taken, the more uncertainty in the information will play a role''* (p. 35). In order to break down planning into manageable parts, de Boer proposes four levels: 1) Strategic resource planning; 2) Rough-cut capacity planning; 3) Resource-constrained project scheduling; and 4) detailed scheduling (see figure 2.10).

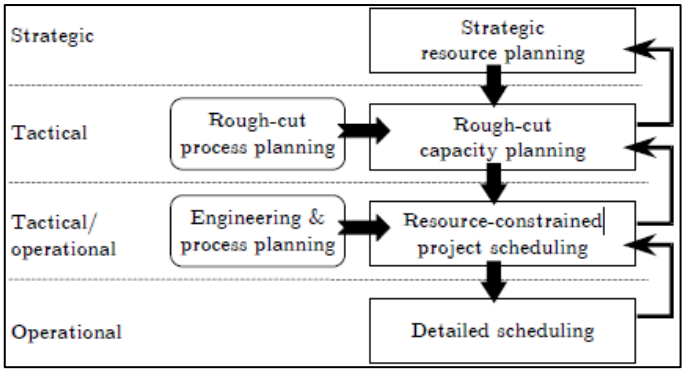


Figure 2.10 Hierarchical planning framework (de Boer, 1998)

Each planning level of this framework has its own time horizon and review interval. The objective of ''strategic resource planning'' is to determine global resource capacity levels. Strategic decisions such as staffing levels, layouts, number of machines and critical resources apply to this level. The planning horizon of such a plan may vary from one to several years and the review interval should depend on the dynamics of the organization's environment. Decisions about due dates and milestones of projects, overtime work levels, subcontracting relate to tactical level, rough-cut capacity level. The rough-cut capacity level focuses on the offer and order acceptance phase of the project life cycle. The planning horizon of the rough-cut capacity planning is about half a year or more, depending on expected projects durations. The next level is the resource-constrained project scheduling. After order acceptance, detailed information about resource and material requirements become available from engineering and process planning. The resource-constrained project scheduling divides and specifies work packages into smaller activities with constant duration, resource rates and precedence relations between activities. The planning horizon of the resource-constrained project scheduling may vary from several weeks to several months.

Hans et al. (2003) proposes a slightly different framework for planning and control partially based on the framework of De Boer. Figure 2.11 shows their proposed framework consisting of three planning levels including strategic, tactical and operational. This framework distinguishes itself in two ways. First, this framework considers not only three hierarchical levels, but includes also supply chain design and warehouse design, and the functional planning area of "Material coordination". Besides, resource-

constrained project scheduling, detailed scheduling and resource allocation both locate at the operational level, since this are two different areas.

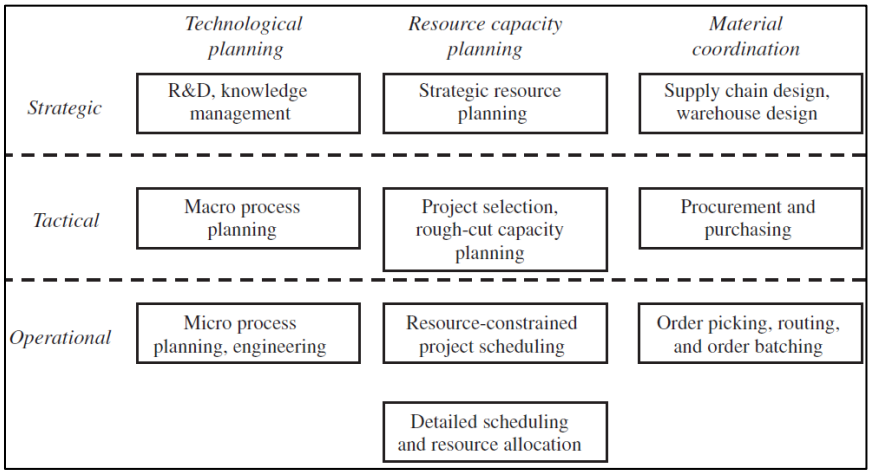


Figure 2.11 Hierarchical Project Planning framework (Hans et al., 2003)

Hans et al. (2003) also describe a methodological framework to position project planning. This framework uses two dimensions (figure 2.12). The degree of variability in the work environment and the degree of dependency of the project. First, variability is in this case an aggregated measure for the uncertainty due the lack of information in the tactical stage and/or operational uncertainties on the shop floor. Secondly, dependency refers to what extent a particular project is dependent on influences external to the individual project. The influences can be from outside the company (e.g. subcontractors, material coordination), but also dependencies from inside like shared resources. Dependency forms here part of the complexity of the planning of a project-based organization. LL projects have a low variability and low dependency that typically relates to a single-project organization. In a LH project environment, many project activities depend on external factors. HL project environments deal with a high variability. HH project environments deal with both and relate to engineering-to-order environments with several complex projects in parallel.

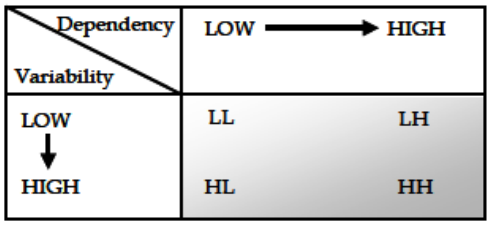


Figure 2.12 Framework for MPE

2.3 Integrated Business Planning

Besides the literature about MPE, we examine the literature about IBP. MPE focusses on the project-oriented aspect where IBP focusses on the functional perspective. Section 2.3.1 provides a description of IBP coordination mechanisms. Section 2.3.2 addresses the integration aspect of IBP. Finally, section 2.3.3 describes the aspects of improvement.

Background

Nowadays, companies continually struggle with misaligned plans and costly inconsistencies between supply and demand in volatile and uncertain times. Therefore, organizational changes are inevitable. Many firms deal with the challenge of establishing a comprehensive plan for each business function to guide the organization in one direction (Wagner, Ullrich, & Transchel, 2014). The difficulty arises from the lack of structure and iterative process for building a single consensus forecast as the basis for all further activities. Therefore, the literature contains concepts such as sales & operations planning (S&OP), S&OP 2.0, advanced/mature S&OP and IBP. Wouters (2009) describes IBP as the step after S&OP. Muzumdar and Viswanathan (2019) supplement this and describe IBP as the evolution of S&OP, which elevates from a purely operational process to a strategic one. Muzumdar and Viswanathan (2009) describe IBP as the key to achieve visibility across the value chain and transform the organization. Bower (2012) argues that IBP is not new. It is just another name of a mature S&OP process. Comparing

forecasts to the operating budget, aligning tactical plans to strategic plans, have a portfolio management process, and going over alternative scenarios for better decisions have always been the vital parts of S&OP (Bower, 2012). Mature S&OP processes expect to identify gaps at the sub-process, which are then vetted, valued, and elevated to senior management for decision-making (Bower, 2012). From a functional perspective, IBP refers to the technologies, applications and processes, which connect the planning function across the company, and improves organizational alignment and financial performance (Singh & Dhir, 2011). These authors define IBP in the following way: *''IBP is a term applied to longstanding objective of finance and corporate executives: to bring together the disparate strands of forward-looking activities across a corporation in a way that fosters internal alignment and enhance agility, enabling it to increase its financial returns and improve its strategic position''* (p. 3). It is exactly what it says: about planning across the entire business in an integrated fashion. To be consistent, this research uses the term ''IBP'' to cover related terms such as S&OP, S&OP 2.0, and advance/mature S&OP.

2.3.1 Coordination

Tuomikangas and Kaipia (2014) distinguish six IBP coordination mechanisms. The first mechanism is the organization. The purpose of this mechanism is to identify the functions involved in IBP. Several essential elements relate to this mechanism such as the formal structure, decision-making, roles and responsibilites, and process activities. Process is the second mechnisms. Purpose of the process mechanism is to define how to create and communicate different sub-plans. This mechanism defines the formal planning activities, decision-making process and the collaboration activities. The third mechanism, tools and data aim to provide the organizaiton with the best-quality information and IT tools to create operational plans. The fourth mechanism is performance management. This refers to measurement, target settting and support to rearch the desired goals. Performance management distinguishes financial, operations, and process performance. Mechanism five is strategic alignment, which serves as link between short-term operational plans and long-term stategic tragets and plans. Finally, the sixth mechanism is about culture and leadership. This mechanism aims to create an organizational culture for succesfull IBP. It includes the organizational mindset and practices such as common aligned business objectives, rewarding and incentives, norms, commitment, trust and empowerment.

2.3.2 Integration

Noroozi and Wikner (2017) describe integration in two directions, vertical and horizontal. Vertical integration refers to linking the strategic plan, business plan, financial plan and long-term objectives to short-term operational planning. Horizontal integration is concerned with the cross-functional integration considering both inter- and intra-company's activities. According to these authors, the realization of this process is bound to the cultural context of the organization. Integration of the various disciplines involves a decision-making process and breaking down organizational silos. To reach balance, it is essential to integrate people from different business areas, both within and outside the company, and provide a platform for inter-/intra-company discussion and decision-making process.

Jurečka (2013) describes IBP as a key platform for operational management, where this platform should not complement, but replaces the multiple planning processes, which are often running in the organizations separately. Companies can benefit from IBP by linking strategy and operations in order to create a close-loop management system. Jurečka (2013) argues that many companies fail to link strategy with operations due to the lack of integration, collaboration, communication and an incentive setting across business units. Singh and Dhir (2011) argue once the company plan reflects the strategy, an IBP process links strategic targets with tactical and operational planning on all hierarchy levels of the organization.

Alignment of different planning processes across the organization and structured management of the gaps between different plans result in a consensus top-down strategy execution and direct bottom up feedback from the marketplace (Jurečka, 2013). According to Wagner et al. (2014), IBP consists of two main components to create horizontal alignment: 1) sales plan, based on forecasted demand, and 2) the manufacturing plan, referring to capacity requirements, inventory levels, and or order backlogs. Muzumdar and Viswanathan (2009) highlight this integration and argue that IBP can be the key to achieving visibility across the value chain. In order to align processes, it is crucial to consider the company strategy to determine the process focus. Figure 2.13 shows three basic IBP set-ups to direct organizations in specific strategic direction.

Generic strategy	Focus	Leading business function	Key Performance Indicators
Cost Leadership	• One number principle for supply • Volume • Costs • Inventory minimization	• Supply Chain/ Operations • Finance	• Forecast accuracy • Redution of forecast bias • Inventory turns • Asset ustilization
Focus on customer relations	• Sales planning • Impact of promotions • Customer segmentation • Risk and opportunities management • Revenue growth	• Sales • Supply Chain/ Operations	• Customer retention • Customer revenue/ profitability • Inventory turns • Delivery reliability
Product/ Service Differentiation	• Scenario planning • Product development • Portfolio management • Risk and opportunities management • Profit growth	• Marketing	• Profitability and revenue growth from new products • Brand value and health • Time-to-market • Inventory obsolence

Figure 2.13 Strategic focus per strategy (Jurečka, 2013)

Green, Giorgio, and Genever (2012) consider two dimensions of integration. Firstly, process integration by translating strategy into execution, so the vertical dimension. Secondly, functional integration, which promotes cross-collaboration between the different functions of an organization. Figure 2.14 shows this relationship. Green et al. (2012) argues that the degree of integration across functions depends on a number of factors such as the size of the organization, operating model, the inherent complexity and the industry. In addition, they describe two primary enablers to consider. First, ''data'' is critical for process and functional integration. This requires consistency of definition from a data set and dimensional perspective. Secondly, ''technology'' can be an efficient and effective mechanism for sharing, transferring and using data and information. Finally, by integrating processes, data and technology across functions the organization can be more nimble and dynamic when making resource allocation decisions.

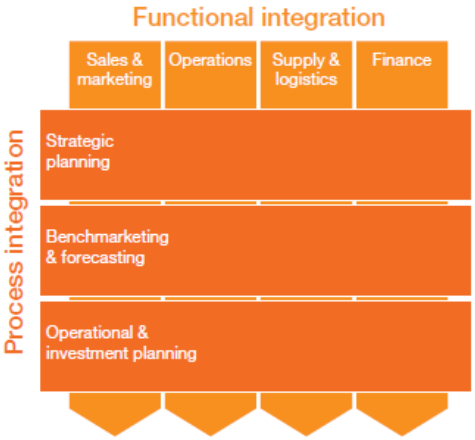


Figure 2.14 The two primary dimensions of IBP (Green et al., 2012)

2.3.3 Improvement

Maturity

Wagner et al. (2014) developed a maturity model in order to improve business processes. This model uses a holistic approach that helps firms to assess their internal IBP processes. It provides a pathway for a better-aligned organization. According to these authors, better aligned operational and strategic plans and a better balance of supply and demand bring tangible benefits to organizations. Therefore, they developed a model with four dimensions, several sub-dimensions and six levels of advancement (see figure 2.15). First, process effectivities refers to the characteristics and activities that an IBP process should include. Details aspects of how to integrate and align a set of plans with minimal effort refer to

the second dimension ''process efficiency''. Thirdly, empowering all members of the cross-functional team, gaining top management support and sponsorship, and managing employees' attitude toward IBP are aspects of people and organization. The last dimension, information technology acts as that is necessary to support the scale needed to achieve all of its benefits. Wagner et al. (2014) argue that many companies face the issue of establishing a comprehensive plan for each business function to guide the organization in one direction. Therefore, the model helps organizations to create a pathway towards an IBP. It helps firms to successfully align organizational plans from the demand-side, supply-side and financial, avoid costly mistakes and satisfy customers through better service levels.

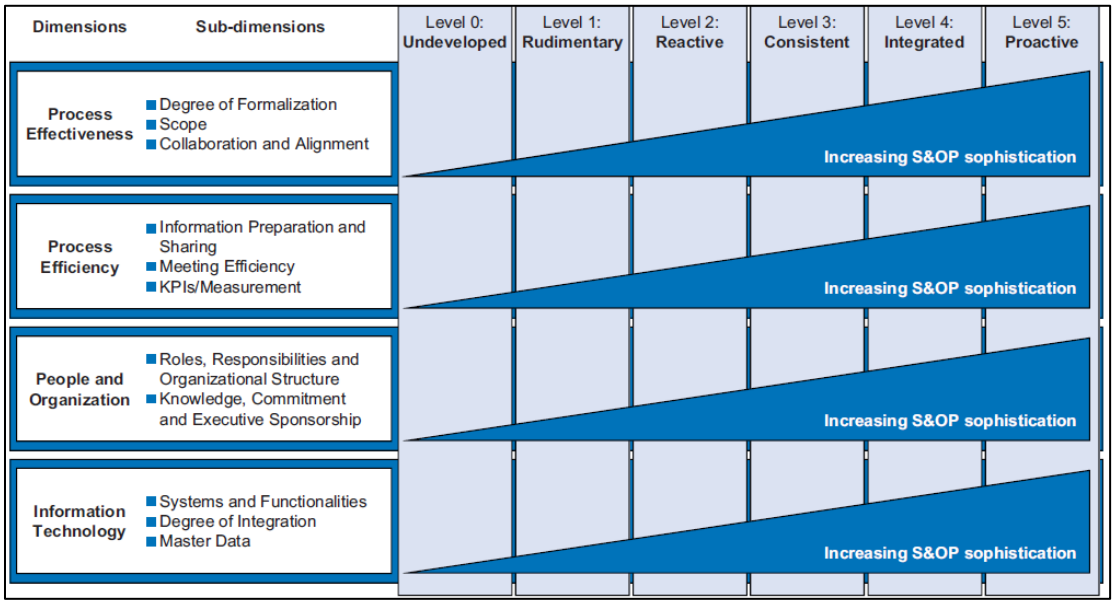


Figure 2.15 Maturity Model (Wagner et al., 2014)

Measurement

According Singh and Dhir (2011), the planning process of each organization must provide the entire organization with the ability to integrate business planning and forecasting, resulted in better coordination in establishing plans consistent with the corporate strategy. Hulthén, Näslund and Normman (2017) argue that IBP results in a focus on the long-term to identify future needs, higher level planning process, senior management involvement and cross-functional integration. Noroozi and Wikner (2017) describe two type of IBP benefits, soft and hard. Soft benefits are difficult to measure. This group refers to benefits like improved visibility, better cooperation between staff and management and between different functions of a company, improved organizational behavior and better decisions with less effort. Benefits like improved turns and improved service, better forecasts accuracy, reduced out-of-stock, reduced inventory, improved portfolio management, improved operational performance and optimized customer service versus inventory level and cost belong to the second group, the hard benefits. Finally, Thomé, Scarvada, Fernandez and Scarvada (2012) categorize IBP goals into three categories concerning 1) alignment and integration, 2) operational improvement, and 3) results focused on single perspective. Their research concludes that the most important goals refer to alignment of demand and supply (plans), improvement of functional plans and managing uncertainty and risks.

Many companies deal with the exchange of planning data, since they have to make ''translations'' between levels and characteristics, resulting in a lot of work and department-based planning. In order to implement IBP successfully, companies need to build and deploy specific best practice capabilities to enable and effectively execute key levers such as demand shaping and trade promotions, lead-time reduction, and inventory optimization (Muzumdar & Viswanathan, 2009). These authors refer to three core IBP capabilities adapted from the Aberdeen Group concerning process, organizational and technology. For inter-/intra-company discussion and decision-making during the S&OP achieve balance, it is crucial to integrate people from different related disciplines, both within and outside the company, and provide a platform process (Noroozi & Wikner, 2017).

Conceptualization and positioning of IBP

Recently, Lahloua, El Barkany and El Khalfi (2018) reviewed the literature on IBP. They argue, if organizations experience opposites and conflicting objectives. Furthermore, a lack of cross-functional integration between processes and no defined process for arbitrating conflicts. These authors describe different frameworks to conceptualize and position IBP. Appendix D shows the frameworks. Below, we describe two frameworks.

The first model, we explain is from Wagner et al. (2014). Their approach brings together all business plans. Figure 2.16 illustrates this by linking vertical and horizontal plans. They describe that IBP is *''an ongoing process of monthly planning, reviewing, and evaluation to generate one set of integrated profit maximizing plans by ensuring the involvement of all key stakeholders''* (Wagner et al., 2014, p. 182).

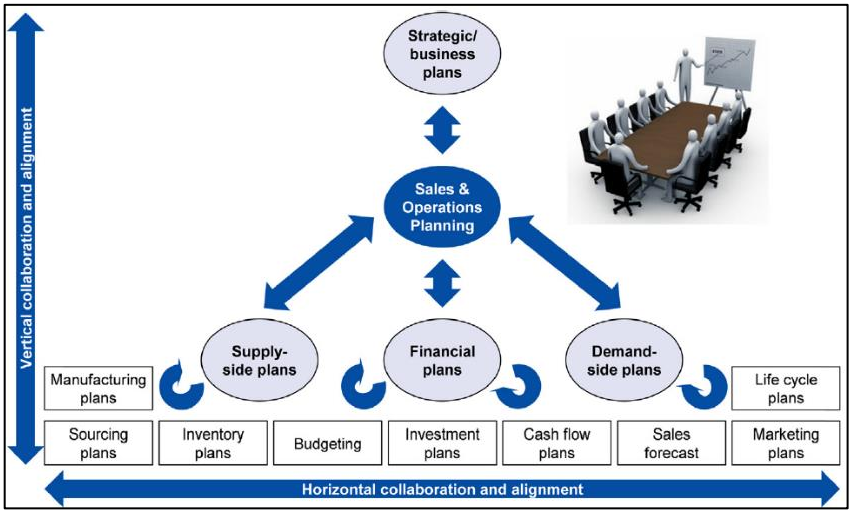
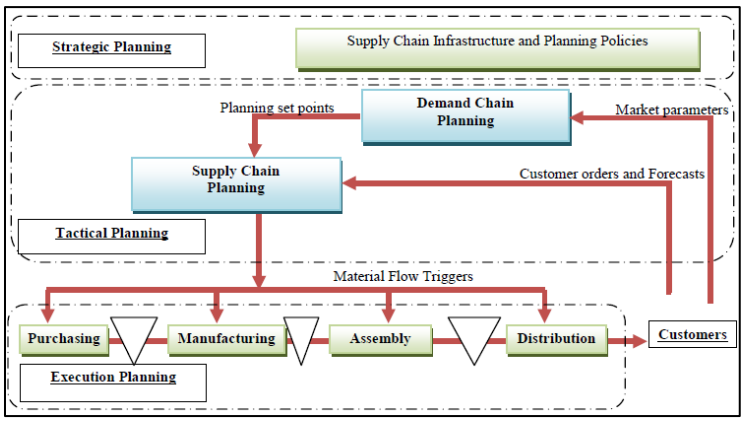


Figure 2.16 IBP framework (Wagner et al., 2014)

Figure 2.17 shows the model of Landeghem and Van Maele (2002). This model distinguishes three levels, strategic, tactical and operational. They argue that it depends on the availability of information and certainty of it, which decision to take (see figure 2.17, right).



Sources of uncertainty in the supply chain (●) low-(●●) medium-(●●●) high leverage of decisions

Sources of uncertainty	Operational	Tactical	Strategical
Exchange rates	●●●	●●	
Supplier lead-time	●	●●●	●
Supplier quality	●●	●	
Manufacturing yield	●●	●●	
Transportation times	●●	●●	●
Stochastic costs	●	●●●	●●
Political environment			●●
Customs regulations	●	●●	●●●
Available capacity	●●	●●	●
Subcontractor availability	●●●	●●	
Information delays	●●●	●●	
Stochastic demand	●	●●●	●●
Price fluctuations	●	●●●	●

Figure 2.17 IBP framework (Landeghem & Van Maele, 2002)

Subsequently, the models of figure 2.16, 2.17 and appendix D have some shared characteristics. Most IBP frameworks focus on the integration and alignment of vertical and horizontal processes. All the frameworks show where IBP connects processes. The purpose distinguishes the different frameworks from one another, such as coordination, decision-making or purely integration. For example, the framework of figure 2.17 focusses on decision-making. The framework of Wagner et al (2014) focusses on the integration aspect. Besides, certain models are more supply chain driven or sales/marketing. At the end, Lahloua et al. (2018) conclude that the main purpose of IBP is *''to develop tactical plans that strategically ensure businesses gain competitive advantage on a continuous basis by integrating the different levels of the company (sales, marketing, development, manufacturing, procurement, and financial) in an integrated set vertically and horizontally''* (p. 186).

2.3 IBP & MPE

In this section, we describe the basic aspects of the previous sections related to Company X. Afterwards, we describe where we apply the literature about IBP and MPE in this research.

Basic characteristics

First, we describe ''project management'' to introduce multi-project management. At Company X, we speak about an MPE, as there are about 75 to 90 in progress at the same time. Based on the typology of Evaristo and Fenema (1999), Company X executes ''multiple traditional projects''. Because there are multiple projects in execution across multiple locations. We describe different challenges and drivers to highlight the complexity of MPE. Company X deals with many of the challenges and can use certain drives to improve their processes. For example, within this research we show that Company X deals with different types of complexity and the resource allocation problem. As we describe in section 2.2.2, there are three organizational structures, where Company X has a matrix structure. Thereby, Company X combines a lightweight and heavyweight structure, since most decisions are situation-dependent.

Use of literature

Figure 3.18 shows the application of the literature in this study. On the left side, we visualize the literature about IBP and on the right side of MPE. We apply aspects of IBP in the desired situation. We describe topics such as ''project management'', ''multi-project management'' and ''project life cycle'' in order to introduce the other topics. Appendix F provides the literature assessment that indicates which articles the author of this research uses per sub-question.

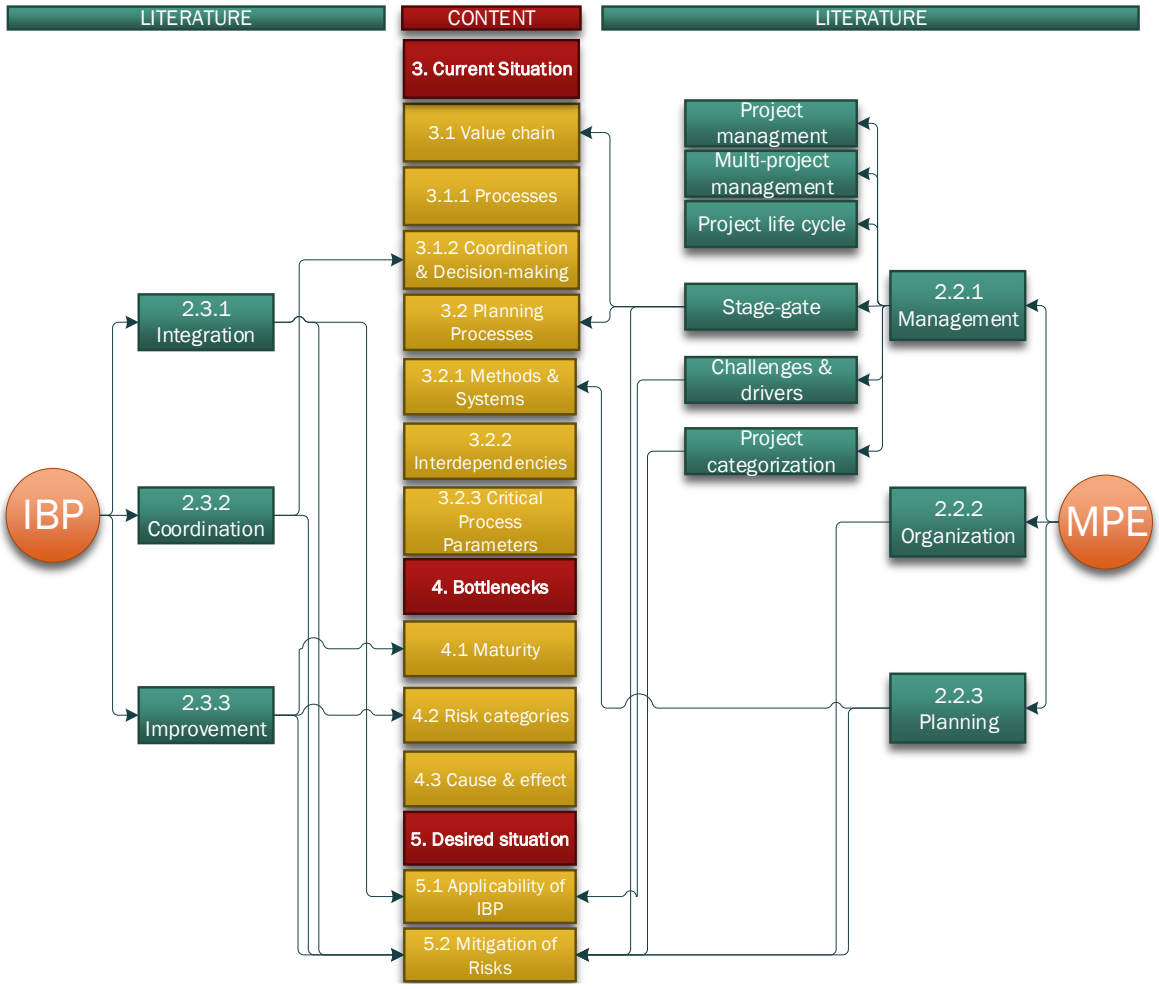


Figure 2.18 Use of literature related to content

2.4 Conclusion

Nowadays, when organizations manage multiple projects simultaneously, one speaks of an MPE. Organizations deal with matters such as prioritizing, accepting and allocating of projects in an uncertain, complex and dynamic environment. Every project follows comparable stages such as order acceptance, engineering and process planning, material and resource scheduling, execution and the evaluation.

Many firms are not aware they use a categorization until someone shows what it might look like. Research shows that organizations categorize projects for two reasons, strategic alignment and capability specialization. Most crucial challenges are complexity and resource allocation. Thereby, complexity has many different definitions. In case of resource allocation, authors describe various ways to allocate resources based on two dimensions. This concerns centralized-decentralized and human-automated decision-making. Thereby, resources exposure different risk levels. The literature distinguishes results-related, process- and resources-related success factors. Simultaneously, multiple factors are a challenge for organizations.

A matrix structure is a helpful organizational structure in an MPE. Within a matrix structure, organizations use a combination of the functional structure and pure project organization, attempting to combine the advantages of both and to avoid some of the disadvantages. In this structure, functional departments operate as workstations and projects are jobs that flow between the workstations. Two matrix structures can be distinguished, light- and heavyweight. In the lightweight matrix, the line manager retains the authority, whereas the project manager has the authority in the heavyweight matrix.

Within an MPE, organizations distinguish three levels of planning. They schedule detailed activities on operational level, plan resource on tactical level and define strategic objectives at the strategic level. On horizontal level, organizations distinguish technology, resources and material planning.

An IBP strives towards horizontal and vertical integration by linking the different disciplines and translating strategic plans into an operational way of working focusing on the processes, technologies and people. It is about planning across the entire business in an integrated fashion. IBP strives for better alignment of organizational plans, better coordination and integration between and with the different processes and strategy.

Coordination has a crucial role in an IBP. Authors refer to various coordination mechanisms such as the organization, process, tools and data, performance management, strategic alignment and culture and leadership. Authors describe integration into two directions, vertical and horizontal. Vertical integration refers to the integration of the strategic, tactical and operational level. Horizontal covers the cross-functional integration. Therefore, it is essential to integrate people from various disciplines. IBP can serve for different functions such as platform for strategy execution, operational management or as gap management process. To identify gaps, organizations can assess their processes using a maturity model.

Organizations can achieve different benefits and goals. Authors define hard and soft benefits, where hard benefits are measureable and soft are not. At the end, the most goals refer to the alignment of demand and supply, improvement of functional plans and managing uncertainty and risks. Finally, the literature provides various frameworks to conceptualize IBP. For a certain extent frameworks are comparable, but they distinguish themselves by which they are driven and the application.

If we take IBP and MPE together, we can conclude that IBP sets the parameters, MPE focuses on the content-related aspect. IBP strives for optimal coordination and integration of horizontal and vertical process, and offers the guidelines for improvement. MPE focuses on the content-related (how aspect) by describing how to deal with the management, organization and planning of projects.

3. Current situation

In this chapter, we describe the current situation of Company X. Section 3.1 describes the value chain processes. Section 3.2 gives a description of each planning process. Section 3.3 shows the critical process parameters. Section 3.4 provides the conclusion of the current situation. We obtained insights trough specific literature, interviews and review sessions. Appendix C contains the results of the interviews and review sessions. Appendix G shows one of the processes as example. Every process has been worked out in a similar way.

3.1 Value Chain

This section starts with a broad, overarching approach to describe the value chain. Afterwards, we use the stage-gate process to describe and visualize the macro process. The last part of this section provides a description of how coordination and decision-making take place.

3.1.1 Processes

To introduce the processes, we use the approach of Porter to distinguish processes in two type of activities, primary and support. Porter's value chain focusses on systems, and the change of inputs into outputs purchased by clients. Primary activities relate directly to the physical creation, sale, and maintenance of a product of service. Support activities support the primary functions such as procurement and technology development. Figure 3.1 shows the primary and support activities of Company X.

Figure 3.1 Value Chain COMPANY X

Under the value chain-concept, we divide research into a three level value-creating process. Firstly, operational design focusses on the primary activities. Secondly, functional design relates to the coordination of functions. Thirdly, anticipative design uses both, focusing on the entire value chain (Mozota, 1998). This research focusses on the functional design.

Stage-gate

We use the stage-gate process to define, simplify and structure the macro process of Company X. This model serves as overarching model, which combines project management tasks in the stages such as team initiation, critical path and milestone review points (Cooper, 2008). This because, we do not analyze the detailed activities, but the relationships between the various processes. According to Cooper (2008), a value stream is simply the connection of all the process steps with the goal of maximizing customer value. In this section, we use the process to introduce the value stream of Company X. Figure 3.2 shows the different stages and gates. We describe the different stages in this section. Section 3.2 contain the milestones referring to the ''gates'' of the stage-gate process. We use the term "milestone", since Company X uses these moments more to indicate an event in time than a gate with certain criteria. Subsequently, it is the need to define "gates" to improve (process/project) monitoring, integration and risk management. Appendix H contains an expanded representation of the stage-gate process.

Relationships

Besides the stage-gate process, we show the relationships between the different primary (square) and supporting (round) activities in figure 3.3. This figure shows the ''formal'' relationships between the primary and supporting activities. It shows one department relates to another department. The direction of the arrow indicates the initiator of the activity.

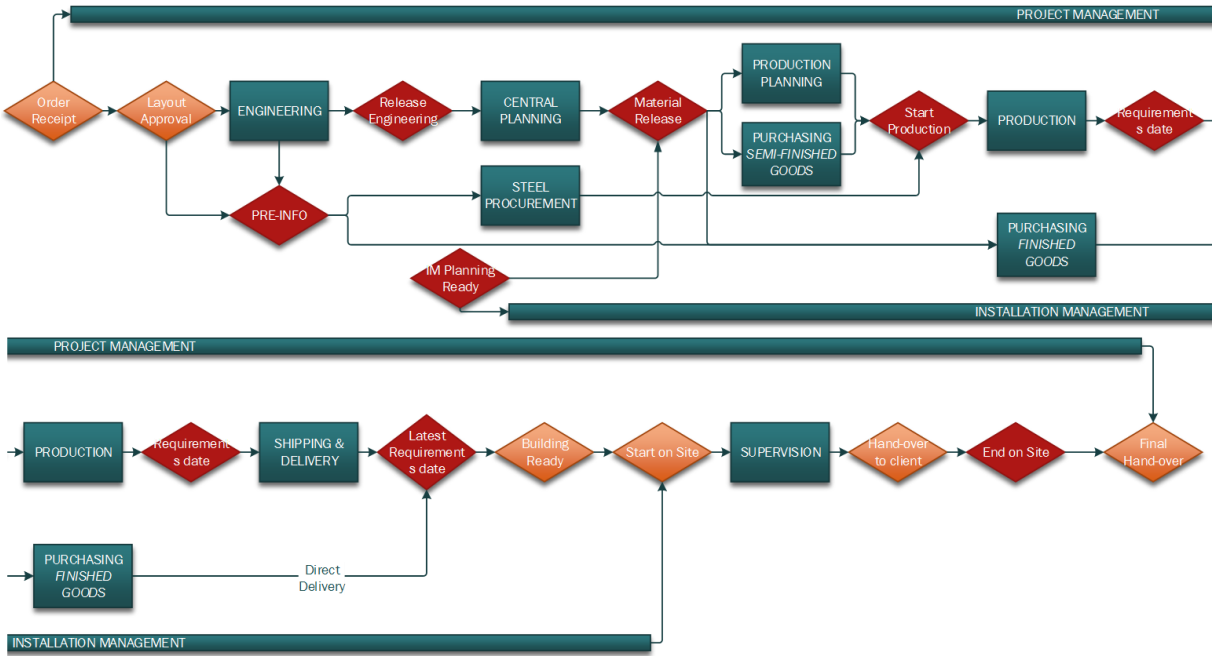


Figure 3.2 Stage-gate model

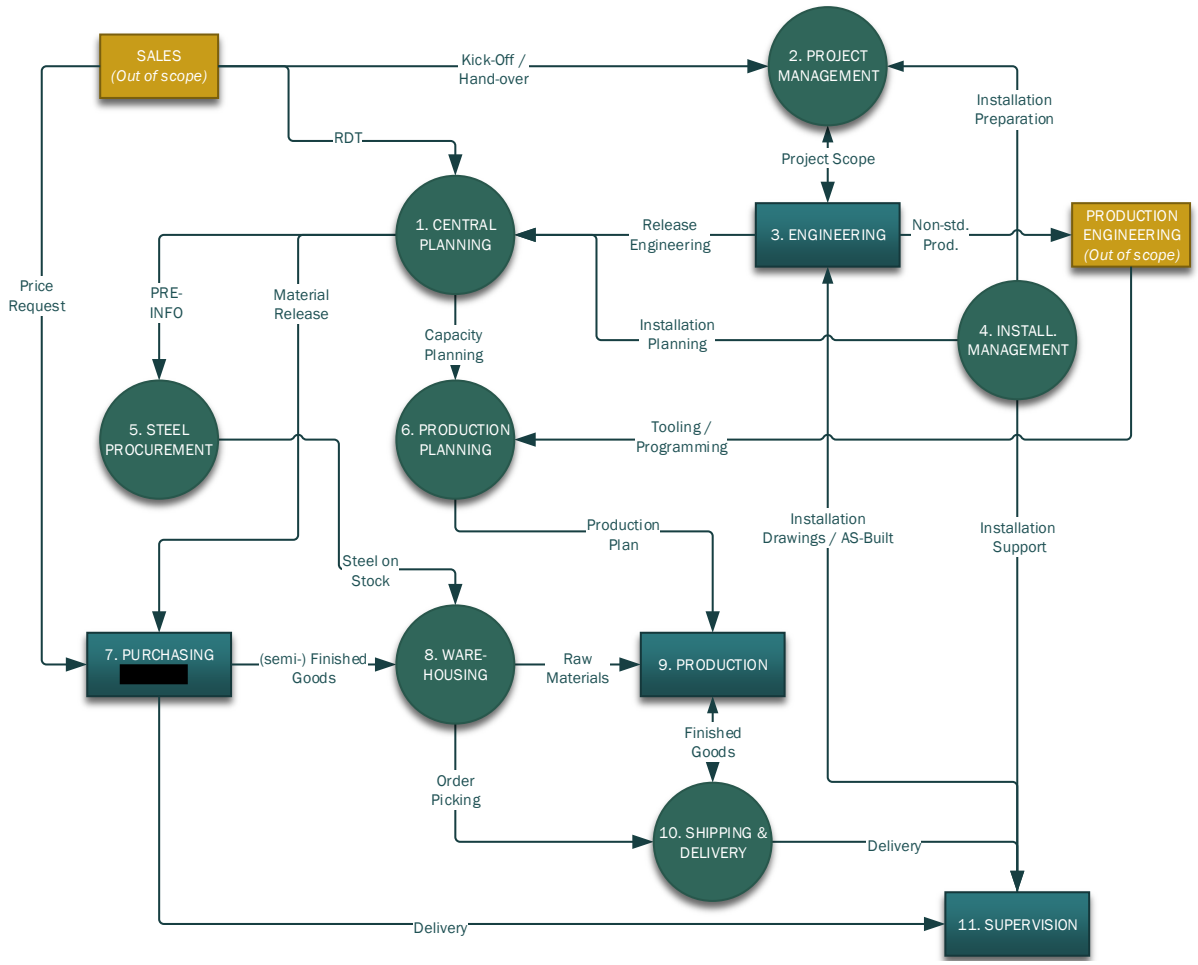


Figure 3.3 Relationships

1. Central planning
Central planning coordinates activities in two phases. Offer & order planners plan in the sales phase and project planners in the execution phase. In the sales phase, they ensure a balance between in supply and demand through a capacity planning (known as ''overall planning). They manage demand by registering RDTs (request for delivery time) and supply by setting capacities based on availability of resources (human and technical). Central planning performs the ''material release'' after receiving the installation planning and the release of engineering. With the material release, central planning creates delivery schedule. As output of the material release, they create requisitions for purchasing and planned orders for production planning. In practice, central planning deals with different issues. Engineering performs partial releases, installation delivers the planning in different formats and the RDT is not always up-to-date and/or complete.

2. Project management
Project management has the responsibility to ensure a controlled project execution. The process starts with a kick-off arranged by sales. The process ends with a final hand-over to the customer. Project managers work with a project team consisting of engineers, installation manager and supervisor. Together they ensure a timely delivery of the project at minimal costs with reliable quality to satisfaction of the customer. Project managers participate in and/or organizes meetings, coordinate relationships with the client/ supplier/ subcontractor and coordinate the internal processes. Project managers deal with all type of challenges, since they are responsible for the projects. At this moment, project management has no central system to manage milestones, these are scattered across various systems. As a result, there is limited control and milestones are not always achieved.

3. Engineering & Structural engineering
Engineering translates customer requirements into technical specifications. Structural engineering verifies and provides support regarding the feasibility of the technical solution. Many of the activities that take place within this department have an impact on other departments, such as purchasing, production and installation. At the main level there are two phases, layout and detail engineering. Layout engineering takes place before an approval of the customer and detail engineering afterwards. Now, the process of engineering is not optimally in line with other processes. For example, there are often partial releases that hinder central planning to perform the material release and production/purchasing to start producing or purchasing.

4. Installation management
Installation management involves in projects from the kick-off until the hand-over to client. Installation managers perform preparatory activities until the start on site and support supervisors during installation. They contract subcontractors for installation and take responsibility for the safety aspect. Installation managers deliver the installation planning to central planning and create together a delivery schedule. This department faces the challenges of the coordination between engineering, installation and supply chain. For example, it occurs that engineering release specifications in the wrong order or that supply chain delivers the products on the wrong moment on site.

5. Steel procurement
Steel procurement reserves and purchases steel for production. They reserve steel based on RDT's and purchase it based on the ''pre-info'' they receive from central planning. Once a quarter, steel procurement negotiates with the steel supplier about steel requirements. Therefore, steel procurement must have a prediction in order to negotiate about quantity and prices. On daily basis, they purchase steel after receiving the pre-info. At this moment, steel procurement faces different challenges. For example, there is limited insight on the long-term. Sometimes this lead to the issue that there is insufficient steel on stock. If Company X receives an order from the customer unexpectedly, this can result in a long delivery time and therefore a process delay.

6. Production Planning
Production planning determines when, what and how to produce. Central planning manages the capacity levels and deliver the input through planned orders. Production planning assigns a ''batch'' number to each planned order in order to create a production plan. Production engineering delivers specific tooling and/or programming, if necessary. Production planning transfers once a week the production plan including the necessary programming, tooling and packaging instructions. Production planning regularly experiences the issues of non-standard items. This means that they have to request new tooling and programming, with as consequence process delay. If this occurs, engineering did not take its responsibility by applying for non-standard items.

7. Purchasing NL & CZ
Purchasing translates requisitions into purchasing specifications. They inform suppliers based on the pre-info about potential purchasing items. After the material release, purchasing selects a supplier and purchases the items. Suppliers deliver the items to the production location or direct on site, depending on the type of product. Purchasing regularly experiences the problem of late involvement into the process. As result, purchasers receive late in the process information of critical items (long lead-time). As effect, there will be negotiations about delivery time instead of price.

8. Warehousing
Warehousing takes care of the stock items and the receipt of (semi-) finished goods and raw materials. They check the quality and quantity of deliverables and prepare it for production and/or shipping & delivery. They are the chain between procurement/purchasing and production/shipping.

9. Production
Production receives the production plan from production planning. Production converts raw materials and/or semi-finished goods into finished goods based on specifications delivered by production planning. The production process contains three sub processes concerning profiling, welding and coating. The packaging process is the next step after the last production step. The first two sub processes process batches based on type of profile. The coating process uses batches based on color.

10. Shipping & Delivery
Shipping and delivery receives finished goods from production and warehousing. They take responsibility to deliver the right goods, at the right site at the right moment in time. Shipping and delivery distinguished three types of transport. They arrange the first two types of transport, container or truck. Type 3 concerns transport arranged by the customer itself. Shipping and delivery serves as chain between production/warehousing and supervision.

11. Supervision
Supervision takes care of safe and complete installation. Supervisors are the representatives of Company X on site for external parties such as the subcontractor (installation partner) and suppliers. They manage the progress, scope and quality and report this to the project manager. Additionally, an installation manager supports the supervisor during installation. Supervisors regularly experience delivery problems. Products arrive too early or too late on site, which is not desirable in both cases.

3.1.2 Coordination & Decision-making
In the current situation, Company X uses various coordination mechanisms. Tuomikangas and Kaipia (2014) distinguishes six IBP coordination mechanisms. We use the six meachisms to describe the coordination and decision-making process of Company X. Decision-making is in this sense part of the ''process'' mechanism.

1. Organization

The ''organization'' mechanism refers to the formal organizational IBP structure. Purpose of this mechanism is to identify the involved actors and functions. At Company X, we can distinguish three actors and functions. First, the project manager is responsible for the projects. A project manager is the connection between internal departments and external parties. Central planning coordinates between different processes. Through the role of central planning as link between various processes, the project manager has fewer communication lines and therefore a more centralized coordination process. Thirdly, there is a project team consisting at least of a project manager, installation manager, engineer, structural engineer and a supervisor.

2. Process

The '''process'' mechanism relates to the formal and standardized process for conducting IBP. The purpose of this mechanism is to define how to create and communicate different sub-plans. It deals with aspects such as collaboration and decision-making. At this moment, there is no or limited integration between planning processes. Below, we briefly describe how people collaborate through the various ''formal'' meetings and how people make decisions.

Collaboration

Periodically, formal and informal meetings take place. At the start of a project, there is a kick-off and/or hand-over from sales to project management. At the end, there is sometimes a project evaluation. Between these meetings, the design review meeting and hand-over to installation take place. Besides this, there are other formal and informal meetings to evaluate for example the project status, changes and so on. Figure 3.4 shows these meetings in sequence.

Figure 3.4 Formal project meetings

Decision-making

Company X has a decentralized decision-making process. There are different planning systems to manage milestones without a link to an overall system. It depends on the type of project and context, who makes the decision. If, for example, it is a matter of allocating resources to projects where priorities need to be set, it makes sense that the project manager sets the priorities and makes the decision and/or delivers input. On the other side, when it comes to the pre-production of goods for a particular project(s) in order to balance capacities, it is logical that the functional manager makes this decision.

3. Tools and data

The mechanism ''tools and data'' aims at providing IBP with best-quality information and purposeful IT tools to create operational plans. Since departments have their own planning system, there is a scattered planning landscape at Company X. Each department receives input via different channels for their planning. There is no centralized system to share information. At this moment, the RDT serves as tool to manage the rough planning of a project, underlying there are several planning processes managed various departments.

4. Performance management

This mechanism defines the methods and activities for performance measurement, target setting and support for reaching the desired situation. Within Company X, most departments have their own performance measures without a link to a central system. Departments measure the performance of their own department and do not make a link to other departments. For example, purchasing measures the quality of deliveries and production uses measures such as the ''overall equipment effectiveness''. Departments focus mainly on their own targets.

5. Strategic alignment

The fifth mechanism ''strategic alignment'' refers to a vertical link between short-term operational plans and the organization's long-term strategic targets and plans. At this moment, there is limited strategic alignment. Horizontal and vertical processes are not consistent and are limited aligned. Through the current way of working, there is also limited transparency. We elaborate further on this point in section 5.1 by linking strategy with projects and processes.

6. Culture and leadership

This coordination mechanism aims at creating an organizational culture favorable for a successful IBP. It includes aspects such as the organizational mindset, practices that facilitate planning and commitment. As mentioned, Company X has the statement ''*If it can be done, consider it done*''. This is visible in the behavior and mindset of the people. With this, Company X strives to solve each storage problem regardless the complexity and context. The result is paramount, meeting the customer's wishes. In doing so, Company X tends towards a ''result-oriented'' organizational culture. Thereby, results are more important than rules and procedures (Quinn & Rohrbaugh, 1981). The power of this culture is the flexibility and a result-driven focus. The bottlenecks phase (chapter 4) confirms this, as many risks relate to the dimensions of process ''effectiveness'' and ''efficiency''.

3.2 Planning Processes

This section describes the different planning processes. Section 3.2.1 provides the methods and systems. Section 3.2.2 shows the interdependencies using milestones. Where the previous section focusses on the ''stages'', activities per department, this section addresses the ''gates'' by describing the planning processes.

3.2.1 Methods & systems

In order to understand the planning processes, we use the framework of Hans et al. (2003) to describe the different planning processes of Company X. Figure 3.5 shows the different planning processes on tactical and operational level. At this moment, the strategic level and technological planning are not applicable (N/A).

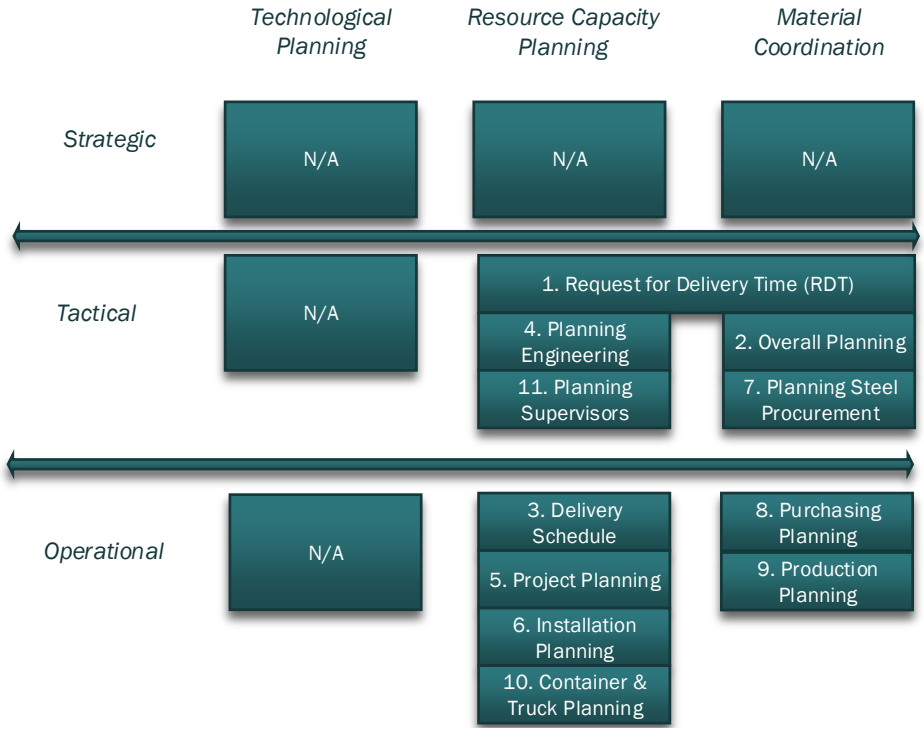


Figure 3.5 Planning Processes based on the framework of Hans et al. (2003)

1. Request for Delivery Time (RDT)

Managed by Central Planning, Resource Capacity planning on short-medium term

The RDT is a rough planning of the project. Sales requests a RDT in the sales phase if a potential project meets certain criteria such as probability, days before closing and size. At this moment, central planning uses the RDT as planning for setting milestones until the release of engineering. The aim of the RDT is to find the perfect balance between the project requirements and the possibilities of production, engineering, installation and suppliers in order to optimize the material and resource flow in early project phase (Company X, 2019)[3]. Information to complete this comes from different departments such as engineering, production, purchasing and central planning. This planning works in two directions, forward or backward. Forward planning applies if the project is in the long term. Backward if execution of the project is in the short term. In both situations sales indicates when the order is expected and when the installation starts on site including the duration of installation. Backward planning plans back from installation until engineering. Forward planning starts with engineering and plans until installation. Appendix B shows the RDT form, workflow and backward/ forward planning. In general, forward planning applies to the offer phase. Backward planning in the order phase when it concerns detailed scheduling. At this moment, several departments mention that this planning tool is not complete and accurate enough. Information in RDT's is not always up-to-date or lack information. For example, no or limited information about critical items or non-standard production items. Above all, it results in manual actions for each department, as there is no integration.

2. Overall planning (a.k.a. Offer & Order Planning)

Managed by Central Planning, Resource Capacity planning on medium-long term

This planning manages the production capacity of each production line in the short and long term. They register RDT's and synchronize released order automatically from SAP to manage demand. Through a manual action, register planners RDT's, but also to remove it, after SAP synchronizes released orders. On the supply side, they set periodically limits for production capacity based on availability of resources (human, operators and technical, machines). Figure 3.6 shows the capacity of the production line ''ML3 Shelves''. The red line indicates the planned capacity and green line the budget capacity. The bars show the demand divided into released orders, planned orders (RDT) and offers (RDT).

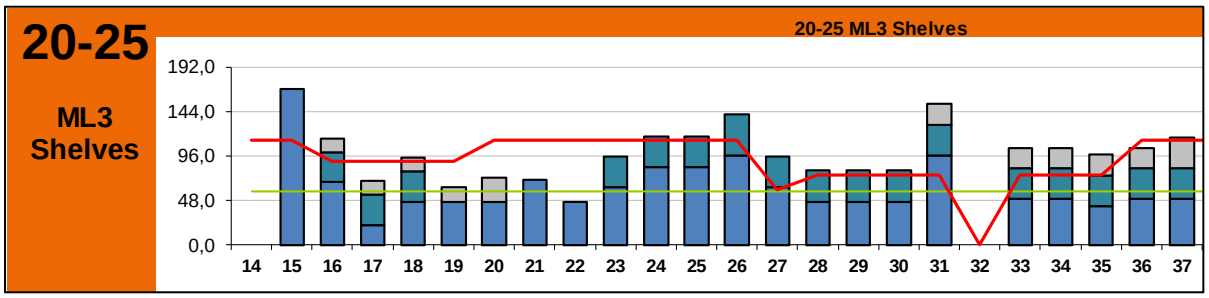


Figure 3.6 Occupancy chart per system

Figure 3.7 shows the input for the overall planning. The details come from the material list. This material list is an attachment of the RDT and delivered by sales. Per production line, it requires different details per week. Offer and order planners complete the white cells. The system automatically calculates the grey cells. Weekly meetings between production planning and central planning take place to manage the planning. The challenge within this planning is to keep it up-to-date. This takes a lot of time because they register RDT's manually. In general, this makes it very prone to errors, mismatches.

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Figure 3.7 Project input overall planning

[3] Source derived from the intranet (not publicly available) of COMPANY X

3. Delivery schedule

Managed by Central Planning, Detailed planning on short-medium term

The delivery schedule determines when what goods to deliver on site. A delivery schedule shows per project which goods must be ready for transport (known as the milestone ''Requirements date'') and when which goods need to be delivered on site (known as the milestone ''Latest requirements date''). The requirements date indicates when production and/or purchasing need to be finished. The latest requirement date determines when items need to be unloaded on site. The requirements date sets the latest requirements date based on location circumstances (country, city, and type of transport). A project planner prepares the delivery schedule in cooperation with an installation manager, so they agree when to deliver which finished goods on site.

4. Planning Engineering

Managed by Engineering, Resource Capacity planning on medium-long term

This resource planning engineering shows the allocation of engineers, structural engineers and project managers to projects. This planning manages demand by registering RDT (offers and orders) and offers without RDT. Sales communicates this via personal communication or by sending an email.

												Structural Report		Approval	Release	First Delivery	Handover
Projects	Order	Hide	Client	Location	Country	Turnover	SE Budget	Engineering budget	PM	IM	SE	Yes/No	date	date	date	date	date
[redacted]	Yes	Yes	Miscellaneous		CH	[redacted]					PWE	No	31-12-18	31-12-18	31-12-18	31-12-18	31-12-18
	No	Yes	Vanderlande		BE							No	31-12-18	31-12-18	31-12-18	31-12-18	31-12-18
	Yes	No	Witron	Bakersfield CA	USA				MSP	RVS	JHR	Yes	31-07-18	31-07-18	31-12-18	01-04-19	01-04-19

Figure 3.8 Project input

Within this planning, they register the customer, location, country and system. They track hours and manage certain milestones in this planning. Figure 3.8 shows the milestones such as structural report, approval/pre-info, release prod/purch., first delivery and provisional handover. Together with the sales department monitors the manager of engineering the planning on a weekly basis.

5. Project planning

Managed by Lead Engineer, Detailed planning on short term

A lead engineer creates the project planning to indicate when which engineering activities to perform in time. The project engineer uses his experience to create the planning. Where the ''planning engineering'' includes the start and end date of a project, manages this planning the detailed activities between the start and end date. Sometimes this planning aligns with the installation planning. We distinguish two phases within the planning concerning ''layout'' engineering and ''detail'' engineering. Layout engineering links the milestone ''Layout Approval''. Detail engineering starts after this milestone and ends with the milestone ''release engineering''. Currently, there is no uniformity in the preparation of the project planning. Lead engineers use their experience to create this planning. At the end, there is no procedure available.

6. Installation Planning

Managed by Installation Manager, Detailed planning on short term

The installation manager prepares the installation planning. This planning shows the installation order see figure 3.9 as example. As indicated, an installation planning aligns sometimes with the project planning; however, this is not always the case. Different people argue that this has to do with the complexity and size of a project. On the other side, there are no agreements how to prepare this. Subsequently, this planning influences all other detailed schedules. Since this planning determines when ''engineering'' has to perform the release. When ''production and purchasing'' need to finish the products and when shipping needs to deliver.

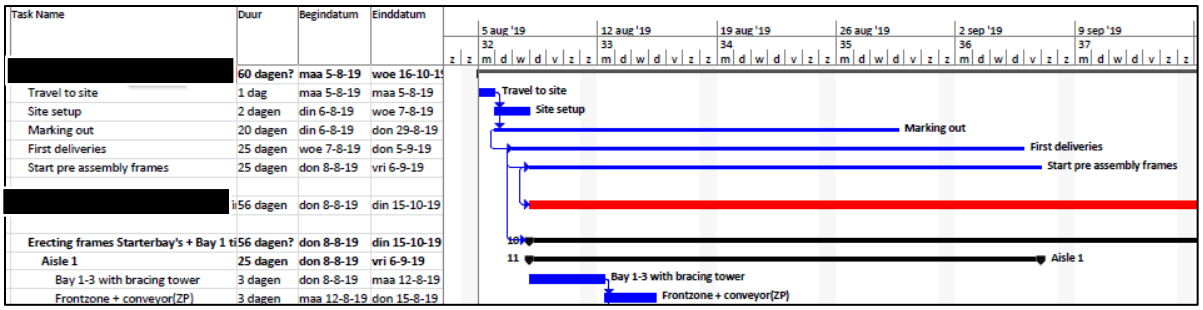

Figure 3.9 Snapshot installation planning

7. Steel Procurement planning

Managed by Steel Procurement, Resource Capacity planning on medium term

Steel procurement makes steel reservations on the long-term (quarterly). Therefore, they negotiate about steel needs and prices once a quarter. Figure 3.10 shows a snapshot of a few steel reservations. They reserve steel based on the RDT, offers without RDT and order releases. In case of a RDT, registering and updating are manual actions. Steel procurement purchases steel after receiving the ''pre-info'' on a daily basis.

REQUESTS FOR DELIVERY DATE

project	project/offer nr	status	exp. order	def. stee	del dat	yea	width	thickness	quality	SAP mat	tons
[redacted]	A-68883	order	35	38	7	2019	320	2.50	S350	1291	561
	A-68883	order	35	38	7	2019	140	1.50	S250	1236	121

Figure 3.10 Snapshot planning steel procurement

8. Purchasing Planning

Managed by Purchasing, Detailed planning on short term

The purchasing planning is not a planning process but more or less an overview prepared by the other planning processes. This overview shows when to deliver which products to production or on site for installation. Purchasing depends on two parties. Internally on central planning, since they need to provide the ''pre-info'' to perform preparatory steps. On the other side, central planning needs to release the materials, so that requisitions become available and purchasing can order the materials. Subsequently, purchasing depends externally on the capabilities and lead-times of their suppliers.

9. Production Planning

Managed by Central Planning, Detailed planning on short-medium term

Production planning manages the production plan in the frozen and short-term period. Central planning manages the ''overall planning'' in the long-term through. The frozen period is the production week following current week. Short-term period refers to a period of 4 weeks following the frozen period. The long-term is the period following the short-term period. Figure 3.11 shows this distribution.

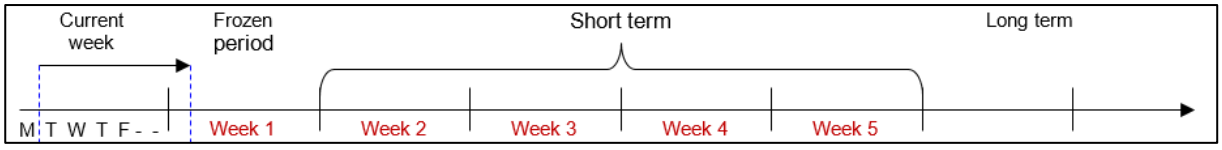

Figure 3.11 Production planning horizons

Production planning receives ''planned orders'' as input for the production planning from SAP. Production planner assign a batch to each ''planned order'' in order to group orders on product type. The batches come from SAP and serve as input for the production plan. Production planners create the production plan in an excel file by assigning batches to the different production lines. We can describe the batch process as follows: where the ''overall planning'' (2) spreads the need over a maximum period per project, production planning strives to produce this as efficiently as possible by combining projects. It concerns manual actions when we talk about assigning a batch and creating the production plan. Production planning transfers the production plan to the production on paper once a week. The challenge for production planning is the interaction with overall planning. They only receive an update once a day, with as consequence planning differences.

The main objective of this planning is to minimize work-in-progress by balancing production capacity within short-term period, minimize negative impact of short production batches and constantly minimize production lead-time. Figure 3.12 shows the difference between production and engineering/ installation planning. Production merges all projects together to produce as efficiently as possible. Engineering and installation execute each project separately.

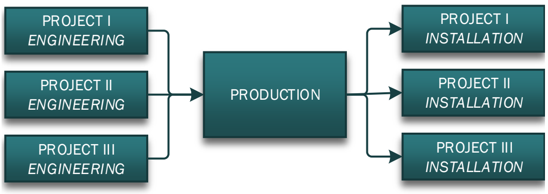

Figure 3.12 Difference production planning vs engineering/installation

10. Container & Truck Planning

Managed by Central Planning, Detailed planning on short-medium term

Shipping and delivery arrange the container and truck transport. Shipping and delivery work according to the delivery schedule. They should receive the finished goods before the ''requirements date'' and need to unload it on site before the ''latest requirements date''. SAP contains both milestones. Shipping and delivery manage the truck planning in Transporeon. This system integrates with SAP and has a direct interface with transport partners. For the other type of transport, container, they plan in excel. Figure 3.13 shows a snapshot of the container planning. This department often deals with the issue that the production delivers products too late, after the requirements date. This reduces the flexibility of shipping and delivery and results in peak moments (imbalance).

Load. week	day	load. date	cont. vol.	type	loading start	Batch	Loading code	project	type	loading start	Batch	Loading code	project	type	loading start		Loading code	project
KW26	We	26.6.2019	3	HC40	6:00	5		[redacted]	HC40	9:00	5		[redacted]	HC40	11:00	5		[redacted]
	Th	27.6.2019	2	HC40	6:00	19			HC40	10:00	19							
	Fr	28.6.2019	2	OT40	6:00	5			HC40	9:00	5							
	Mo	1.7.2019	3	HC40	6:00	19			HC40	8:00	19			HC40	11:00	19		
	Tu	2.7.2019	2	OT40	6:00	19			HC40	10:00	19							
KW27	We	3.7.2019	3	HC40	6:00	9			HC40	8:00	9			HC40	11:00	9		
	Th	4.7.2019	2	OT40	6:00	6			HC40	10:00	6							

Figure 3.13 Snapshot container planning

11. Planning Supervisors

Managed by Central Planning, Detailed planning on short-medium term

The ''supervisor planning'' manages the allocation of supervisors on projects. This planning distinguishes projects and repair/service/snagging activities across Europe and all over the world. This planning plans only orders. The input comes from Salesforce (CRM-system) on a weekly basis. They register from each project the installation, project manager, subcontractor, location, system integrator and type of system(s). Furthermore, the manager of the supervisors manages several other activities in this planning. It concerns holidays of supervisors, KPI measurement and progress of projects. Besides, this planning includes basic competences such as where a supervisor is/is not allowed to work. In addition to the fact that there are a limited number of supervisors, decision-making is a critical aspect here. Especially if there are several projects at the same time, which one is preferred? What is important? Which criteria do I take into account? Etc.

ORDERS/Supervisors			16-4-2019						15-4	22-4	29-4	6-5	13-5	20-5	27-5	3-6	10-6	17-6	24-6
Projekt		PM	[redacted]-Installation	Subcontractor	Location	La	System Part	Typ			MAY					JUNE			
									16	17	18	19	20	21	22	23	24	25	26
[redacted]		BHO	[redacted]	[redacted]					3	4	5	d	d	d	d	d	d	d	
		SOE																	1
		BHO																	
		AKL							7	8	9	10	11	12	13	14	15		

Figure 3.14 Snapshot supervisors planning

Currently, project managers monitor their projects based on the different planning processes. Company X does not have a central system that contains all milestones and activities. This way of working requires a lot of communication and collaboration. Especially, in case of modifications. Project managers have to manage it in their way. In addition, a project manager has a great challenge to keep everything under control. This requires close cooperation with the project team.

3.2.2 Interdependencies

Milestones

Andersen defines a milestone as *''the completion of an activity, usually an especially important one" but as "a result to be achieved. A description of a condition or a state that the project should reach by a certain point in time. A milestone describes what is to be fulfilled, not the method to fulfil it"* (Andersen, 1995, p. 90). Thereby, milestones can be interdependent in different ways. Most milestones have a ''Finish-to-start'' relationship, which means that task B cannot start before someone finishes task A. These relationships are visible in the figure 3.2. This figure shows the sequence and dependencies of the milestones. Additionally, milestones could be hard or soft. Hard milestones, if not met, results in severe penalties; soft milestones are discretionary, which might be associated with penalties or other liabilities after a statement of work is agreed (Miranda, 2018).

Within Company X, different planning systems monitor milestones. Since there is no central ''overarching'' system, the project manager has to use several systems or contact several people in order to get insights in the entire project ''route, plan''. There are no uniform definitions about milestones. Besides, the same milestone can have different names. Resulting in different ways of working. At this moment, a milestone is less or more a specific moment along a project timeline and not a fixed gate with go/kill decision. However, these milestones are the connection between the current processes and planning processes.

Several characteristics influence the usage of a milestone at Company X. First, a project manager need to consider the influence of the customer on milestones, since they can adjust the date. Secondly, certain milestones can be in plural, such as the ''requirements date''. Thirdly, the impact of each milestone on the internal process. Figure 3.15 provides an overview of all planning processes including milestones. The bold milestones influence several processes, plural milestones have yellow marking and the customer influences the milestones with a *. In addition, certain milestones can have consequences such as a penalty. For example, if the ''End on Site'' exceeds, Company X may receive a penalty. On the other hand, Company X can also issue a penalty if suppliers/subcontractors do not work/supply according to the arrangements. However, this characteristic is not included in this overview. To highlight a few milestones, we describe some significant milestones within the current planning processes:

- *PRE-INFO*: engineering needs to deliver the pre-information. After this, purchasing can inform suppliers to reserve capacity and steel procurement has the permission to purchase steel for production.
- *Material Release*: central planning performs the material release after engineering releases specifications (drawings and material list). With as result, requisitions and planned orders. Purchasing can officially start buying based on the requisitions; production planning can batch the planned orders for production.
- *Requirements date (req. date)* & *Latest Requirements date*: central planning sets these milestones. The latest requirements date determines the requirements date based on the certain criteria. The requirements indicates when production goods need to be ready for shipping, the latest requirements date indicates when goods need to be ''unloaded'' on site. The requirements date is for production an endpoint and for shipping the starting point.
- *Start on Site*: the customer influences this date and is the starting point for Company X on site. From this moment, shipping can deliver materials and the subcontractor can start building.

Appendix E provides descriptions of all milestones. As mentioned, figure 3.15 shows all planning process including milestones. This figure shows certain important properties. First, it shows the impact of each milestone. It shows which department works with which milestones and thus shows the interdependencies between departments. Modifications in milestones can have various consequences, since each department uses a separate planning system.

Besides showing certain properties, figure 3.15 shows the role of milestones (gates) in the stage-gate process. Now, we call it ''milestones'' instead of gates, since the follow-up is not consistent and there is lack of transparency/clarity about the interpretation. A practical example that shows the dependencies is the milestone ''Material release''. Central planning cannot complete the material release without a number of conditions. First, there must be an installation planning. Secondly, engineering has to release specifications. After these two aspects are present, central planning can perform the ‘’material release’’. Although, in practice departments do not always follow up these conditions. Installation management delivers an IM Planning in various ways (layouts, systems). It is not always in line with the engineering planning, which means that it takes a lot of ''research work''. In addition, engineering often delivers partial releases, which means that central planning has to deal with many change orders (manual actions).

For example, if the ‘’Start on site’’ changes. Production has the choice to produce sooner, later or to store goods (if the planning offers this possibility). Purchasing has to coordinate other ‘’requirement dates’’ with its suppliers. Installation management has to contact the subcontractor whether it is possible to start earlier/later. All this because of a modification in a milestone. Subsequently, this requires in the current situation accurate communication, coordination and active risk management. The fact that there is no central system means that such aspects require a lot of (additional) attention from each department.

					PLANNING PROCESSES													
No.	Department	Process	Level	System	**Order Receipt***	Layout Approval*	**PRE-INFO**	IM Planning Ready	Release Eng.	**Material Release**	Start Prod.	**Req. Date**	**Latest Req. Date**	Building Ready*	**Start on Site***	Hand-over to Client*	End on Site	Final Hand-over*
1	Central Planning	RDT	Tactical	SharePoint	x	x	x		x	x	x	x	x		x		x	
2	Central Planning	Overall Planning	Tactical	Excel	x		x	x	x									
3	Central Planning	Delivery Schedule	Operational	SAP				x	x	x		x	x					
4	Engineering & Struc. Eng	Planning Engineering	Tactical	Excel		x	x		x				x			x		
5	Engineering & Struc. Eng	Project Planning	Operational	MS-Project/ Excel		x	x		x						x			
6	Installation Management	Installation Planning	Operational	MS-Project/ Excel									x	x	x	x	x	x
7	Steel Procurement	Request Delivery Dates	Tactical	Excel	x		x				x							
8	Purchasing [redacted]	Purchasing Planning	Operational	SAP			x			x	x	x	x		x			
9	Production Planning	Production Planning	Operational	Excel						x	x	x						
10	Shipping & Delivery	Container & Truckplanning	Operational	Excel and Transporeon								x	x					
11	Supervisors	Planning Supervisors	Tactical	Excel	x									x	x		x	
		Total			*4*	*3*	*6*	*2*	*5*	*4*	*4*	*5*	*6*	*2*	*5*	*2*	*3*	*1*

	Multiple		
*	External influence	**BOLT**	Influence several processes

Figure 3.15 Planning processes including milestones

3.2.3 Critical process parameters

Various critical parameters influence the current (planning) processes. These parameters influence the processes and the planning processes. We summarize the critical process parameters based on the different interviews/focus groups with functional managers and project managers. Figure 3.16 shows which department copes with which parameters.

Figure 3.16 shows that the most critical parameters are ‘’location circumstances’’, ‘’complexity’’ and the ‘’delivery schedule’’. We describe these as ''most critical'' because several departments deal with these parameters. Since project managers are responsible for the projects in general, they have to deal with all parameters.

Department/ Criteria	Location Circumstances	Layout Approval	Complexity (System(s), (non-)std, size)	Type of Material (Strip Size & Quantity)	Critical Items	Delivery Schedule	Release Eng.	Type of Customer
Project Management	x	x	x	x	x	x	x	x
Installation Management	x		x			x		
Engineering & Struc. Eng.		x	x					
Central Planning	x		x				x	
Steel Procurement				x				
Purchasing [redacted]					x			
Production Planning			x	x		x	x	
Production			x					
Warehousing						x		
Shipping & Delivery	x		x			x		
Supervisors	x		x			x		x
Total	5	2	8	3	2	6	3	2

Figure 3.16 Critical parameters per department

1. Location circumstances

Location circumstances refers in principle to the country, city where installation takes place. The country, place can have various circumstances. Location circumstances influence the type of transport (truck or container) and the technical design. For example, if it concerns an earthquake area, it asks for another technical design than in non-earthquake area. In case of container transport, central planning must consider more aspects and plan differently. It takes more time, involves more actions and, above all, more risks.

2. Complexity

We describe complexity in different ways. For example, engineering experiences something as complex, if there are new (technical) developments. For production (planning) is it complex if it concerns non-standard production, since they have to develop new tooling and programming. Ultimately, engineering determines the impact of complexity by translating customer requirements into technical specifications. The different views on complexity reflect on the complexity theory of Geraldi and Adlbrecht (2007). They describe three categories of complexity (figure 2.4). Multiple dimensions apply such as customization, number of sources, interdependence and size. Location circumstances refer to the ''context'' dimension of Payne (1995).

3. Delivery schedule

The delivery schedule is critical for certain reasons. With a delivery schedule, several processes depend on this planning process. It determines when production and purchase must deliver the goods to shipping and delivery. On the other side, it determines the progress of the installation by the timely delivery of the goods. Indirectly, it also affects engineering since production only can produce when engineering releases. Subsequently, a modification in this schedule can have various consequences.

Overall, we argue that each parameter has an impact on the entire process, direct or indirect. However, the importance of each parameter is not the same and therefore figure 3.16 shows when a department experiences a parameter as critical.

3.3 Conclusion

In the current situation, Company X has various primary and supporting processes. There is more or less a silo structure since there is limited process alignment. Through this, departments are not fully aware of their dependencies with a lack of consideration for all aspects of the process. Company X is result-oriented where rules and procedures are less important. The stage-gate model shows the interdependencies, but in practice, this process is not consistent and transparent. There is limited consistency due the different use of terminology and way of sharing /using information. Because departments consider rules and procedures as less important, processes are not completely transparent with various consequences. The current situation leads to misalignment of processes, limited involvement, and different ways of working and results of activities.

Company X has a scattered not/limited connected planning process. Planning take place on two levels. On tactical level departments plan resources and capacities. On operational level, detailed activities. Planning data come from different sources; there is no central source, single truth. The current way of planning is not suitable for changes/adjustments and mainly communication-driven. As consequence, there are a lot of manual operations, translations and interfaces. Milestones connect the current planning process. Company X coordinates milestones decentral, whereas changes have major influences. Besides, there are no uniform milestone definitions, which are not always correctly followed up. Subsequently, the current situation results in difficulties with resource allocation, prioritization and decision-making.

Departments deal with different critical parameters in the current situation. The most critical are complexity, location circumstances and the delivery schedule. The idea that departments face with various parameters emphasizes again limited integration of processes.

4. Bottlenecks

In this chapter, we show the planning risks. Section 4.1 assesses the maturity of the current planning processes. Section 4.2 provides an overview of the risk categories. Section 4.3 describes the causes and effects of three type of risks. When speaking about risks, we refer to ''planning-related'' risks.

The risks in this chapter fulfil two purposes. First, to show the weaknesses of the current situation. Secondly, to show the contribution of IBP in the desired situation by mitigating these risks. We used different sources to identify the risks. First, interviews with functional managers of each department. Secondly, a brainstorm session with several project managers. Thirdly, insights of the researcher based on the interviews and literature led to additional planning-related risks. We summarized all risks in a risk register. With a result of approximately 60 risks. Figure 4.1 shows a snapshot of the risk register, to show the way of working.

			BOTTLENECKS				
No.	Discipline	Bottleneck/issue	Cause	Effect	Business solution (Solution principle)	Dimension	Sub-dimension
4	Project Management	No clear picture of how XS projects are carried out in relation to all processes.	No formalized procedure.	Different way of working.	Classify and define basic process steps for uniformity in execution.	Process effectiviness	Degree of Formalization
5	Project Management	Site visits do not always take place (No regular, fixed step).	No formalized procedure.	No guarantee that the building site is ready for installation.	Define as an official process step with the link to the milestone "Building ready".	Process effectiviness	Degree of Formalization
6	Project Management	Various sources in use regarding status update on site.	No fixed procedure or tool present.	Different way of working and lack of information/structure.	Define one tool, template for site updates.	Process efficiency	Information Preparation and Sharing

Figure 4.1 Snapshot risk register

First, we describe each risk (2) with the main cause (3) and effect (4). Secondly, we categorize each risk using the dimensions (6) and sub-dimensions (7) of the maturity model. Thirdly, we describe a solution principle (5) to indicate how to mitigate risks. Section 5.2 elaborates on the solution principles for three different risks. Subsequently, several people from the organization reviewed the list in order to have consistency. Appendix I shows the definitions of the (sub-) dimensions and the criteria for the maturity assessment. Based on these definitions, we categorized the risks. Afterwards, we used the criteria to determine the maturity of the current planning processes.

4.1 Maturity

We use the maturity model of Wagner et al. (2014) to assess the maturity of the current processes. This because of its holistic approach, (sub-) dimensions and pathway for improvement. The original model focusses uses terms as S&OP. Figure 4.2 shows the maturity of planning processes of Company X. On the next page, we describe the maturity level of each dimension.

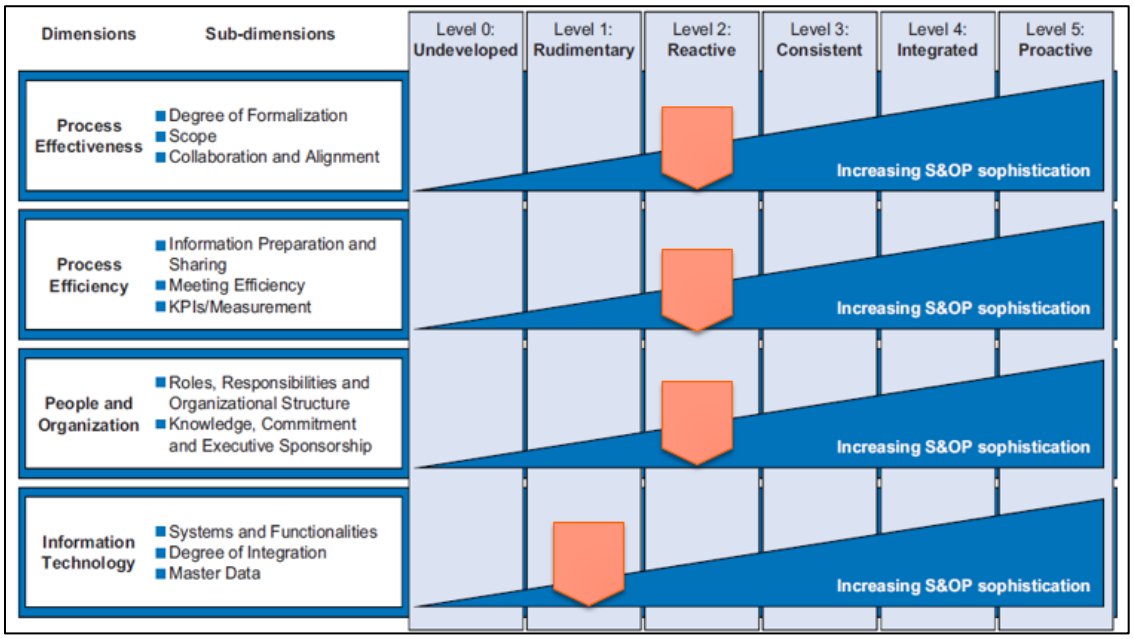

Figure 4.2 Maturity model (Wagner et al., 2014)

1. Process effectiveness
This dimension uses different aspects to determine the maturity of ''process effectiveness'', such as:

- Formalization of planning meetings
- Issues like changes, capacities and risks and how to deal with it
- Alignment of supply and demand

At Company X, departments have moderately scheduled meetings to manage the planning. For example, supervision has each week a meeting together with installation managers to manage the planning. Production planning has a meeting with central planning to manage the planning on a weekly basis. However, they discuss their own planning here and do not look at other planning processes such as engineering planning or shipment planning. With insufficient planning of issues like changes, capacities, risks and life cycles consequently. There are regular issues such as a building site that is not ready or a non-standard production item that is unknown in the planning. The demand-side provides no synchronized plan, since central planning has to make many translations in order to manage capacities. Subsequently, on this dimension score level two ''reactive'' applies for Company X.

2. Process efficiency
The dimension ''process efficiency'' uses the following aspects to assess the maturity of planning processes:

- Information storage and cross-departmental information flows
- Plan alignment
- KPI definition and measurement and performance tracking

Company X has no centralized information storages that contains all planning data. In the current situation, departments use multiple input channels. Supervision derives planning data from Salesforce, central planning from the RDT and engineering gets planning data through personal communication. Since there are no cross-departmental information flows, planning differences regularly arise. Planning processes regularly requires re-planning because there is no alignment. For example, project planning and installation planning are set up and managed separately. Production planning receives once a day an update of the overall planning. Resulting in re-planning due to planning differences. Departments have their own performance tracking and KPI's. Therefore, departments can use such measures in project evaluations, but project managers do not plan these meetings on a structural basis. At the end, we place Company X at level two ''reactive''.

3. People and organization
This dimension uses the following criteria to assess the maturity of this dimension:

- Roles and responsibility definition
- Accountability for plans and performance
- Commitment and sponsorship

Company X has a clear definition of roles and responsibilities, but there is not always a successful follow-up. For example, if a supervisor on site receives a delivery 3 weeks before they can use it, he does not always control the delivered goods. At that moment, a supervisor has other priorities.

Departments partially held accountable for their plans and performance. For example, production often delivers the goods too late for shipping and delivery. On the other side, engineering performs often a partial release instead of full release. Finally, there is moderate commitment and sponsorship. In case of purchasing CZ, sometimes they receive information about ''critical items'' after the material release. As a result, purchasing CZ negotiates about delivery time instead of price. For the third dimension, we categorize Company X also the second level ''reactive''.

4. Information technology

The last dimension ''Information technology'' uses different aspects to determine the maturity level, such as:

- Planning systems and integration of systems
- Planning data, master data

As the current situation shows, each department has its own planning system and there is a lack of integration. In many cases, departments have to register planning data manually into the system. For example, offer and order planners register and remove RDT's manually into the overall planning. Finally, there is no harmonization of master data throughout the organization. For this dimension, we position Company X on level one ''rudimentary''.

4.2 Risk Categories

Before the maturity assessment, we labelled each risk with a dimension. We use the dimensions and sub-dimensions of the maturity model to categorize the planning-related risks. Specifically, because this model covers the aspects people, process and technology and pays a specific attention to the ''planning'' aspect. We could also use the categorization of Hashim and Chileshe (2012), hence, their reserach ignores the planning part.

As described at the beginning of this chapter, each risk has a category based on the cause and effect and in comparison to the definitions of appendix I. Based on ''count'', we calculated this percentage. In this case, 32 of the 60 risks belong to the category ''Process Effectiveness''. Figure 4.3 shows that the category ''process effectiveness'' covers the most risks (54%). The sub-dimensions with the most risks are ''Degree of Formalization'' (23%), ''Collaboration and Alignment'' (20%) and ''Information Preparation and Sharing'' (17%). Figure 4.4 shows some example risks. For instance, risk number 1 has the category ''Process effectiveness'' and sub-dimension ''Degree of Formalization''. Because there is no formalized procedure for this activity. Ultimately, this activity influences the effectiveness of the processes and can have various effects.

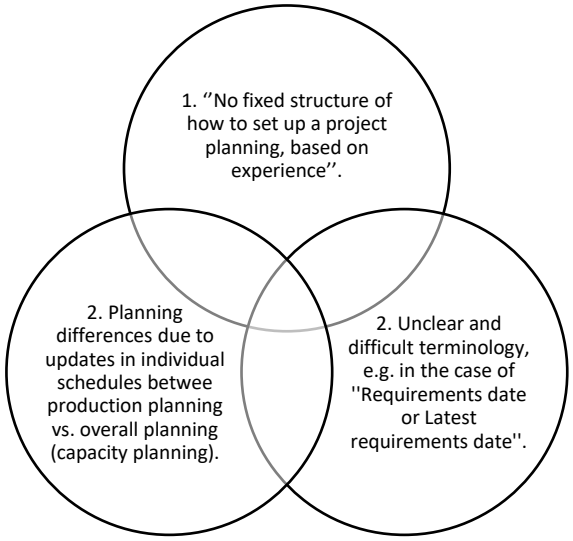

Figure 4.4 Example risks

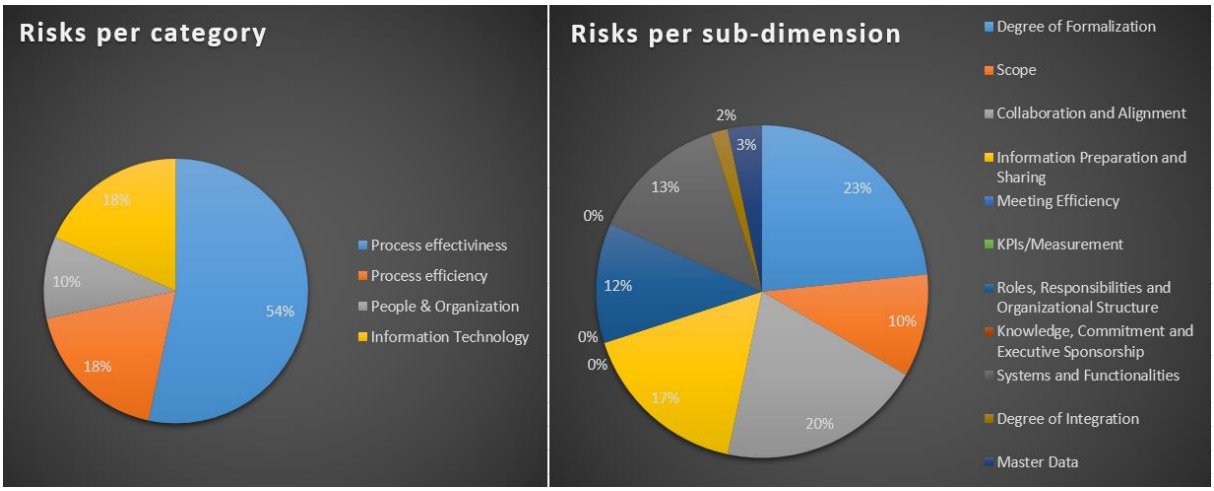

Figure 4.3 Risks per maturity group (dimension), sub-dimension

4.3 Cause & Effect

To give some practical insights related to the maturity model and risk categories, we describe the causes and effects of three risks. For this purpose, we describe three risks that apply to several departments. In total, we identified approximately 60 risks during the interviews and brainstorm sessions. We can undoubtedly add more risks to this list, but most likely less important.

I. Resource allocation

At this moment, department managers face the challenge of resource allocation. Due to the growth in the number of projects and their complexity, the allocation and availability of resources becomes critical. Nowadays, the customers of Company X expect shorter lead-times and simultaneously demand for more personalized solutions. Company X receives an order late in the process and department managers have to make early choices for the allocation of resources (human and technical). Figure 4.5 shows several causes that affect the risk of resource allocation. In this case, there are several information channels, no formalized procedures and limited process alignment. Resulting in different ways of working and outcomes of activities. With as effect, planning, decision-making and prioritization issues. Different results in the sense that each department manager makes subjective choices. This risk reflects the statement of Engwall & Jerbrant (2003) about resource allocation in an MPE. They argue that managers not know how to properly deal with resource allocation under uncertainty.

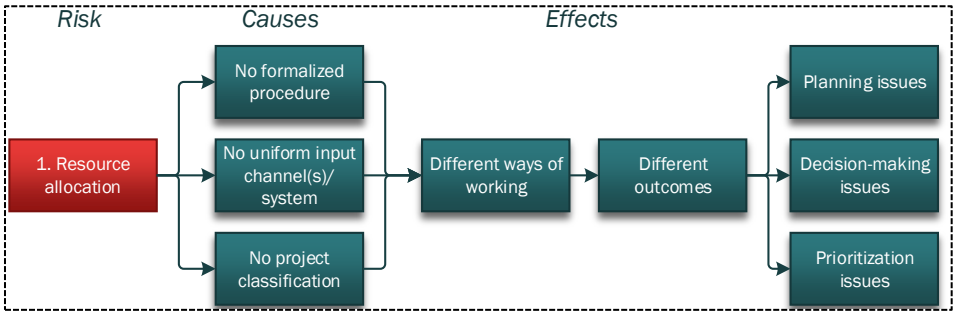

Figure 4.5 Risk I: Resource allocation

For example, the manager of the engineering department receives planning data via personal communication or email. A project has no official classification and there is no formalized procedure for resource allocation when there are several potential projects. Another example is the lack of supervisors. Currently, the manager of supervisors allocates supervisors based on mutual communication. Planning data comes from various sources whereby subjective decision-making follows, since there are no rules or arrangements. This way of working is no longer possible, as projects do not always achieve milestones.

II. No long-term insights

In order to plan on the long-term, departments need information from the past and future in order to create a forecast. At this moment, departments such as procurement, purchasing and shipping and delivery have no or limited information in the long-term. Figure 4.6 shows several causes for this. Departments do not share information and/or it is not complete enough. There is no/limited process alignment and no ''formalized'' project classification. For this reason, departments experience it as difficult to make predictions about the future resulting in subjective forecasts or in the worst case, no forecast.

For example, steel procurement negotiates once a quarter about the steel prices with their steel supplier. Therefore, steel procurement must predict how many tons of steel Company X needs in the next period. At this moment, they make a prediction based on figures of the past. However, due to rapid market developments, figures of the past becomes unreliable and the need for information on future projects increases. Another example is the number of projects with container transport. Company X has

only two loadings docks for containers. This year, Company X was unable to cope with the number of projects including container transport. As a result, they had to shift projects to another period.

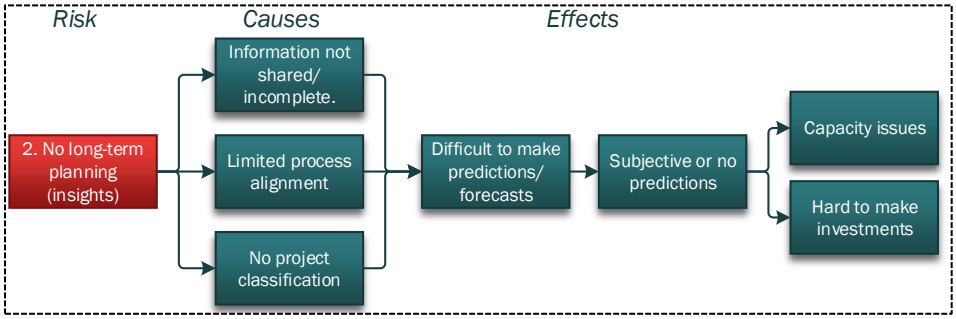

Figure 4.6 Risk II. No Long-term planning

As mentioned in section 2.3.2, Jurečka (2013) describes that companies can benefit from IBP by linking strategy and operations in order to create a close-loop management system. At the same time, many companies fail to link strategy (long-term) with operations due to the lack of integration, collaboration, communication and an incentive setting across business units.

III. Limited plan alignment

The third risk is about plan alignment. In the current situation, there is no or limited plan alignment. First, because there is no central planning system. At this moment, there are only some manual interfaces between different systems. Secondly, there are no formalized procedures, since Company X describes most processes separately. Resulting in department-based planning processes and various planning issues. With this, we refer to issues such as the lack of capacity and planning mismatches (see figure 4.7). Another effect is a complex network of communication channels. Muzumdar and Viswanathan (2009) essmphasize this (section 2.3.2) and argue that many companies deal with this issue. Because departments have to make translations between levels and characteristics.

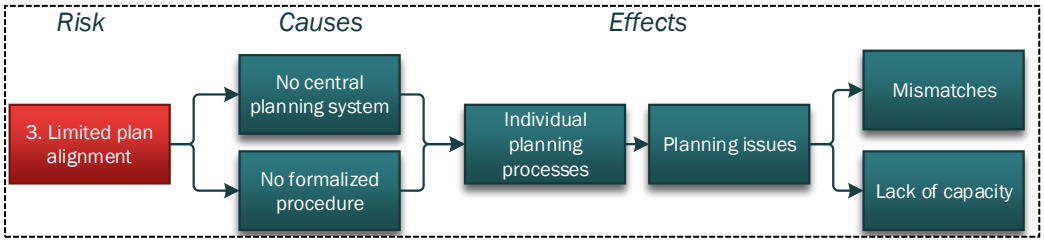

Figure 4.7 Risk III. Limited plan alignment

For instance, there is no alignment between the project planning and installation planning. First, this creates planning differences. For example, engineering releases a project in a different order than the order of installation. Another example is the link between the ''overall planning'' (capacity planning production) and production plan of production planning. There is no interface between these processes. Production planning receives an update of the overall planning on a daily basis. Hence, when central planning changes the overall planning without communicating this, there is a likelihood for planning mismatches.

4.4 Conclusion

Based on the maturity assessment, we conclude that Company X has a ''reactive'' planning landscape. Planning processes are limited formalized. Planning processes are not consistent, often self-organised and not part of a broader system.

There are limited rules when and how for example to allocate resources. Each planning process uses several information channels, which are subject to change. There is no ''single truth''. This causes mismatches and frequently re-planning. At a lower level, departments plan detailed activities on an

''individual'' basis, often on experience, with limited alignment to other processes. Currently, resulting in a decentralized coordination and communication-driven planning process. Planning processes deal with the challenges such as resource allocation, limited or no long-term insights and above all, limited plan alignment.

The current planning landscape contains ''isolated'' planning systems/processes. There is no integration between systems, only in some cases by manual interfaces. As a result, many translations have to be made between different planning processes, resulting in manual operations. At the end, more than half of the planning-related risks relate to the ''process''. Specifically, many risks relate to the degree of formalization, alignment and way of preparing and sharing information.

5. Desired situation

In chapter 3, we described the current situation. In the previous chapter, we described the planning-related risks. Within this chapter, we show *to what extent* and *in what way* IBP and MPE can contribute to the value chain of Company X. Besides, we show how to mitigate the risks of the bottleneck phase.

Figure 5.1 presents the ''basic'' conceptual IBP framework, which the author of this research designed. The framework includes references to which we refer in the sections. The framework serves as ''umbrella'' to illustrate the contribution of IBP.

- *5.1 Applicability of an Integrated Business Planning*
  - Section 5.1 describes how IBP fits towards the value chain of Company X from a strategic, tactical and operational perspective.
  - Section 5.1.1 describes the contribution of IBP and MPE from a strategic (3), tactical (2) and operational (1) perspective. Afterwards, we emphasize the importance of aligning business strategy with projects and processes (4). The researcher created a three-dimensional cube to highlight the importance of alignment.
  - Section 5.1.2 provides the areas of improvement (A, B, C). The framework indicates the areas of improvement.
- *5.2 Mitigation of risks*
  - Section 5.2 describes how IBP and MPE contribute to mitigate three planning-related risks. This section elaborates on the risks of ''resource allocation'' (I), ''long-term insights'' (II) and ''plan alignment'' (III).

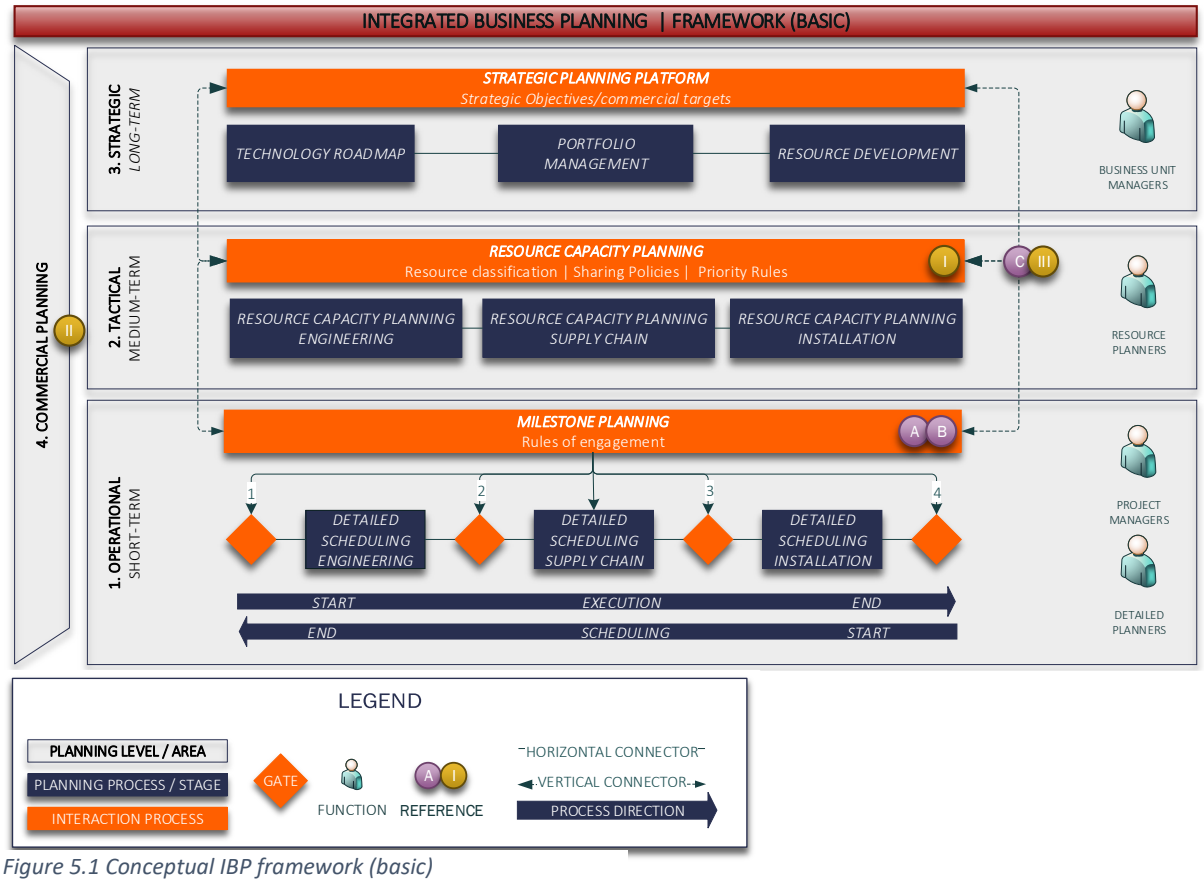

Figure 5.1 Conceptual IBP framework (basic)

As mentioned, figure 5.1 shows the ''basic'' conceptual IBP framework, including legend. The author of the research designed multiple versions of the framework containing different levels of detail. Appendix J shows two detailed levels of the framework.

5.1 Applicability of an Integrated Business Planning

Section 5.1.1 describes the objective of the conceptual IBP framework and explains each component. With the framework, we address the main question by describing the contribution of IBP towards the value chain of Company X. Section 5.1.2 highlights from an abstract level in what way to benefit from the contribution of IBP.

5.1.1 Conceptual framework

Before we describe the conceptual framework, we highlight the used definitions of IBP and MPE:

- *IBP:* an IBP strives towards horizontal and vertical integration by linking the different disciplines and translating strategic plans into an operational way of working focusing on the processes, people and technology.
- *MPE*: in an MPE, several projects accomplish side by side, while drawing, at least some, resources from a common resource pool.

Company X strives to *''be the easiest to work with''* using the key words *speed*, *consistency* and *transparency*. The desired situation would comprise a system, which covers project resources, logistical, production and financial interfacing to one backbone of data. With this, there are digital interactions between the different parts of the organization and no manual interfaces. This makes reporting and forecasting possible from one viewpoint, where changes are more easily manageable.

The IBP framework of figure 5.1 combines aspects of IBP and MPE. In section 2.3.3, we described the IBP frameworks of Wagner et al. (2014) and Landeghem and Van Maele (2002). In addition, appendix J shows several IBP frameworks. All these frameworks have some common characteristics, but they differ based on the purpose. Based on the ''existing'' IBP frameworks, the current situation and planning-related risks, we designed the framework of figure 5.1. Reviews with stakeholders took place to improve the quality of the framework. With the framework, we focus on one ''single source of truth'' in order to be *consistent*. Therefore, integrated processes and clear procedures can improve the *transparency*. Finally, the model strives to improve the *speed*.

Integration

The basis for the framework is vertical and horizontal integration of processes. For this reason, we emphasize the role of people and processes in the model. Below we briefly describe the basis for vertical and horizontal integration. The following pages cover each part of the IBP framework.

Vertical

With ''vertical integration'', we strive to connect the strategic, tactical and operational levels. Therefore, the stage-gate (milestone planning) serves as connection between the operational and tactical level. The resource capacity planning creates the link to the strategic level for portfolio management, resource development and the technology roadmap. We apply the planning horizons of El Lahloua et al. (2018): strategic (1 to 5 years), tactical (1 month to 1 year) and operational (1 day to 1 month).

Horizontal

Horizontal integration focusses on the integration of different business processes. Therefore, the ''gates'' of the stage-gate process connect the business processes on operational level. On tactical level, we aim to create pools of resources to manage capacities using resource classifications and sharing policies. On the strategic level, we connect portfolio management with the technology roadmap and resource development in order to see where to invest or develop.

1. Operational

From an operational perspective (figure 5.2), we propose the following:

1. Work according to a ''stage-gate'' process (milestone planning) to improve integration, monitoring and risk management.
2. Use ''rules of engagement'' to ensure the quality of the stage-gate process.
3. Apply different ''levels of detail'' to make the process flexible, adaptable and effective.
4. Plan backward after order acceptance, as sales specifies together with the customer the installation period in the sales phase.

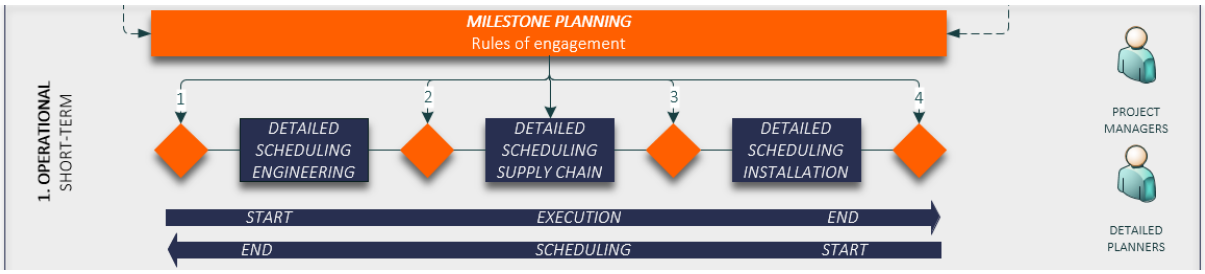

Figure 5.2 Operational level, IBP framework

1. Stage-gate

With the stage-gate process, we propose to describe the macro process of Company X, which serves as link between tactical and operational level, where:

- Each business process works in a stage and between two gates. For example, engineering works between the gates ''order receipt'' and ''material release''. The detailed planners schedule the activities between the gates.
- The gates come together in the ''milestone planning'' which are managed by the project manager per project. Resource managers use also the gates on the tactical level for resource allocation. They can use the start and end gate of a process in order to allocate resources.
- As mentioned, the RDT is a rough planning of the project requested by sales in the sales phase. We propose to use an improved form of the RDT, which fully integrates with other planning processes and contains accurate/complete information. We propose to convert the RDT into a milestone planning in the execution phase. The RDT is only leading in the sales phase.

2. Rules of engagement

For the gates, we propose to use ''rules of engagement''. Cooper (2008) describes that organizations need to define rules of engagement to ensure the quality of the stage-gate process. For example ''*all projects must pass through the gates. There is no special treatment or bypassing of gates for pet projects''* (Cooper, 2008, p. 220). In case of Company X, we propose to use comparable rules, such as:

- A project manager needs to convert The RDT into a ''milestone planning'' within 10 working days after the hand-over of sales to project management.
- Critical purchasing parts or non-standard production items have to be communicated prior of with the PRE-INFO. The basis for this is a clear list with items.
- After ''Release engineering'', materials must be released by central planning within two working days.
- Information about new orders is shared through "Salesforce" on a weekly basis.

During a benchmark visit (interview 18), the respondent showed us their way of working. The benchmark organization works also with rules, hence, they call ''process agreements''. The benchmark company uses for example the following rule: *''after receiving an order there must be a layout drawing within 3 working days''*. The respondent argues that it gives direction to the process and ensures the interaction between departments. Subsequently, the basis for such rules are clear definitions and procedures. For example, what should a milestone planning comply with and what is the definition of a critical item.

3. Levels of detail

To remain flexible in the dynamics of an MPE, Company X needs to consider the recent developments of the ''next-generation stage-gate'' process. The business process must remain flexible, adaptable and suitable for different risks levels. This flexibility is important due to their result-oriented focus and project-based context. Therefore, we propose to use different levels of detail.

Figure 5.3 shows two levels of detail. Engineering performs their activities between the gates of level I. Resource managers can use this level to allocate resources. Level II includes an additional milestone concerning ''layout approval''. The layout approval is crucial for engineering to continue their work, but does not directly affect the other processes. Appendix J presents a complete overview of both levels.

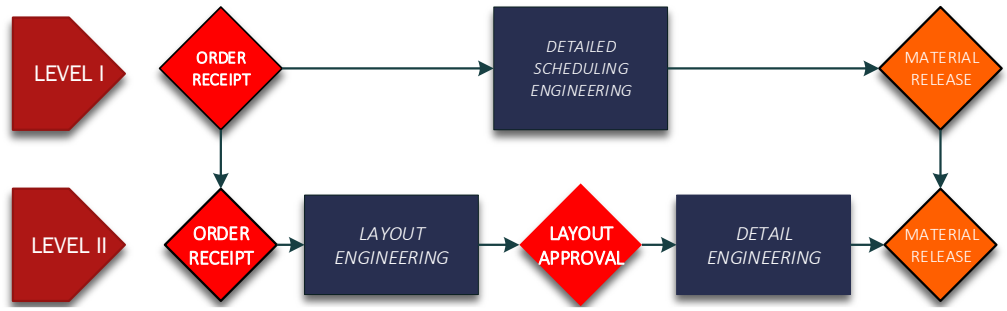

Figure 5.3 Levels of detail

The gates in figure 5.3 have different characteristics. We propose to differentiate gates visually from each other. For example, the customer influences a gate with an ''red'' color and the gates with a ''black border'' are managed on multiple levels.

The benchmark organization uses an integrated system to define a ''route'' for each project. In this case, this functionality for defining a project ''route'' could be an option for defining the stage-gate process for a project, including characteristics.

4. Planning vs. execution

The gates serve as link between the different ''detailed scheduling'' processes. Between these gates, installation, supply chain and engineering schedule detailed activities. We propose to plan ''backward'' after order acceptance, as sales determines together with the customer the installation period. In that case, installation determines when supply chain needs to deliver the goods on site and when engineering has to release specifications. How they exactly schedule in detail remains flexible, as long as they work according to the milestones.

Figure 5.4 shows the relationship between these three departments. Installation managers determine the delivery schedule based on the installation schedule together with central planning. This determines when supply chain has to deliver and when engineering has to release.

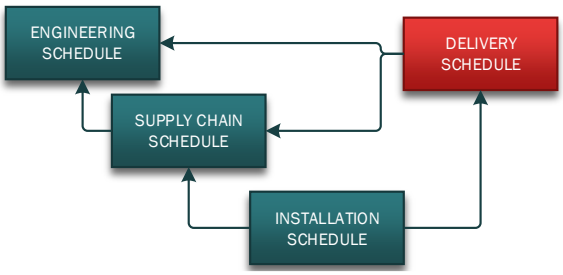

Figure 5.4 Link installation, supply chain and engineering

The project manager has an important role in this stage-gate process. The project manager is the ''gatekeeper'' to ensure a controlled project execution. With this process, a project manager has a complete overview of the process and avoids looking into each individual planning. Therefore, a project manager is the chain between the detailed planners and resource managers. Central planning has the coordinating role between these detailed schedules. With this, we propose to work towards a ''heavyweight'' matrix structure where the project manager has the authority in order to reduce friction and set clear responsibilities.

2. Tactical, resource capacity planning

On tactical level, there are two important functions. First, resource managers need to determine the capacity levels to balance supply and demand. On the supply side, resource managers determine their capacity levels for human and technical resources. On the demand side, they receive periodically a commercial planning (4) with potential projects and orders. Figure 5.5 shows the tactical level.

Figure 5.5 Tactical level, IBP framework

Therefore, Company X needs to integrate sales with execution. At point 4 ''commercial planning'', we elaborate on this point. Section 5.2 describes how to deal with the risk of ''resource allocation'' at risk I. We propose to classify resources and use sharing policies and priority rules on the supply side.

3. Strategic, portfolio management, technology roadmap & resource development

On strategic level, we describe three components (figure 5.6):

- With the technology roadmap: a plan that contains an organization's technology strategy. In the case of Company X, we refer to aspects such as make or buy decisions, product development strategies and investments in production capacities.
- Portfolio management: the centralized management of one or more portfolios to achieve strategic objectives (PMI, 2013). Therefore, Crawford et al. (2006) argue that organizations deliver business strategy through projects, and so project management capability is key to their ability to deliver their strategic intent.
- Resource development: this concerns the development of resources (human and technical). For example, optimization of the production floor or development of specific engineering capabilities.

On this level, business unit managers take the responsibility to develop resources, manage portfolios and set the technology roadmap. On this level, they have the platform to steer and manage the tactical and operational level.

Figure 5.6 Strategic level, IBP framework

In the next paragraph, we highlight the importance of alignment. The alignment of the commercial units with the execution processes on the different levels. With execution, we refer to the processes after sales. Therefore, the author of the research created a three-dimensional cube to illustrate and visualize the role of alignment.

4. Commercial planning

To highlight the relationship between the commercial planning (4) and different execution processes, we created a three-dimensional cube. With the cube, we illustrate and visualize the relationship between projects and internal processes. Crawford et al. (2006) recognize the need to align project delivery capabilities with business strategy. Many organizations argue they deliver strategy through projects.

To ensure alignment, organizations must be sure they are ''doing'' the right projects and ''can do'' the projects right. In order to make best choices, organizations need to assign labels to their projects, so they can categorize them and create a ''shared language'' (Crawford et al., 2006). On the other side, organizations need to categorize resources to make the right match. The authors argue that organizations categorize projects for two primary purposes: 1) strategic alignment and 2) capability specialization.

Therefore, the author of this research designed the three-dimensional cube to illustrate, visualize and indicate the importance of ''alignment''. We link aspects of the digitalization strategy, project characteristics and the critical process parameters from an abstract level. With this, we align of the commercial planning with the operational, tactical and strategic level (figure 5.7).

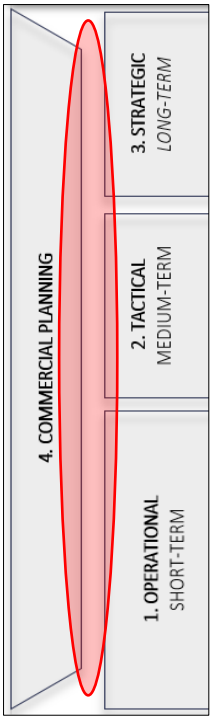

Figure 5.7 Commercial planning, IBP framework

1. Digitalization strategy

Within the digitalization strategy, Company X created a tooling-based definition to distinguish different types of projects/orders. Figure 5.8 shows that the human impact increases as the complexity of the solution increases (Company X, 2019)[4].

1. *Component selling (COMP),* fixed components, unique products defined by a fully determined (fixed) set of properties.
2. *Configure to order 1 (CTO1),* products defined by a set of properties, where some properties are fully determined (fixed) and some are can be selected from limited, pre-defined options for individual customer needs.
3. *Configure to order 2 (CTO2),* where CTO1 only uses stock items (SSR); CTO2 has the possibility to use products that are not standard in stock, but items that need to be produced.
4. *Engineering to order (ETO),* products defined by a design/engineering activity based on customer-specific requirements, specification is stored in a custom component drawing.

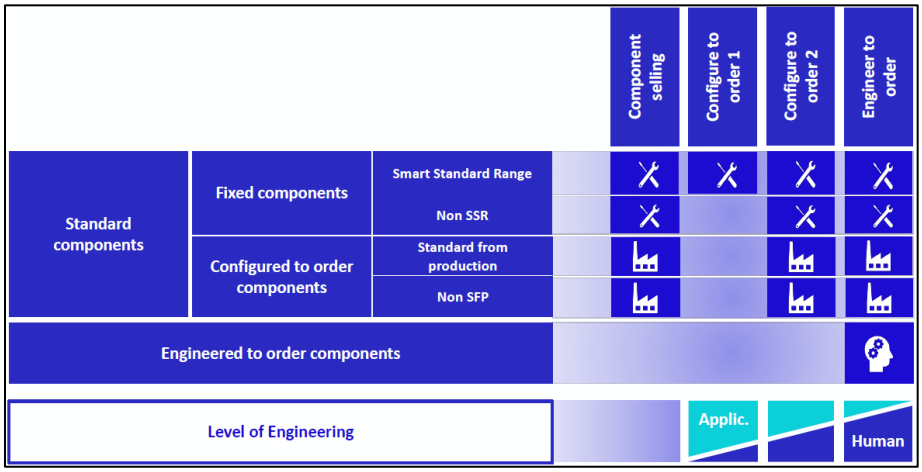

Figure 5.8 Project categorization based on tooling

[4] Source derived from the intranet (not publicly available) of COMPANY X

With figure 5.9, we propose to show the relationship between the projects and processes using three dimensions:

1. *Scale:* this dimension refers to the size of a project in terms of price, number of systems, duration and weight.
2. *Dependency:* the aim of this dimension is to indicate the extent to which a project is dependent on internal disciplines (engineering, production, R&D, etc.) and external partners (suppliers, subcontractors).
3. *Standardization:* this dimension focusses on the complexity of a project by establishing the degree of standardization.

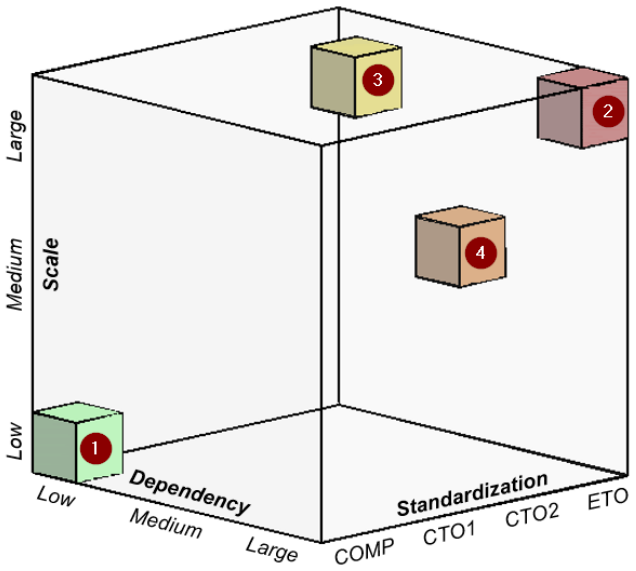

Figure 5.9 Three-dimensional cube

To demonstrate the cube, we describe each number of the cube:

1. *Green,* this project indicates a standardized (comp) project with a small size and low dependency. In practice, it means that it concerns *standard* products of Company X's own production. Company X has complete control and is not dependent on third parties.
2. *Red,* this project shows the opposite of the green one. It shows a ''ETO'' solution where the customer has a large impact. A lot of engineering work, resulting in a high ''internal'' dependency. Additionally, the large scale ensures that Company X must cooperate with an installation partner for a long time and has to make use of external parties. This because, the solution has multiple systems and Company X does not produce all items in-house.
3. *Yellow,* this block shows project I (*Company A*) from section 1.5. This project has a large scale (20 weeks of installation, multiple systems). The project contains some non-standard items, but the vast majority is standard (CTO2). At the end, Company X had to purchase parts due to the size of this project.
4. *Orange,* this block shows project II (*Company B*). This was a ''ETO''-project, since the storage solution was tailor-made. It mainly concerned own production (non-standard) items and some purchasing parts. The project was in terms of scale ''medium''.

With figure 5.9, we highlight certain aspects. First, the need to align sales with execution. On strategic level, business unit managers want to know as early as possible which potential projects are in the pipeline. On a tactical level, resource managers balance supply and demand. For this, there is the need to know the number and needs of projects but also the type of project. On the operational level, project managers and detail planners want to know the characteristics of the project. Figure 5.10 shows certain questions that departments want to know as early as possible. Therefore, we propose to categorize projects in relation to the internal processes considering the external environment.

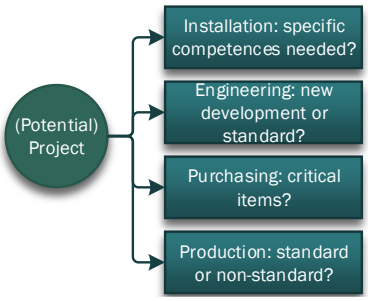

Figure 5.10 Questions about a potential project

Figure 5.9 indicates also the risk level of each project. As scale and/or complexity increase, risk levels increase. It makes a difference whether someone makes a decision for a small, standard project or a large, non-standard project. The influence of such decisions have various effects on the processes. Furthermore, collaboration and alignment require more attention when the scale and complexity increases, since there are more (internal/external) parties involved. Ideally, we propose to align risk levels with the project classification.

5.1.2 Improvement

In this section, we indicate in what way IBP can successfully deliver a contribution towards the value chain of Company X. We use the framework to indicate the ''rough'' steps in order to improve the current situation, mitigate risks and achieve the desired situation. Therefore, we combine aspects of the maturity model, literature and digitalization strategy to prepare a pathway towards IBP. Figure 5.11 shows the sequence of the proposed steps.

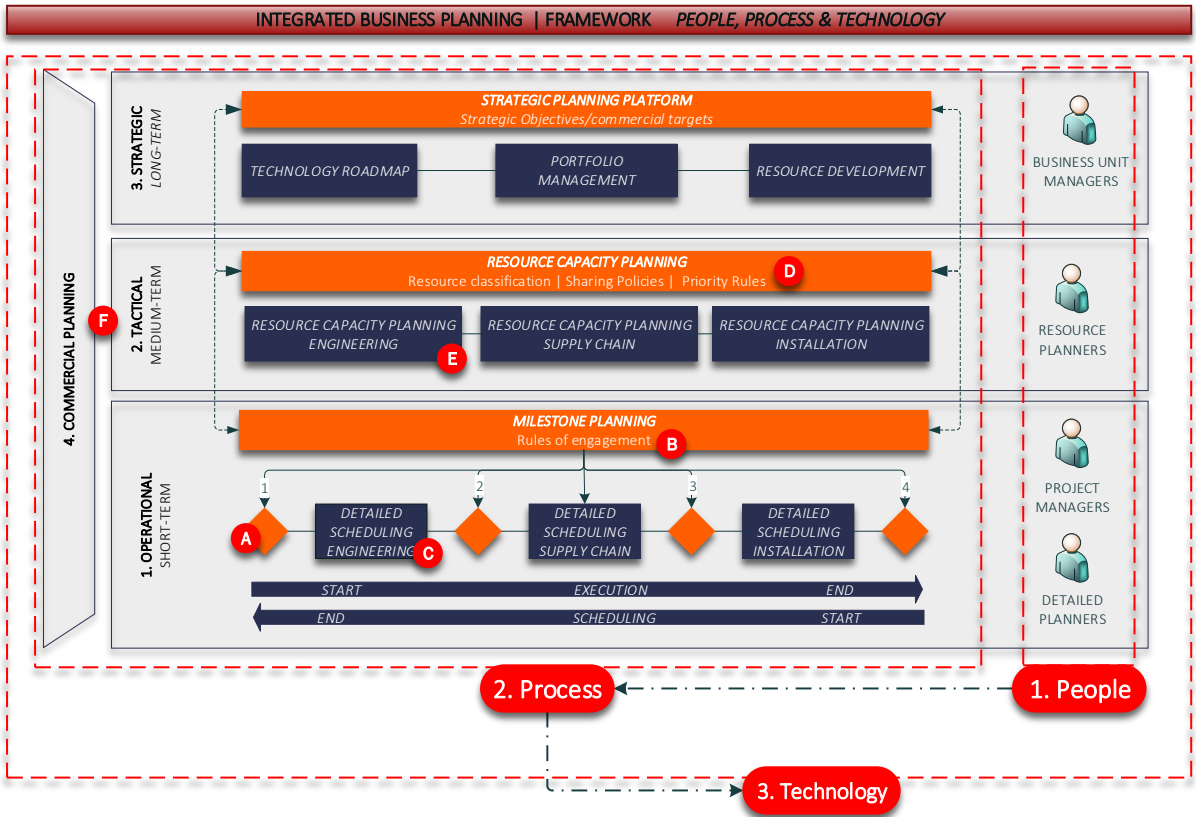

Figure 5.11 IBP framework including people, process & technology

Many whitepapers emphasize a certain basis for a successful IBP. Green et al. (2012) describe three challenges for realization:

1. The largest barrier to success is often the behaviors and cultures of each function within an organization.
2. Introducing successful IBP does not need to be onerous. Specific focus on improving functional process ''touch points'' can drive significantly efficiency and effectiveness improvements.
3. Consider how data and technology integration improve the enablement of the planning processes and tighten the linkage with management reporting.

Palmatier and Crum (2018) have a similar approach. Figure 5.12 presents the primary elements. They focus first on the ''people'' enabler, including key behaviors such as:

- Establishing a disciplined, regular and routine process governed by a process calendar.
- Demonstrating leadership participation and ownership.
- Operating the process with open and honest communications.

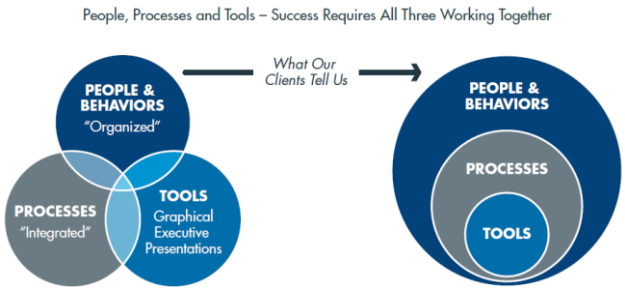

Figure 5.12 People, Processes & Tools (Palmatier & Crum, 2018)

1. People

To successfully work towards an IBP, we propose to start with the ''people'' dimension. With the people dimension, we refer to the organization around an IBP (see point 1, figure 5.11). Therefore, understanding, leadership and commitment are crucial (Oliver Wight, 2019). Before Company X focusses on processes, it is important to understand the need of an IBP on each level. The framework of figure 5.11 supports by making the ''need'' clear.

Everybody in the organization needs to be committed. Commitment begins at the top and afterwards at the most senior level and then leaders for each of the key processes. Communication is key and organizations need to design and deliver a process that makes sure that the entire organization knows the goals of IBP. In other words, what the benefit is to them and what role they have.

2. Process

After there is understanding and commitment, we propose to focus on the ''process'' dimension. As shown, two of the four dimensions of the maturity model are process-related, concerning process effectiveness and process efficiency. Based on this research, we propose a bottom-up approach whereby the operational level is the starting point:

1. Operational

A. Define each ''gate'' including criteria and deliverables. Since project managers serve as ''gatekeepers'', we propose to define the gates together with the project managers followed by a review of the resource managers and business unit managers.
B. Formulate ''rules of engagement'' for each gate in order to have consistency in the processes.
C. Determine the set-up of each detailed schedule.

2. Tactical

D. Classify resources using a matrix, set up sharing policies and priority rules.
E. For the resource capacity planning, we propose to define a standard for each planning. Specify the input, define the process of monitoring and matters such as capacity levels and KPIs.

3. Strategic, for this level we formulate at this moment no specific activities. We propose to focus first on the operational and tactical level.

4. Commercial planning

F. Define when what and how to exchange information between sales and execution on operational, tactical and strategic level.
G. Create a ''up-to-date'' project classification that links projects to internal processes considering the environment.

Since we approach this research from a process perspective, we can be more specific about this dimension, as described. The activities above provide basic steps that Company X can take towards an IBP.

3. Technology

Finally, we propose to focus on the role of ''technology''. As Oliver Wight (2019) argues, the challenge with IBP is primarily about people and process; IBP requires understanding of process and alignment of people's behavior. However, technology tools do play a major part in ensuring the data and information is available to the process, and in helping to drive improvement in the more sophisticated processes.

However, we visited a benchmark company to look at their ''integrated'' system and to get an idea which possibilities there are. The benchmark company uses an integrated planning system and illustrated that a system offers possibilities to connect horizontal and vertical planning processes.

5.2 Mitigation of risks

In this section, we show how IBP and MPE contribute to mitigate planning-related risks. Therefore, we elaborate further on the risks section 4.3. For each risk, we formulate a solution principle. The idea behind a solution principle is to indicate in which direction to mitigate a risk. Thereby, it is currently not the intention to formulate ''functional requirements'' for a potential system, as we approach it from ''process'' perspective. Figure 5.1 shows the position of each risk (I, II & III).

I. Resource allocation

In order to mitigate the risk of ''resource allocation'', we propose to follow several steps based on the situation of Company X. This, because managers do not know how to properly deal with resource allocation under uncertainty. Therefore, we give Company X some advice to create consistency and transparency in resource allocation. In the current situation, there is no direct classification for projects and resources. Figure 5.13 shows the solution principle for this risk.

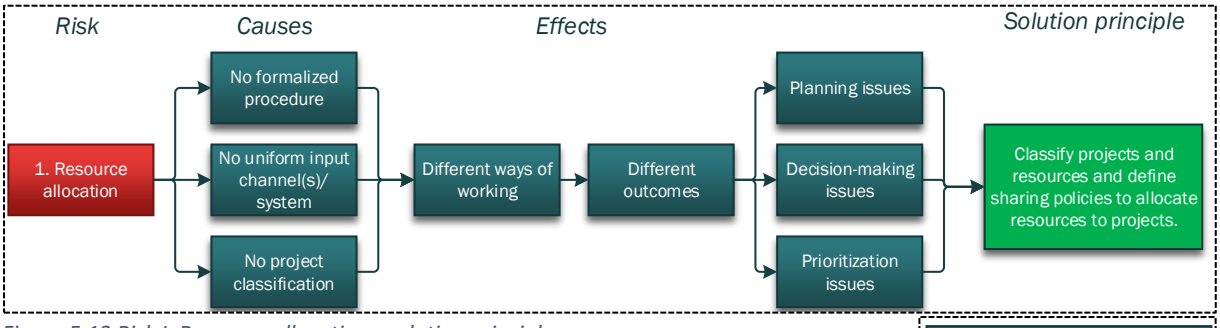

Figure 5.13 Risk I: Resource allocation - solution principle

Therefore, we propose to follow the steps of figure 5.14. First, classify each resource using a matrix. Currently, managers often know for example what an engineer or supervisor may or may not master based on experience. Secondly, Company X can use sharing policies to distinguish resource groups. Therefore, we describe below a few sharing policies from the literature with some examples for Company X. Thirdly, priority rules support resource managers in making a decision when there are multiple projects simultaneously.

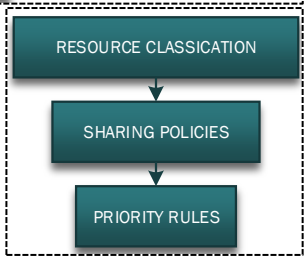

Figure 5.14 Allocation steps

For the risk of ''resource allocation'', we refer to sharing policies, since this applies to human and centralized decision-making (Ponsteen & Klusters, 2015). Currently, automated decision-making is not practical for Company X due to the complex and dynamic environment. Therefore, we propose first to structure the resource allocation with sharing policies and priority rules.

Sharing policies

According Laslo and Goldberg (2008), the allocation of resources is a problem between project and resource managers. Besikci, Bilge and Ulusoy (2011) summarize four types of sharing policies:

- *Shared resource policy*, this policy is a multi-project approach where a shared resource pool is available for all projects in the portfolio.
- *Resource dedication policy*, this policy refers to the assignment of resources to a single project in the portfolio.
- *Relaxed resource dedication policy*, in this policy, resources that finish on one project are allocated to new projects.
- *Generalized resource management policy*, this policy combines the three mentioned types of resource sharing; sharing all resources, using dedicated resources and use of the relaxed resource dedication policy.

In case of Company X, we can for example use a sharing policy to divide engineers that can work on manual and/or automated storage solutions. In case of supervision, we can do the same and add some specific competencies to determine the level of a supervisor.

Priority rules

Priority rules guide resource managers of Company X to make resource allocation decisions (Ponsteen & Klusters, 2015). According these authors, a wide variety of heuristic methods optimize, slack, cost or delay in different kinds of project settings. Therefore, these authors argue that different project settings influence the outcome. Figure 5.15 shows a summary of priority rules, broadly applied by scholars (Pakgohar, 2014). In case of multiple projects, resource managers can already use the first rule ''First Come First Served''.

Priority Rule	Explanation
FCFS	First Come First Served
SOF	Shortest Operation First
SASP	Shortest Activity From the Shortest Project
LALP	Longest Activity From the Longest Project
MINSLK	Minimum Slack First
MAXSLK	Maximum Slack First
MINTWK	Minimum Total Work Content
MAXTWK	Maximum Total Work Content
MINLFT	Minimum Latest Finish Time
MAXDUP	Maximum duration and penalty
MAXTOP	Maximum total duration Penalty

Figure 5.15 Example Priority rules (Pakgohar, 2014)

A practical example is the allocation of supervisors. The manager of this department needs to know what type of project it concerns. Is it a complex or standard project? What language does the customer speak? And so on. As soon as he knows, he can make a match between the project and his available supervisors. When there are limited resources and multiple projects need resources, he has to make important decisions. Therefore, priority rules support to make a decision.

Ultimately, the combination of a project classification, sharing policies and priority rules contributes to the mitigation of this risk. Therefore, resource managers need to classify their resources. Together they need to set up sharing policies and priority rules to have a consistent and transparent resource allocation process.

II. Long-term planning

To mitigate the risk of the ''long-term planning'', Company X needs to focus on the integration aspect of IBP. Therefore, we describe the solution principle to ''Integrate sales with the execution phase by defining basic information that is required gradually'' (see figure 5.16). As Jurečka (2013) argues: ''IBP as linkage between a company's strategy and operations'' (p. 30). Therefore, alignment of different planning processes across the organization and structured management of the gaps between different plans should result in a consensus between top-down strategy execution and direct bottom up feedback from the marketplace.

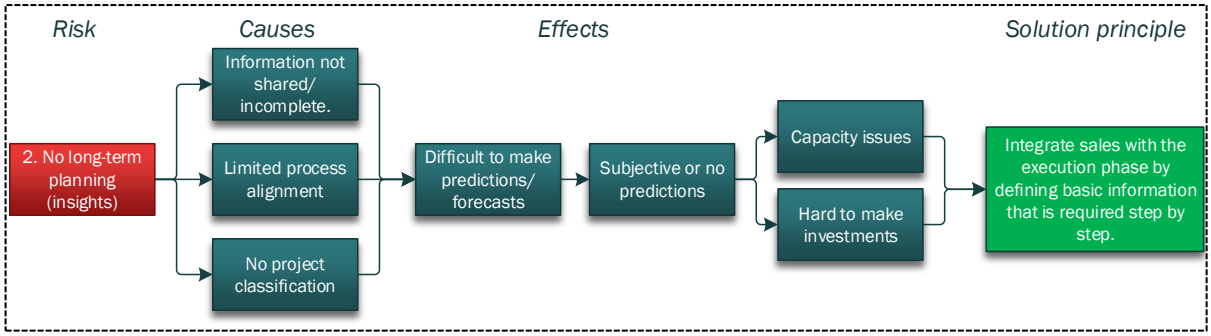

Figure 5.16 Risk II. No Long-term planning - solution principle

In order to plan on the long-term, information from the sales is required to get insights. At this moment, it not clear when sales informs realization and supply chain about potential projects. Some are precise and inform execution early, some inform execution when there is a negotiation upcoming. However, a lot of information is already available in the early stage of a project, such as:

- *The country, city*, with this in mind, shipping and delivery can already determine the type of transport. Supervision can already filter on available supervisors, based on language and so on. Engineering already knows whether it is an earthquake area or not.
- *Product type*, based on this engineering can make predictions which competences are required. Supervision can already see who has experience with this system and who needs training. In addition, it is already possible to make estimates about the ratio of purchasing to production.
- *Duration*, with this fact, supervision can reserve resources. This provides them a view of the occupation in the long term.

To mitigate this risk, we propose two ways for an integration with sales. On the long-term through the CRM-system of sales by providing a forecast of potential projects. On the short term, medium term through the stage-gate process. Therefore, Company X can use the gates to describe when departments need information. For example, with the hand-over, sales need to inform purchasing about critical parts and production if it concerns standard or non-standard production. At this moment, the RDT serves as link between sales and execution. However, this tool is outdated (not complete and accurate enough).

By providing long-term insights, departments can achieve various benefits such as:

- *Engineering*, reserve capacity, gain knowledge for the long-term or recruit new resources for specific competences.
- *Production & purchasing*, improve the relationship with current suppliers by providing information, invest in new supplier relationships or invest in additional production capacity to get better prices and reduce risks.
- *Installation management*, invest in existing and new relationships with subcontractors to get better prices and reduce risks.
- *Supervision*, recruiting and training of supervisors.
- *Steel procurement*, create a more accurate steel forecasts.

III. Plan alignment

The risk of ''plan alignment'' has various causes and effects. To reduce the risk of plan alignment, the advice is to integrate different horizontal and vertical processes as proposed with the conceptual framework. To mitigate this risk, we formulate the following solution principle: ''Use an integrated planning system that is always up-to-date without manual interfaces'' (figure 5.17). This system needs to integrate different business processes across the value chain. Therefore, it is important to have cross-functional information flows and consistent/updated master data.

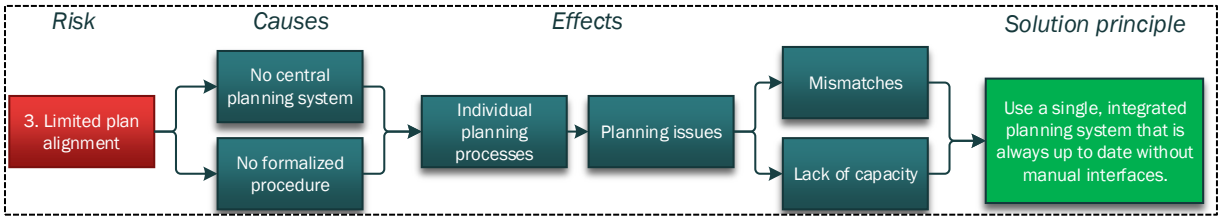

Figure 5.17 Risk III. Limited plan alignment - solution principle

Now, for example, central planning manages the production capacity in an excel file. On the other side, production planning creates a production plan in excel file using input from SAP. Now, there are regularly planning differences, since they share the capacity planning once a day. Alternatively, central planning has to contact production planning about each change, but that is not a workable situation. Therefore, an integrated system that connects these systems visualizes the processes and avoids planning differences like this. During the benchmark visit, the respondent shows an integrated planning system called ''Rob-Ex''. In their case, there was an integration between the tactical and operational planning processes. For example, if they try to change a detailed activity of production, the system

checks if this is possible and which consequences it has. This way of working would also suit to Company X, as it integrates planning processes and avoid planning differences.

At the end, an integrated system can bring various benefits to the organization. It improves organizational alignment and provides more transparency and accountability (Singh & Dhir, 2011). It provides decision-support and data is always up-to-date, unless users do not update it. In addition, it better identifies risks and reduces the complexity of the current communication network. Therefore, the solution principle only indicates the use of an integrated system and not yet how to design the system. For this, an organization such as Company X has to formulate a scope with user requirements.

5.3 Conclusion

In the desired situation, we provide an answer on how IBP can fit towards the value chain of Company X and what options there are to mitigate planning-related risks. Based on the literature, we concluded that organizations use IBP for different applications. Each business is unique and therefore, it depends on the business how to shape IBP in terms of content.

Generally, we see in the bottlenecks phase a similar level of risks between the literature on IBP and the situation at Company X. From this, we conclude that IBP is a feasible way to improve the current situation process by mitigating risks. Therefore, we designed a conceptual IBP framework to illustrate the fit towards the value chain of Company X. From an abstract level, this framework provides guidance for integration, coordination and improvement.

In the desired situation, IBP fits to Company X on an operational level using the stage-gate process. This process integrates the operational processes and serves as coordination mechanism for project managers. With this, Company X can work towards centralized coordination. Rules of engagement can improve the consistency and transparency of the process.

The stage-gate creates also the link to the tactical level. On the tactical level, resource classifications, sharing policies and priority rules guide resource managers to improve decision-making in case of resource allocation. These three aspects provide the interaction to the strategic level. The output of this level provides input for the strategic level to perform portfolio management, develop resources and create a technology roadmap.

6. Conclusion & recommendations

The last chapter of the report describes the conclusion and recommendations of the research. The goal of the research is to provide the management with an advice towards an IBP in their MPE. In Section 6.1, we give the conclusion of the research. In Section 6.2, we give recommendations to the organization. Finally, section 6.3 highlights the limitations of the research and section 6.4 gives recommendations for further research.

6.1 Conclusion

The main question of this research is:

''To what extent and in what way can an Integrated Business Planning contribute to the value chain of Company X within their multi-project environment?''

To answer the central question, we have formulated several sub questions per phase. We present the key findings per phase.

1. Current situation

In the current situation, Company X has various primary and support processes. There is more or less a silo structure, since there is limited process alignment over the different departments. Through this, departments are not fully aware of their dependencies with a lack of consideration for all aspects of the process. Company X is result-oriented where rules and procedures are less important. The stage-gate process shows the interdependencies, but in practice, this process is not consistent and transparent. There is limited consistency due the different use of terminology and way of sharing /using information. Because departments consider rules and procedures as less important, processes are not completely transparent with various consequences. The current situation leads to misalignment of processes, limited involvement and different ways of working.

Company X has a scattered and loosely connected planning process. Planning take places on two levels. On tactical level departments plan resources and capacities. On operational level, detailed activities. Planning data come from different sources; there is no central source, single truth. The current way of planning is not suitable for changes/adjustments and mainly communication-driven. Consequently, there are a lot of manual operations, translations and interfaces. Milestones connect the current planning process. Currently, Company X coordinates milestones decentrally, where changes have different consequences. Besides, there are no uniform milestone definitions. In line with this, milestones are not always correctly followed up. Subsequently, the current situation results in challenges with resource allocation, prioritization and decision-making.

Departments deal with different critical parameters in the current situation. The most critical are complexity, location circumstances and the delivery schedule. The idea that departments face with various parameters emphasizes again limited process integration.

2. Bottlenecks

Based on the maturity assessment, we conclude that Company X has a ''reactive'' planning landscape. Planning processes lack formalization. Planning processes are not consistent, often self-organised and not part of a broader system.

There are limited rules when and how for example to allocate resources. Each planning process uses several information channels, which are subject to change. There is no ''single truth''. This causes mismatches and frequently re-planning. At a lower level, departments plan detailed activities on an ''individual'' basis, often on experience, with limited alignment to other processes. Currently, resulting in a decentralized coordination and communication-driven planning process. Planning processes deal

with challenges such as resource allocation, limited or no long-term insights and above all, limited plan alignment.

The current planning landscape contains ''isolated'' planning systems/processes. There is limited integration between systems, only in some cases by manual interfaces. As a result, many translations have to be made between different planning processes, resulting in manual operations. Subsequently, 70% of the identified planning risks relate to ''process effectiveness'' and ''process efficiency''. Specifically, many risks relate to the degree of formalization, alignment and way of preparing and sharing information. The other 30% concerns risks related to people & organization and IT.

3. Desired situation
In the desired situation, we provide an answer on how IBP can fit towards the value chain of Company X and what options there are to mitigate planning-related risks. Based on the literature, we concluded that organizations use IBP for different applications. Each business is unique and therefore, it depends on the business how to shape IBP in terms of content.

Generally, we see in the bottlenecks phase a similar level of risks between the literature on IBP and the situation at Company X. From this, we conclude that IBP is a feasible way to improve the current situation process by mitigating risks. Therefore, we designed a conceptual IBP framework to illustrate the fit towards the value chain of Company X. From an abstract level, this framework provides guidance for integration, coordination and improvement.

In the desired situation, IBP fits to Company X on an operational level using the stage-gate process. This process integrates the operational processes and serves as coordination mechanism for project managers. With this, Company X can work towards centralized coordination. Rules of engagement can improve the consistency and transparency of the process.

The stage-gate creates also the link to the tactical level. On the tactical level, resource classifications, sharing policies and priority rules guide resource managers to improve decision-making in case of resource allocation. These three aspects provide the interaction to the strategic level. The output of this level provides input for the strategic level to perform portfolio management, develop resources and create a technology roadmap.

6.2 Recommendations

In this section, we give the recommendations of the research. Based on the framework, we give Company X practical recommendations *in what way* to improve the current situation, mitigate planning-related risks and work towards the desired situation:

1. *Operational,* on operational level an integrated business planning fits to Company X using the stage-gate process. This process aligns the operational processes and serves as coordination mechanism for project managers. We recommend backward planning, as sales specifies the installation period.
   A. Company X needs to set up a ''stage-gate'' process to improve integration and coordination.
   B. Use ''rules of engagement'' to ensure the quality of the stage-gate process. Rules can improve the consistency and transparency of their processes.
   C. Define a standard way to create detailed schedules (templates, input-transform-output). Important here is to integrate with the other processes using the gates.
2. *Tactical,* the stage-gate process creates also a link to the tactical level. On this level, resource classifications, sharing policies and priority rules guide resource managers to improve resource allocation.
   D. Company X can classify resources using a matrix, set up sharing policies and priority rules to structure the process of resource allocation.

E. For the resource capacity planning, we propose to define a standard for each planning. Specify the input, define the process of monitoring and matters such as capacity levels and KPIs.

3. *Strategic,* the resource capacity planning provides the interaction to the strategic level. The output of the tactical level serves as input for the strategic level to perform portfolio management, develop resources and create a technology roadmap.

4. *Commercial planning,* to ensure that Company X is ''doing'' the right projects and ''can do'' the project right, Company X needs to align projects with processes.

F. Therefore, we recommend to create an ''up-to-date'' project classification that considers process characteristics and the external environment.

To show in *what way* to benefit from the contribution of IBP, Company X needs to start with the ''people'' to have understanding, leadership and commitment. Afterwards, Company X must focus on the ''processes'' using a bottom-up approach. Therefore, starting at the operational level.

Finally we propose to focus on the role of ''technology'' (3). An integrated business planning is primarily about people and process; it requires understanding of processes and alignment of people's behavior. However, technology tools do play a major part in ensuring data and information is available to the process, and in helping to drive improvement in processes that are more sophisticated.

6.3 Limitations

The research has several limitations concerning:

- Sales was out of the scope of this research. As a result, we made limited statements about the aspects such as forecasts and portfolio management from a sales perspective. However, the RDT is part of the research, since it is one of the planning tools of central planning. The RDT serves as link between sales and execution.
- Due to the level of detail, we cannot make statements about the ''detailed activities'' within the departments themselves.

6.4 Future research

Besides recommendations regarding the *desired situation*, we have a few recommendations for further research in the near future:

- Finance was out of the scope. However, the literature addresses in many areas the role of finance within IBP. Therefore, we recommend further research into the role of finance.
- There is a late involvement of purchasing into the process of engineering. Therefore, we propose the following:
    - Perform a maturity assessment on the purchasing department. An assessment provides practical insights into the maturity of the purchasing department.
    - Explore the applicability of value engineering to create early involvement of purchasing. With value engineering, organizations eliminate any unnecessary costs, in order to achieve value for money on a project (Shaw, 2016). At the benchmark company, purchasing has an immediate role at the start of the engineering process.
- Within this research, we had a focus on the macro process. Therefore, methods such as critical path method and program evaluation and review technique were out of scope. We recommend using one of these methods to assess micro processes when analyzing ''operational'' processes.

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