FACULTY OF TECHNOLOGY

IMPROVING RESOURCE MANAGEMENT IN A PROJECT-ORIENTED COMPANY

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INDUSTRIAL ENGINEERING AND MANAGEMENT

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ABSTRACT

Improving resource management in a project-oriented company

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In a setting where multiple parallel projects depend on the same pool of scarce human resources, adequate resource management is crucial but also a challenging managerial task. The objective of this study was to improve resource management in a large industrial company that uses projects for most of its operations. The aim was to find solutions to the company's current challenges and propose a better approach for multi-project resource management, with a focus on the company's R&D and engineering resources.

This study was conducted as a qualitative case study. The study used multiple data collection methods, of which semi-structured interviews provided the most valuable data for the current state analysis. Solutions to the identified challenges were developed by combining the findings of the current state analysis with those of the literature review.

Based on the current state analysis, the company's resource planning practices were inadequate and required improvement. In addition, other fundamental challenges such as unclear roles and responsibilities, insufficient communication practices, and deficient data management contributed to the company's problems. The most significant improvement recommendation considers the adoption of a defined multi-project resource planning process with the goal of connecting the company's business plan to its daily resource assignments. The process also serves as a basis for other proposed solutions by guiding how roles and responsibilities, communication, and data management should be organized to support overall resource management. Although formulated for the case company and its circumstances, the proposed solutions can be beneficial for any company operating in a multi-project environment and facing similar challenges.

Keywords: resource management, project-oriented company, multi-project environment

TIIVISTELMÄ

Resurssienhallinnan parantaminen projektilähtöisessä yrityksessä

Lotta Arbelius

Oulun yliopisto, Tuotantotalous

Diplomityö 2023, 79 sivua + 1 liite

Ohjaaja yliopistolla: Jaakko Kujala

Resurssienhallinta on ratkaisevan tärkeä, mutta samalla myös haastava johtamistehtävä tilanteessa, jossa useat rinnakkaiset projektit ovat riippuvaisia samoista niukoista resursseista. Tämän tutkimuksen tavoitteena oli parantaa resurssienhallintaa suuressa teollisuusyrityksessä, joka käyttää projekteja valtaosaan toiminnastaan. Tarkoituksena oli löytää ratkaisuja yrityksen nykyisiin haasteisiin ja ehdottaa parempaa lähestymistapaa moniprojektiresurssien hallintaan. Tutkimuksen fokus on yrityksen tutkimus- ja tuotekehitysresursseissa sekä niiden hallinnassa.

Tutkimus toteutettiin laadullisena tapaustutkimuksena. Tutkimuksessa käytettiin useita tiedonkeruumenetelmiä, joista puolirakenteiset haastattelut tuottivat arvokkaimman aineiston nykytila-analyysille. Ehdotetut ratkaisut tunnistettuihin haasteisiin perustuivat nykytila-analyysin tulosten ja kirjallisuuskatsauksen yhdistämiseen.

Nykytila-analyysin perusteella yrityksen resurssien suunnittelukäytännöt olivat puutteelliset ja vaativat parannusta. Lisäksi muut haasteet, kuten epäselvät roolit ja vastuut, riittämättömät viestintäkäytännöt sekä puutteellinen tietojenhallinta, vaikuttivat yrityksen ongelmiin. Merkittävin parannusehdotus koskee moniprojektiresurssien suunnitteluprosessin käyttöönottoa, jonka tavoitteena on yhdistää yrityksen liiketoimintasuunnitelma päivittäisiin resurssien allokointeihin. Prosessi toimii myös perustana muille ehdotetuille ratkaisuille ohjaamalla roolien ja vastuiden, viestinnän ja tietojenhallinnan järjestämistä tukemaan kokonaisvaltaista resurssienhallintaa. Vaikka ratkaisut on muotoiltu tapausyritykselle ja sen olosuhteisiin, ne voivat hyödyttää mitä tahansa moniprojektiympäristössä toimivaa yritystä, joka kohtaa samanlaisia haasteita.

Avainsanat: resurssienhallinta, projektilähtöinen yritys, moniprojektiympäristö

FOREWORD

This thesis aims to examine resource management in a multi-project setting and provide justified suggestions for improving the current state of resource management in the case company. The thesis process was initiated in December 2021 and the written document was finally completed in June 2023. This writing process has taught me that even though everything does not always go as originally planned, and there may be a few bumps on the road, it is important to remain hopeful and keep the goal in mind. Eventually, you will reach it.

I would like to thank my supervisor Jaakko Kujala for his feedback and encouragement throughout this process. I am also grateful to Hannele Lampela for providing useful comments at the end of this process. I would also like to thank the case company for taking me on board and giving me this opportunity. Big thanks go to all the participants of the interviews who generously contributed their time to this thesis.

I am thankful to my family and friends, who have encouraged me throughout this process. Special thanks go to my lovely daughters; the joy you bring to my life every day prompted me to keep pushing forward. Finally, I want to express my deepest gratitude to my husband, Esa, who has been my greatest source of support during this process and at every step of my university studies.

Oulu, 6.6.2023

Lotta Arbelius
Author

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LIST OF ABBREVIATIONS

ERP	Enterprise Resource Planning
HR	Human Resource
HRM	Human Resource Management
R&D	Research and Development

1 INTRODUCTION

1.1 Background of this study

Projects are temporary organizations that utilize resources to deliver objectives of change (Turner and Müller 2003). Many organizations use projects as a form of work for at least part of their operations. Compared to traditional organizations, projects are considered flexible and less bureaucratic ways to operate and manage uncertainties (Jerbrant 2013). "Project-oriented" is a term used to describe organizations that utilize projects as a strategic choice to create change (Huemann et al. 2007).

Like any organizational operation, projects should contribute to accomplishing goals set by an organizational strategy. This requires management practices that simultaneously direct the set of projects towards the organization's strategic aims. (Artto and Dietrich 2004) A group of projects should be managed so that their interfaces are coordinated, and shared resources are prioritized between them to reduce uncertainty (Turner and Müller 2003). To accomplish organizational goals, it is crucial that the many times scarce organizational resources are allocated to the projects in a way that produces the best outcome for the organization (Aalto 2001).

The traditional project management approach considers projects as separate entities without links to each other (Laslo and Goldberg 2008). However, this is not always the case, as in addition to their internal interfaces, projects may have links to other projects either directly or indirectly, such as through shared resources (Payne 1995). In a multi-project environment, in which several projects are executed simultaneously and successively while drawing resources from a common resource pool, resource allocation becomes a complex management task (Engwall and Jerbrant 2003). As the number of projects and resource capabilities needed to realize them increases, so does the importance and difficulty of the resource allocation process. In multi-project environments, traditional project management practices appear to be less sufficient; thus, different, dynamic multi-project management practices are required to allocate resources efficiently. (Dye and Pennypacker 2000) The ultimately purpose of these practices should be to connect the day-to-day work assignments of persons to the organization's long-term business plan (Hendriks et al. 1999).

However, finding the best management practices, especially in such complex environments, is easier said than done. The project-oriented case company participating in this study has experienced difficulties in resource management and planning. The case company is a large Finnish industrial company that executes multiple simultaneous and successive projects. The projects of the case company are large and complex, and depend heavily on the same human resource pool. Thus, resource management plays a significant role, as it is crucial to ensure that resources are planned and allocated to projects and tasks in a manner that best supports the company's overall success and helps achieve its strategic business goals. However, the current resource management approaches in the case company, which may be more traditional, are experienced to be ineffective and inefficient for the intended purposes. It is necessary to adopt management practices and processes that consider the complexity of the multi-project environment, as well as the specific circumstances of the company, to improve the current state of multi-project resource management.

1.2 Research objectives and scope

The objective of this study is to improve resource management in a project-oriented case company. This study aims to develop solutions to the challenges currently occurring in the case company and propose better processes and practices for resource management in a multi-project environment. The objective of this study is reached by researching previous literature of the topic and conducting a current state analysis of the case company's situation in order to produce adequate improvement recommendations. To guide and support the research process, the following research questions (RQs) were developed:

RQ1: How to manage resources in a multi-project environment? This research question is answered by conducting a literature review of previous research related to the topic. The aim is to determine what kinds of organizational structures are used to house projects and what are the special characteristics of human resource management in project-oriented organizations. The literature review is then continued to understand how resources are managed in multi-project environments, what practices have been observed to be useful in multi-project resource management, and what kind of challenges are associated with it, according to earlier research.

RQ2: What is the current state of multi-project resource management in the case company regarding its R&D and engineering resources? This research question is addressed by conducting a current state analysis of the case company's multi-project resource management. The aim is to find out what kind of challenges the company has experienced related to resource management, and what are the organizational structures, practices, and processes currently used in the case company for multi-project resource management. This research focuses on one of the company's functional departments, R&D and Engineering, and its resources.

RQ3: What kind of management approach would be suitable for the case company to better manage its R&D and engineering resources? This research question is covered by discussing and mirroring the results of the literature review and the empirical study. Based on the insights provided by the literature review of earlier research and the current state analysis of the company's multi-project resource management, justified recommendations on how the company's resource management could be improved are provided.

1.3 Structure of the study

This master's thesis consists of five distinct parts. In the introduction, the study's background, research objectives, scope, and structure are described. The next part, the literature review, focuses on building a theoretical foundation for resource management in a multi-project environment. The literature review focuses on three themes: organizational structures used to house projects, resource management in project-oriented organizations, and multi-project resource management. At the end of the literature review, the findings of the three theoretical themes were synthesized.

The third part of this thesis is concerned with the current state analysis. In this empirical part of the thesis, the case company's current situation, challenges, and management approaches regarding resource management are researched using a qualitative case study method. At the end of the current state analysis, the findings are synthesized into a distinct list of identified resource management challenges.

The fourth part of this thesis discusses the results of the literature review and empirical study. Furthermore, the findings from the literature review are utilized as a theoretical

background to propose improvement recommendations for the case company's current situation. The discussion and improvement recommendations primarily focus on the challenges identified as the most significant areas that require attention and change to enhance the case company's resource management. The proposed solutions to the identified challenges are summarized at the end of the section.

Finally, in the fifth part of this thesis, conclusions are presented by stating the key results of the study, its managerial implications, and scientific contributions. In addition, the fifth part includes a critical evaluation of the research and recommendations for further research. The structure of the master's thesis, along with its connections to the research questions, is illustrated in Figure 1.

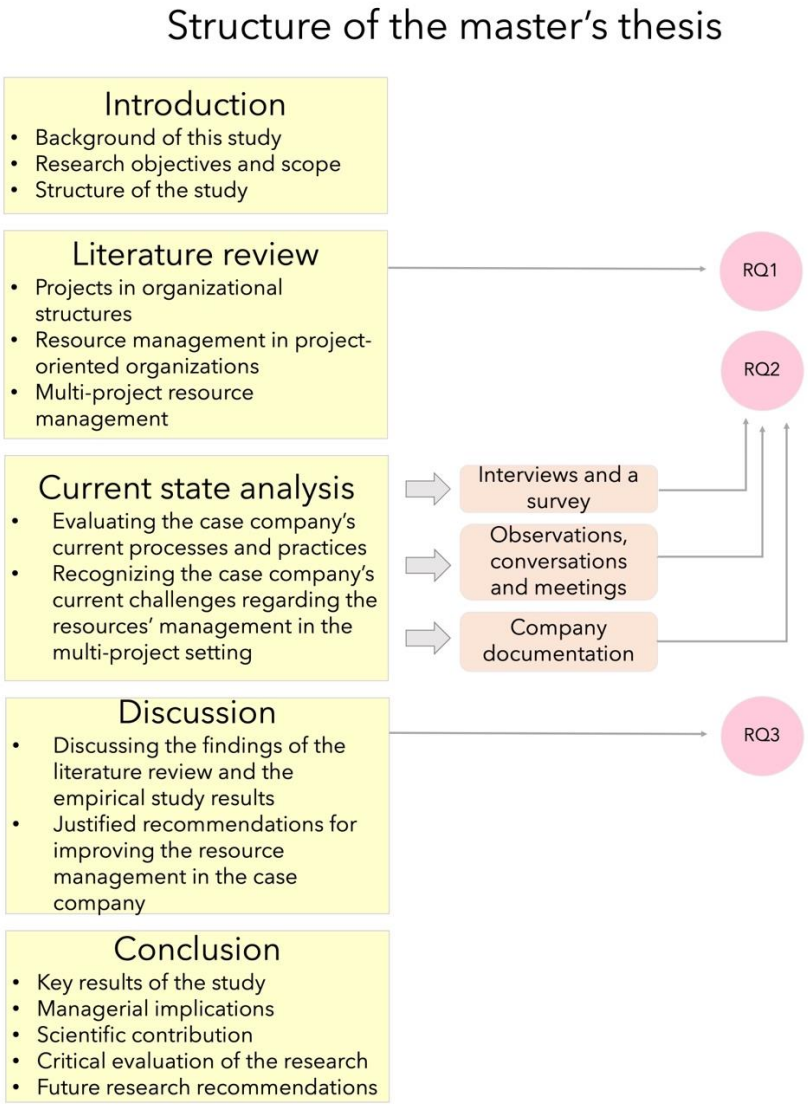

Figure 1. Structure of the master's thesis.

2 LITERATURE REVIEW

2.1 Projects in organizational structures

Organizations use different types of organizational structures to execute and manage their projects. The choice of selecting an organizational structure for a project and what kind of interfaces it has with the parent organization are addressed to senior management (Meredith et al. 2016). The selection of the organizational structure is done by considering the project and the situation in hand – and even so, it is argued to be at least partly an intuitive process (Meredith et al. 2016). According to Cristóbal et al. (2018), key factors that affect the selection of the organizational structure include: division of labor; the organization's previous experience with different project organizational forms; interdependence of systems and cross-functional activities and interactive management; concurrent engineering of cross-functional teams; authority, responsibility and leadership; unity of command; personnel; stakeholders; spans of control; flexibility; cultural values; and other factors, such as project size and duration, external environment and technologies to be used.

The organizational structures differ in who operates, manages, and controls the project, and who has authority and management responsibility over the resources and their work in the project. Usually, several parties are involved in project management in some way, such as senior management, project managers, organization functions (e.g., Finance, Marketing, Manufacturing, Engineering, etc.), and functional managers of these functions. The literature recognizes three general organizational forms that organizations commonly use to arrange projects: a functional organization, a projectized organization, and a matrix organization (Meredith et al. 2016, p. 137; PMI 2017; Larson and Gobeli 1989). However, these general structures in their "purest" form are seldom found in organizations, as the organizations tend to alter or even use a mix of these structures (Meredith et al. 2016, p. 147); nevertheless, the general forms are still suitable for understanding the different ways to house projects. The general project organizational structures are described in the following text.

2.1.1 Functional organization

In a functional organization structure, a project can be assigned to an organization's functions to be planned, executed, and managed, with functional or upper-level management coordinating the project (Larson and Gobeli 1989). Coordination concerning the project is thus maintained through the usual management channels (Larson 2007). For example, a project can be placed in the organizational structure under the function that can provide the most effort to implement the project or is most interested in making it successful (Meredith et al. 2016, p. 137; Larson 2007). Alternatively, the project could be delegated to all relevant functions or groups within the functions, with each being held responsible for their part of the project (Meredith et al. 2016, p. 137; Larson 2007; Larson and Gobeli 1989). A separate project manager, if even assigned, usually works only part-time and has limited authority over resources and the project budget, functioning primarily as a coordinator and planner of the project (PMI 2017; Turner et al. 1998). Figure 2 presents a simplified model of a functional organization.

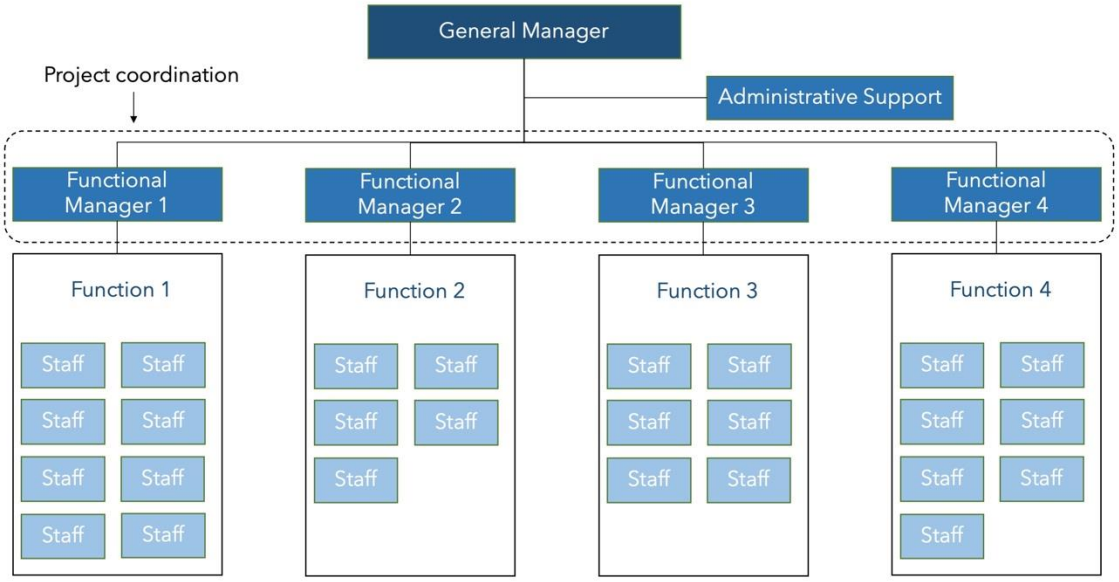

Figure 2. Functional organization (modified from Larson 2007).

2.1.2 Projectized organization

A projectized organization or *project team* organization (see Figure 3) can be seen as the opposite of a functional organization, as instead of functions, the whole organization is dedicated to serving projects (Hobday 2000; Larson 2007). A projectized organization is an organizational structure in which each project has its own core workers needed for its

operations, meaning that they are self-sufficient with staff from different functional areas assigned to work directly for the project, usually full-time (Larson and Gobeli 1989; Meredith et al. 2016, p. 140). In some organizations, projects may have complete freedom to organize within the boundaries of financial accountability, while others may appoint common administrative support that serves all the organization's projects (Meredith et al. 2016, p. 140). In this organizational form, a project manager composes and manages the project and its team with full authority. Functional managers are not formally involved in project management, and project workers are directly responsible only for project managers. (Larson and Gobeli 1989; Meredith et al 2016, p. 141)

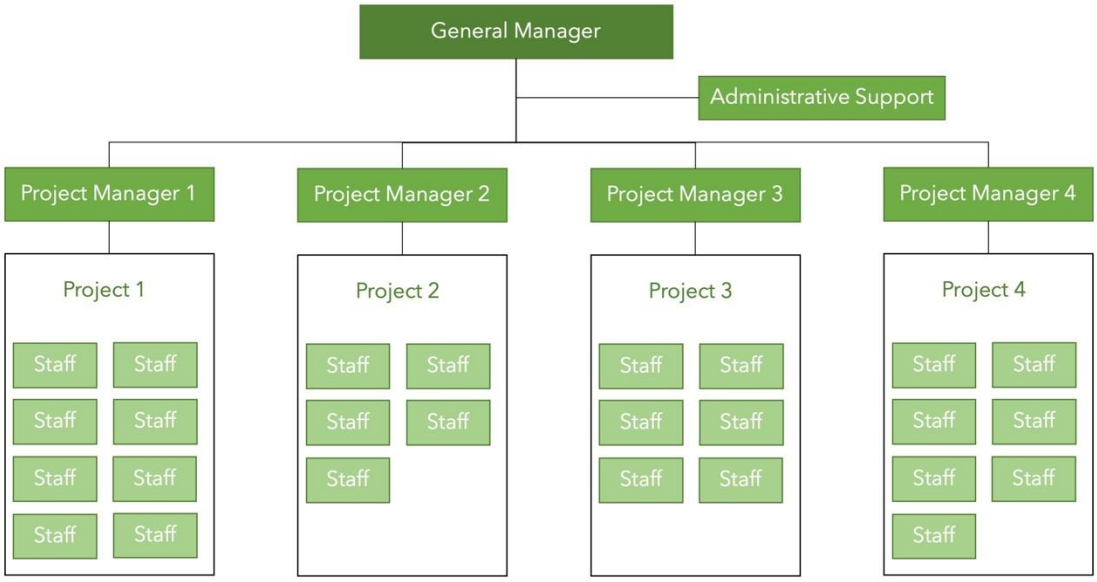

Figure 3. Projectized organization (modified from Meredith et al. 2016, p. 141).

2.1.3 Matrix organization

A matrix organizational structure (see Figure 4) can be perceived as a combination or hybrid of the two organizational structures described earlier. The matrix structure can be defined as *"a grid-like structure with horizontal and vertical dimensions representing functions, geographical zones, projects, or products"* (Moodley et al. 2016, p. 104). Integrating a matrix organization and project management creates a cross-functional organizational overlay, where multiple authority lines exist and workers are assigned to teams to work on specific tasks for designated time periods (Ford and Randolph 1992). Generally, this means that employees of a matrix organization have technical responsibilities for the projects they work on, while the function they represent assesses and defines their performance and promotion (Moodley et al. 2016).

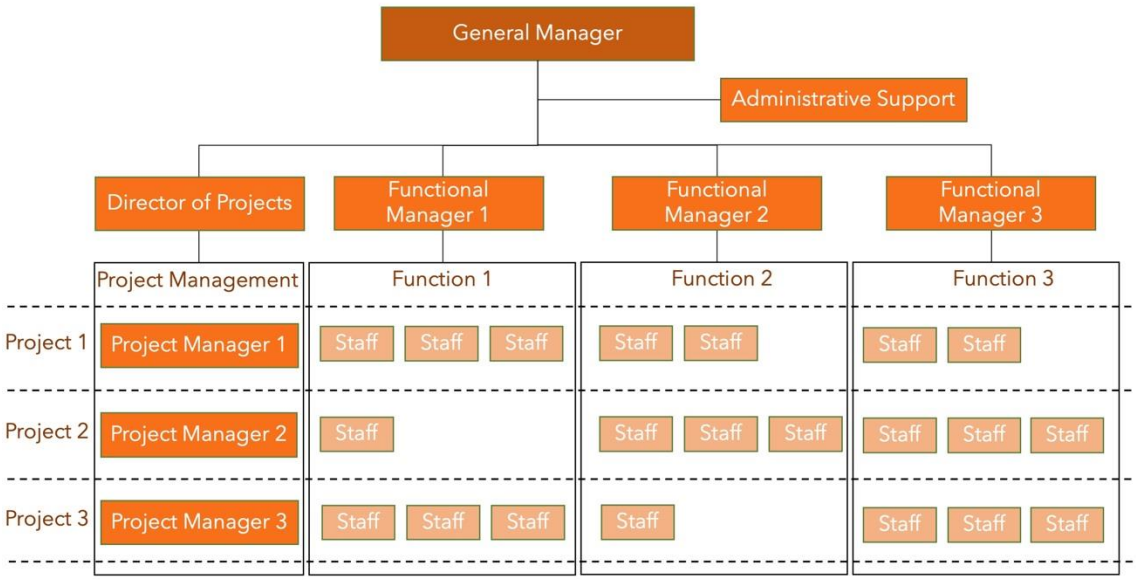

Figure 4. Matrix organization (modified from Larson 2007).

The matrix is an organizational structure in which people are grouped from different functional organizations into temporary project teams based on the specific skills that projects need, creating a dual-authority situation in which each individual working for a project is accountable for both a project manager and a functional manager (Dunn 2001). How much authority and responsibility the managers have over the project and over the individuals working in it depends on the type of matrix structure the organization has adopted. Earlier literature usually describes three general types of matrix organization that differ in how the authorities and responsibilities over the project, its resources, and work are divided between the project manager and the functional manager:

In a *functional matrix* or *weak matrix*, a project has a formally designated coordinator, a project manager, who plans project work across different functional areas but has limited authority over functional project workers (Larson and Gobeli 1989; Larson 2007). Functional management has the main responsibility of executing the functions' parts of the project, and instead of workers as individuals, they provide work capacity for the project. (Meredith et al. 2016, p. 144) Functional managers have the authority to make almost all significant decisions in the project, and the project manager works rather as a staff assistant with indirect authority to expedite and monitor the project (Larson 2007).

In a *project matrix* or *a strong matrix,* a project manager is held responsible for the completion of the project and manages its budget, scheduling, and execution with high authority. In the project matrix, functional managers' involvement in the project is limited

to providing the resources the project manager asks for to work either part-time or full-time, based on the project's needs. (Larson and Gobeli 1989) Meredith et al. (2016, p. 143) describe the different authorities of the project manager and functional manager over the project workers in the strong matrix by stating that *"(Project manager) controls when and what these people will do, while the functional managers control who will be assigned to the project and how the work will be done, including the technology used"*.

A *balanced matrix* is a matrix organization type between the strong matrix and weak matrix and may include different combination of project and functional responsibilities (Meredith et al. 2016, p. 144). In balanced matrix, a project coordinator oversees and plans a project, and together with functional managers directs project work segments and agrees with technical and operational decisions (Larson and Gobeli 1989; Turner et al. 1998) – thus, close cooperation between the parties is required to make the balanced matrix work (Larson 2007). Larson (2007) describes more in detail that in balanced matrix, the project manager formulates the overall project plan with combined contributions of different functional areas, sets schedules and monitors the projects' progress, and based on the project manager's plan and standards, the functional manager assigns correct people to execute their part of the project.

2.1.4 Comparison of the organizational structures

Due to uniqueness of projects and special circumstances of organizations executing them, there is not a single project organization structure that would be universally best for all projects (Cristóbal et al. 2018; Meredith et al. 2016, p. 136). Each project structure has its own advantages and disadvantages. A functional organization enables flexible use of resources, does not require the parent organization to make fundamental changes to its design (Larson 2007), and members of a project team are most likely familiar with each other (Cristóbal et al. 2018). However, low commitment to project work, poor integration across different functions, lack of ownership, and employees' low motivation are possible disadvantages of the functional organizational form (Larson 2007; Cristóbal et al. 2018).

The advantages of the projectized organization as a form to house projects include, for example, better communication between the project manager and senior management due to shortened lines of communication, unity of command, the project manager's full line authority over the project, and the possibility of increasing motivation, commitment, and learning of the project workforce as a result of a stable project team with a strong and

separate identity (Meredith et al. 2016, p. 141). On the other hand, the projectized organization can be expensive, resources might not be used efficiently because of their possible duplication in various projects, sharing knowledge across projects is limited, and the transition from project work to other tasks post-project might be difficult (Larson 2007; Cristóbal et al. 2018).

The advantages of matrix organization include the efficient use of resources, employees' flexible movement from one project to another without making the change permanent, strong project focus combined with functional input, and easy post-project assimilation (Cristóbal et al. 2018; Larson 2007). In addition to the inherent tendency of matrix organizations for constant conflicts between functional managers and project managers, as well as between different project managers due to their infighting over often scarce resources (Laslo and Goldberg 2008), other possible disadvantages of the form include slow decision-making, absence of unity of command, high administrative costs, stressful work environment, and complex reporting relations (Cristóbal et al. 2018; Larson 2007).

It is argued that the functional organization would be more suitable for projects where the focus is on the systematic application of a technology or to projects demanding sizeable capital investments in equipment or buildings that are typically used by the function (Meredith et al. 2016, p. 149). A projectized organization for project management is preferred for an organization that executes a very specific one-time project requiring high control and is not suitable for only one functional area, or engages in a large number of similar projects that are typically huge, valuable, and long-term, such as construction projects (Cristóbal et al. 2018; Meredith et al. 2016, p. 149). Because projects with the projectized form operate separately from other operations in the organization, the projectized form is also suitable for flexible working on new products or services without being constrained by old habits and limitations of other operations of the organization (Poli et al. 2010). Matrix organizational structures are typically found in organizations that produce several different products or services and must be able to react and adapt quickly to diverse technological, environmental, and other changes by altering their product or service offerings (Ford and Randolph 1992).

Although there appears to be few studies conducted on how the adopted project organization structure can influence success of an organization's projects, they still indicate differences in success between the organizational structures. Lechler and Dvir

(2010) state that projects using structures in which project managers lack proper responsibility and authority, or the support of senior management, tend to fail. Larson and Gobeli (1989) judged in their study over 500 development projects' success based on cost control, schedule, technical performance, and overall results. They found that development projects using functional organization and functional matrix for their project management were the least successful and had problems in all the judged areas, whereas for the development projects using the project team, the project matrix or the balanced matrix were found to be the most successful and did not have clear differences in technical performance and overall results between them. (Larson and Gobeli 1989) Results of a survey study on project-oriented companies by Hyväri (2006) are somewhat consistent with Larson and Gobeli (1989), as they indicate that the project team and the project matrix are the most effective organizational structures of project management in companies that realize most of their operations through projects. Poli et al. (2010) studied real-life projects using the project team, matrix, and functional organizational structures and concluded that the project team form achieved the best results regardless of the amount of change the projects were meant to create.

2.2 Resource management in project-oriented organizations

2.2.1 Project-oriented organizations

Project-oriented organizations are organizations that use projects as a strategic choice to develop and realize their strategies, and to create new products, services, and business models (Gemünden et al. 2018). To implement this chosen organizational strategy of "managing by projects", the project-oriented organizations also form their work policies and practices, organizational culture, and strategies to answer the challenges of project management (Huemann et al. 2007). Some of the biggest managerial challenges of project-oriented organizations are ensuring that their projects follow and apply the same strategy as the organization management, and that the often-scarce organizational resources are allocated to the projects moving the organization in the desired direction (Aalto 2001).

All organizations are not similarly project-oriented (Keegan et al. 2012). The degrees of project orientation among organizations vary, for example, due to the number, sizes, and types of projects. The extent of project orientation can also vary: some organizations implement almost all their internal and external operations and actions through projects,

such as some construction firms, whereas others may use projects for a specific part of their activities or for an organizational unit, such as a research and development (R&D) department of a manufacturing firm. (Huemann et al. 2007) Keegan et al. (2012) argue that, among all project-oriented organizations, the latter are more common.

According to Huemann et al. (2007), project-oriented companies have certain significant features relevant to resource management. The temporary and uncertain nature of projects and the continual fluctuation and variation of a project portfolio result in a need for resource management processes and practices for managing the dynamic work environment, repeated resource configuration changes, and varying resource and multi-role demands (Huemann et al. 2007). Compared to a classical functional organization, current and future resource requirements for the project-oriented organization are uncertain, the career paths of people differ from the traditional climbing up of "career ladders" resembling more like "spiral stairs", and all people in the organization may not have a functional home they belong to outside projects (Huemann et al. 2004).

2.2.2 Project-oriented organizations' resource management process

Huemann et al. (2007) discuss the differences of resource management process between the classically managed company and the project-oriented company. In a classically managed company, human resource management (HRM) at a large extent can be simplified to a linear process consisting of the selection, employment, and release of human resources, whereas in project-oriented companies, there is also a sub-process that considers a temporary project (Huemann et al. 2007). In project-oriented companies, fluctuations in the number of projects and changes in the projects' needs require continual reconfiguration of personnel (Keegan et al. 2012; Huemann et al. 2007). Thus, at the project level, company resources are assigned, employed, and dispersed from the project repeatedly during the project's life cycle, and this requires attention and effort from resource management as well. (Huemann et al. 2007) Simplified resource management processes in classically managed and project-oriented companies are presented in Figure 5.

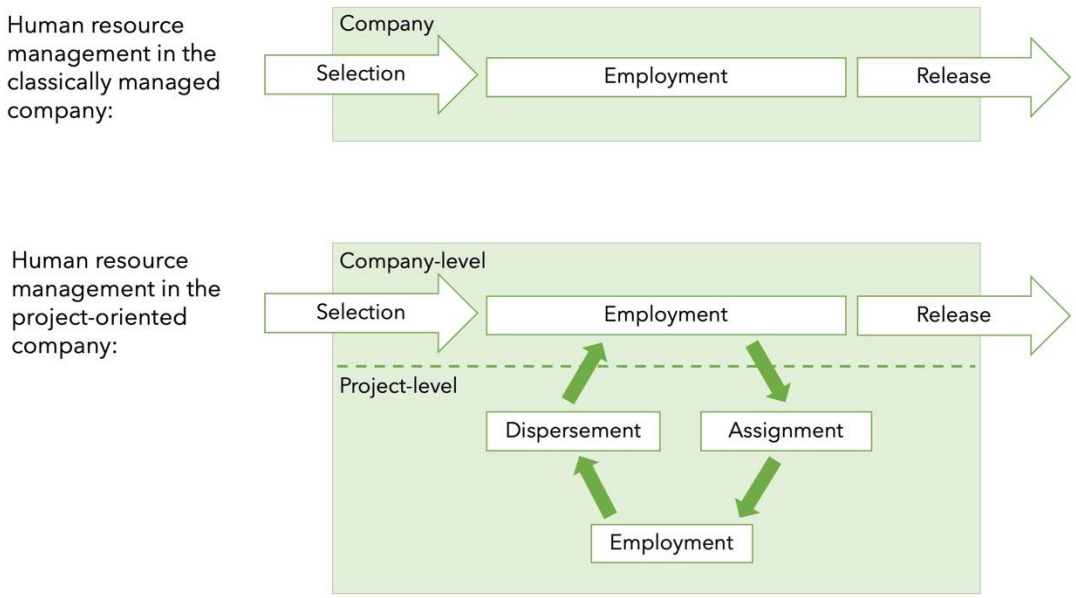

Figure 5. Human resource management in a classically managed versus project-oriented company (modified from Huemann et al. 2007).

In project-oriented organizations, responsibilities and authorities for managing human resources across boundaries of permanent and temporary organizations are typically shared between an HRM department, line managers, and project managers, but the exact division of these responsibilities differs between organizations (Keegan et al. 2012). As projects as temporary organizations create a secondary layer to an organization, the resource management must extend to this temporary part of the organization in addition to the permanent line organization. The permanent organization's resource management and the project's resource management must be linked and ensured that they support one another; for example, in terms of recruiting, the line resource management must recruit needed capable personnel on time for the projects based on their schedule, and the project resource management on the other hand must maintain a project resource management system and forecast its resource requirements. (Huemann 2014)

Earlier research indicates that project-oriented organizations tend to adopt the matrix as an organizational structure for project management, while the projectized organizational form is also a frequently selected structure (Turner et al. 1998; Hyväri 2006). Keegan et al. (2012) argue that adopting the matrix as an organizational structure for project management is especially preferred in companies that use the project-oriented approach only for a particular part of their operations or to an organizational unit.

2.2.3 Resource management related challenges in project-oriented organizations

The features of project-oriented organizations influence also possible resource management challenges that should be acknowledged and addressed. Despite some common trends, there are a variety of ways how human resource management practices are implemented in project-oriented organizations (Keegan et al. 2012). Keegan et al. (2012) studied the roles and responsibilities of project managers, line managers, and a HRM department in different organizations. They claim that roles and responsibilities in resource management may be perceived differently by both managers and employees in project-oriented organizations, and that this unclarity may result in the overall human resource management not being as effective as intended (Keegan et al. 2012).

Turner et al. (2008) researched well-being and ethical treatment of employees in project-oriented organizations. They argue that, for employees in project-oriented organizations, constantly changing configurations of human resources and the transient and dynamic work environment may create additional pressures through peaking workloads, difficulties in matching project assignments to career development goals, and uncertainty about the future in terms of the schedule of the next assignments, nature and location of the assignments, and project work colleagues. Unfortunately, their research also confirms that organizations do not tend to tackle these problems very well because taking corrective actions usually threatens profitability and would require a proper resource management system that they lack. (Turner et al. 2008)

The allocation of project personnel is one of the critical tasks of resource management in project-oriented organizations, as it has a direct impact on project management and project personnel's career development, learning opportunities, and progression in the organization, as well as strongly influencing work-life balance (Keegan et al. 2012). In addition to criticality, resource allocation is also an area in which organizations that use projects as a main principle for organizing tend to have problems with (Jerbrant 2013).

2.3 Multi-project resource management

The traditional way to manage a project is to consider it as an independent entity with no relation to other possible projects in an organization (Laslo and Goldberg 2008; Laslo 2010; Jerbrant 2013). Traditional project management can be applied to project-oriented organizations whose projects are self-sufficient. However, this is usually not the case, as

multiple projects in an organization tend to compete for shared scarce organizational resources (Laslo and Goldberg 2008; Jerbrant 2013). If an organization's projects are executed side-by-side while using resources from the same organizational resource pool, such an organization is said to be operating in a multi-project environment (Engwall and Jerbrant 2003).

2.3.1 Multi-project environment

A multi-project environment is an organizational setting in which multiple projects are planned and executed simultaneously or successively, drawing at least some resources from a shared resource pool, thus tending to compete for the same, many times scarce, resources (Hans et al. 2007; Ponsteen and Kusters 2015; Engwall and Jerbrant 2003; Payne 1995). In addition to sharing resources, the projects also share the same management system (Zika-Viktorsson et al. 2006; Ponsteen and Kusters 2015; Payne 1995). The multi-project setting is a way for organizations to use scarce resources efficiently by using them in several projects (Zika-Viktorsson et al. 2006). The projects in the multi-project environment may not have functional relations with each other, meaning that there might be both standalone projects and projects with interlinked goals, but they are still managed together as a set of projects to fulfill the objectives set by the organization with shared resources (Ponsteen and Kusters 2015). A model of the multi-project environment is shown in Figure 6.

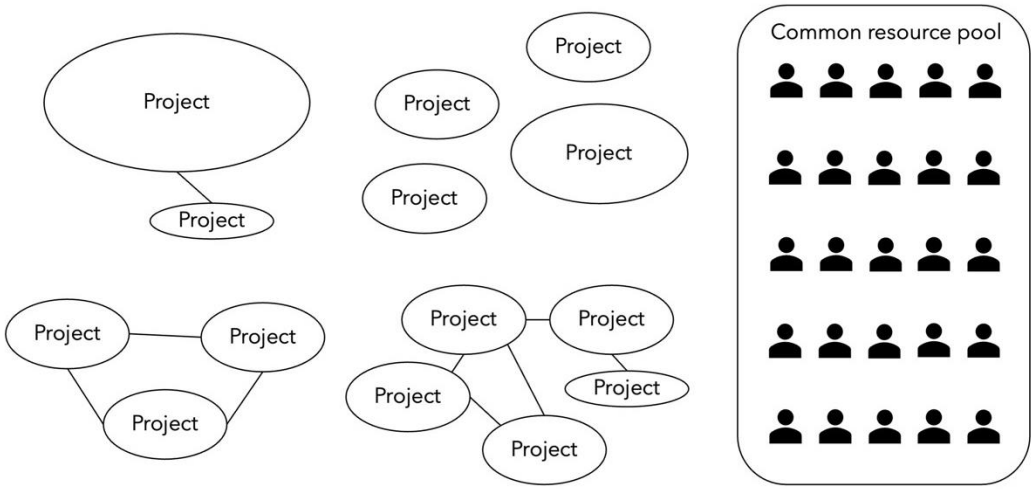

Figure 6. Multi-project environment (modified from Ponsteen and Kusters 2015).

As there are differences between projects, so there are differences between multi-project environments. Hans et al. (2007) classify in their positioning framework the multi-project environments based on two factors: a degree of variability of projects and their activities, and a degree of dependency, which describes how dependent projects are from external factors outside the project, such as work and materials from suppliers and internal organizational resources shared with other projects in the organization. In general, the higher the degrees of variability and dependency, the more difficult it is to manage the multi-project environment (Hans et al. 2007).

Organizations operating in multi-project settings use different structures and practices for their management. According to Geraldi (2008), dealing with the projects' and project portfolios' different types and intensities of complexity in the multi-project organizations demands management structures that allow different degrees of flexibility. Hans et al. (2007) argue that the degree of dependency of a multi-project organization usually strongly affects its selection of an organization structure. For example, multi-project organizations with a high degree of dependency tend to adopt a matrix organizational structure (Hans et al. 2007) — in an environment where workloads change fast between functional departments, the matrix organization is argued to allow easier accomplishment of projects' work objects (Laslo and Goldberg 2008).

2.3.2 Project portfolio management and multi-project management

To successfully manage multiple projects, organizations use different practices that are typically intended to strategically align projects and an organizational strategy, balance numerous parameters for project prioritization, and maximize the total value from multiple concurrent projects (Martinsuo et al. 2020). It is essential that management processes above the projects build links from the projects to the organization's goals, and thus support accomplishing or exceeding the targets set by the organizational strategy (Artto and Dietrich 2004).

Terms of *multi-project management* (or sometimes multiple project management) and *project portfolio management* have both been used in past literature in the context of managing multi-project environments. PMI (2017) defines project portfolio management as collected management of a set of projects that are not necessarily directly related to accomplish strategic objectives. Its purpose is to ensure that the executed projects implement the company strategy, move the company to the wanted direction, and produce

value for shareholders (Aalto 2001). Project portfolio management concerns managerial actions of evaluation, selection, and prioritization of projects; simultaneous reprioritization of the portfolio's projects; and resource allocation and reallocation to projects based on priority (Blichfeldt and Eskerod 2008). It is a dynamic decision process that overlaps with or covers several decision-making processes within the business and is marked by information that changes and is uncertain, numerous objectives and strategic considerations, dynamic opportunities, interdependent projects, and several decision-makers and locations (Cooper et al. 1999). Even though the project portfolio management is a continuous process, Aalto (2001) states that the projects of the portfolio should not be evaluated constantly; instead, the decision-making should concentrate on defined milestones, that is, decision points in the project, and their frequency should be arranged based on the project type and size.

In some earlier studies, multi-project management is discussed under the concept of project portfolio management in a multi-project environment (Elonen and Artto 2003, Laslo 2010; Platje et al. 1994), or it is referred to as the overall management of multi-project environments (Hans et al. 2007). Some other studies differentiate between project portfolio management and multi-project management by stating that although both relate to the management of a set of projects, the terms are not synonyms; for example, Ponsteen and Kusners (2015, p. 166) define multi-project management as "*short-term tactical management of a set of projects in execution that share the same resources".* Dye and Pennypacker (2000) further distinguish the processes of project portfolio management and multi-project management at a high level by stating that project portfolio management focuses on strategic selection and prioritization of projects with long-term and medium-term planning emphasis, while multi-project management focuses on short-term resource allocation for multiple selected projects. Usually, portfolio management is the responsibility of senior management, while project and line managers are responsible for multi-project management (Dye and Pennypacker 2000). The differences in project portfolio management and multi-project management at a high level are listed in Table 1.

Table 1. Differences of project portfolio management and multi-project management on a high level (modified from Dye and Pennypacker 2000).

	Project portfolio management	**Multi-project management**
Objectives	Selection of projects and their prioritization	Resource allocation for multiple projects
Responsibility of	Executive and senior managers	Project and resource managers
Focus	Strategic	Tactical
Planning emphasis	Long- to medium-term	Short-term

2.3.3 Multi-project resource planning and allocation

In the literature that considers multi-project management, resource allocation seems to be a commonly discussed theme (Hendriks et al. 1999; Ponsteen and Kusners 2015; Laslo and Goldberg 2008; Payne 1995; Engwall & Jerbrant 2003). The focus and main purpose of resource management in a multi-project context should be to allocate resources to projects in a way that is most favorable to an organization and its overall goals (Laslo and Goldberg 2008). To accomplish this, organizations must link long-term business strategies to short-term resource allocation for multiple projects (Dye and Pennypacker 2000; Hendriks et al. 1999).

However, there is a large gap in drawing a connection between an organization's business strategy and the day-to-day planning of resources in multiple projects. Thus, Dye and Pennypacker (2000) argue that an additional process step, medium-term resource allocation, is vitally needed to successfully link strategy and day-to-day planning. Hendriks et al. (1999) contribute for solving this problem by presenting their multi-project resource allocation process for a R&D organization consisting of five fundamental elements: long-term resource allocation, medium-term resource allocation, short-term resource allocation, links, and feedback (see Figure 7). The elements of long-, medium-, and short-term resource allocation have their own goals, but they should all be linked together to enable the best business results. In addition, feedback and data should be exploited during all subprocesses and shared between them to optimize the overall multi-project resource allocation. (Hendriks et al. 1999) The ultimately goal of the multi-project resource allocation process by Hendriks et al. (1999) is to increase efficiency and the overall results of multiple projects, especially by urging the management to make

decisions on the project portfolio and their resource allocation, and by pushing the project managers into contacting the resource managers in a structured manner.

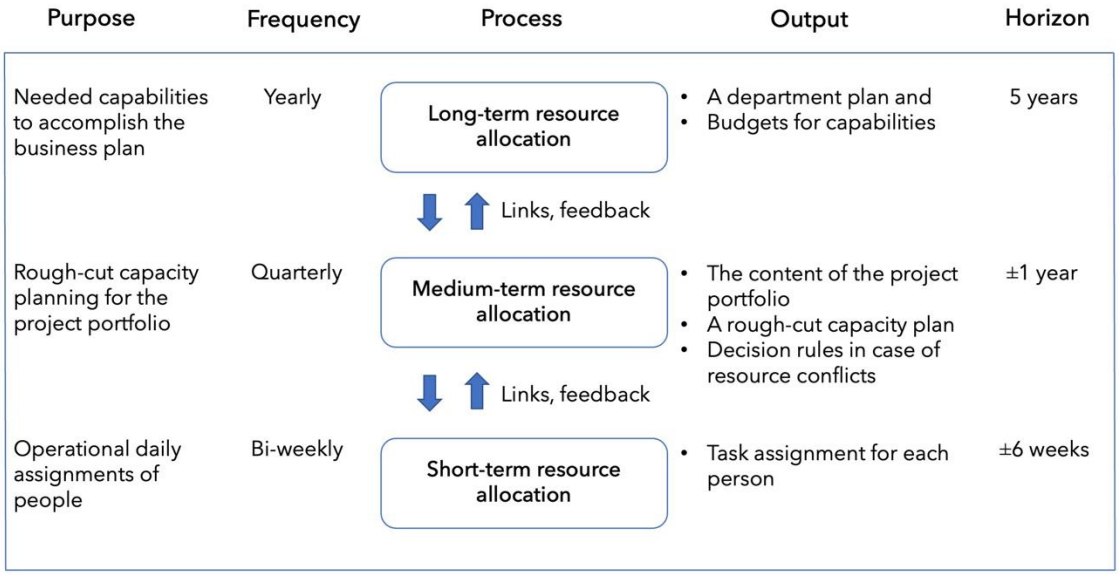

Figure 7. Multi-project resource allocation process for an R&D organization (modified from Hendriks et al. 1999)

It is a common state that at least occasionally, resource claims by projects exceed the available number of resources (Payne 1995; Hendriks et al. 1999; Dye and Pennypacker 2000). In addition, conflicts tend to arise when two or more projects demand the same resources simultaneously (Hans et al. 2007). Thus, possibly the most essential outputs of the overall resource allocation process presented by Hendriks et al. (1999) are the decision rules and rough-cut capacity plan created during the medium-term resource allocation. As resource overload is always a possibility, the purpose of the decision rules is to guide project and resource managers in case of resource conflict by making it apparent which tasks should then be executed first. The rough-cut capacity plan on the other hand is a plan in which resources are roughly allocated to different projects and should be composed in an agreement between project managers and resource managers. When the use of resources is agreed on an approximate level for a certain time horizon, project managers can estimate the expected effect of possible unavailability of resources on their project's schedule, communicate the delay further, and prepare for it with needed actions. (Hendriks et al. 1999)

Other multi-project management frameworks that aim to connect strategic planning to daily activities have also been introduced in the literature. The hierarchical planning framework proposed by de Boer (1998) consists of four levels, starting from strategic

resource planning and moving all the way to the operational level process of detailed scheduling (see Figure 8). De Boer (1998) states that in most multi-project environments, it is not usually reasonable to plan all the work on a single level, as the information would be inaccurate due to uncertainty revolving around it, and collecting all the data would require too much time. Thus, planning should be divided into different levels with different planning horizons, review intervals, and needs for input data and data accuracy (de Boer 1998). Similar to the framework of Hendriks et al. (1999), the planning levels in de Boer's (1998) framework have different goals, receive information as inputs from preceding levels, and exchange feedback to ensure upward compatibility. The four levels of the planning framework also require input from process planning: work packages needed to realize the project are at first roughly planned based on customer specifications ("rough-cut process planning"), but as the project is accepted and goes on, the work packages can be broken down into more detailed activities with resource and material requirements ("engineering & process planning"). (de Boer 1998)

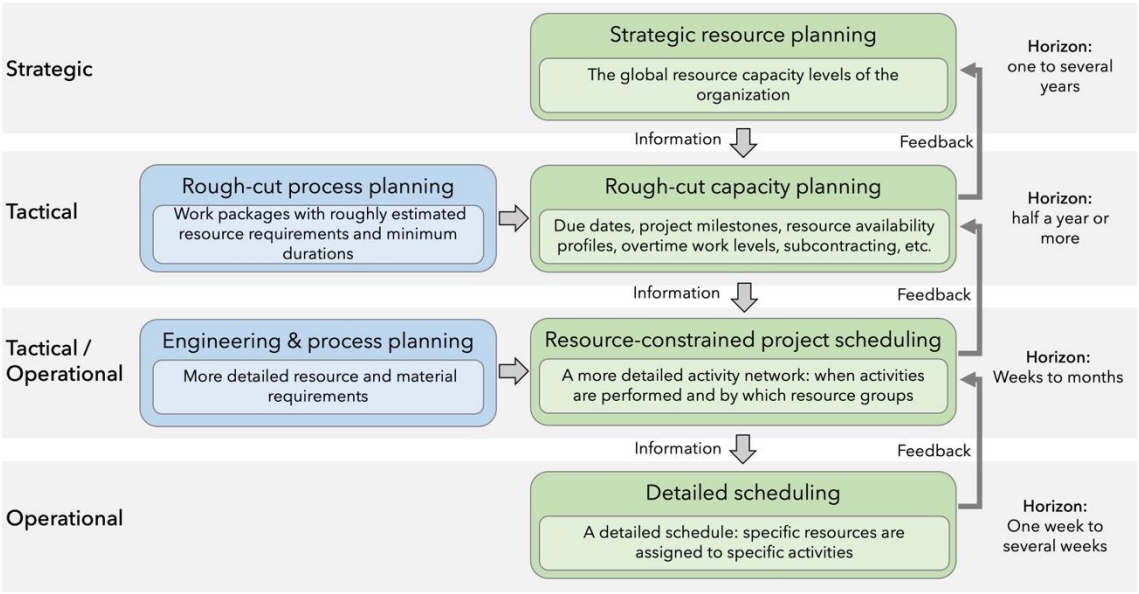

Figure 8. Hierarchical planning framework (modified from de Boer 1998, p. 36).

Hans et al. (2007) propose a hierarchical planning framework for multi-project management (see Figure 9) that builds partly on the framework by de Boer (1998). Compared to de Boer (1998), Hans et al. (2007) place both the processes of resource-constrained project scheduling and detailed scheduling on the operational planning level and include also technological planning and material coordination planning functions into their framework. To perform multi-project planning properly, Hans et al. (2007) argue

that projects in a multi-project environment should be considered together at the same time on each of the planning levels while acknowledging that the levels have different aims, flexibility of capacity, and aggregation degrees.

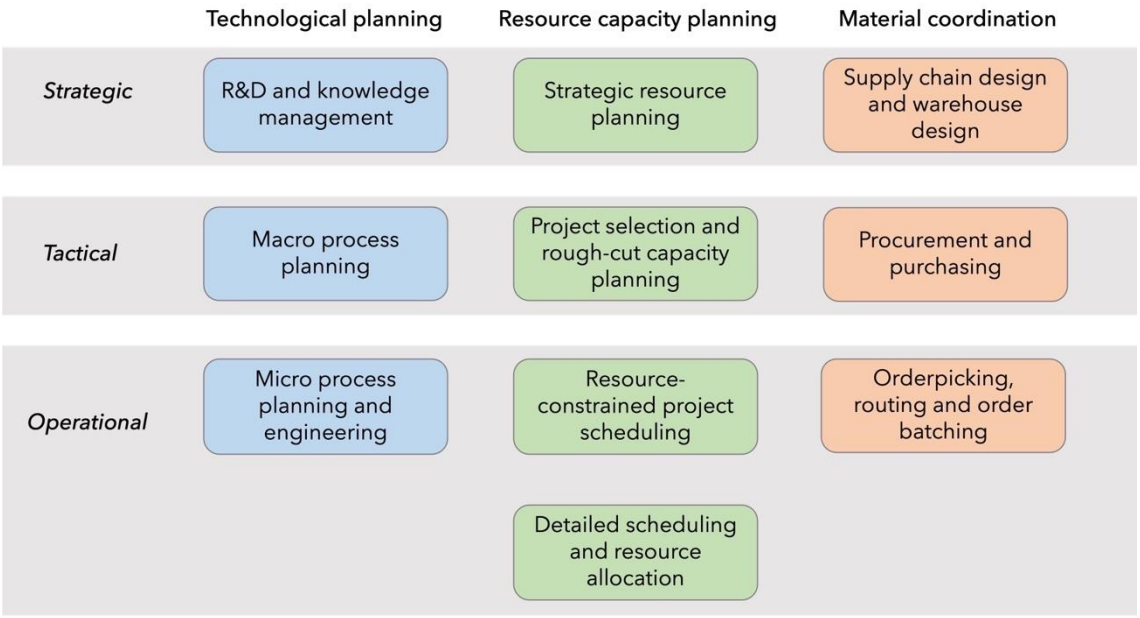

Figure 9. Hierarchical framework for multi-project planning (modified from Hans et al. 2007).

Hans et al. (2007) emphasize that the hierarchical levels presented in their framework cannot operate on their own, but instead should utilize information created during the other planning levels. Hans et al. (2007) state that multi-project organizations with different degrees of dependency (see chapter 2.3.1) should exchange information between the planning levels differently. Thus, the authors suggest that in organizations with high dependency, which usually adopt a matrix organization structure, the most important inputs passed on from the tactical to the operational planning level during the first phases of a project when information about project content is limited are due dates, required resource capacity levels, and project milestones. These data serve as an initial basis for the possible acquisition of additional resources, material ordering, and fine-tuning of due dates. As the project proceeds and more preparatory work is conducted, more information is available to be used for more detailed planning. On the other hand, in low-dependency multi-project organizations adopting the projectized organization structure, resource allocation decisions can be passed on from tactical to operational planning level at the start, as the resources are dedicated to each of the projects and not generally shared between them. (Hans et al. 2007)

Different methods can be employed for resource allocation decision making in multi-project environments. Many of the methods presented in the literature seem to focus on tactical or operational-level planning in a multi-project environment. For example, performance of different priority rules for resource-constrained multi-project scheduling has been studied (for example, Browning and Yassine 2010; Wang et al. 2017), and different models for allocating scarce resources in multi-project settings that take into account different parameters (e.g., Certa et al. 2009; Heimerl and Kolisch 2010; Felberbauer et al. 2019; Ballesteros-Pérez et al. 2019), such as employee skill levels or social relationships in teams, have been presented in the literature. Ponsteen and Kusters (2015) identified different human and automated resource allocation approaches used in multi-project management and argued that in complex multi-project environments, human decision-making approaches (such as. Scrum of scrums or resource sharing policies) are more applicable than automated decision-making approaches (such as Critical Chain, heuristic models, auction-based multi-agent systems, or systems management views) due to humans' better capability to adapt to unexpected situations than automated approaches, which are computed based on simple models of reality. Leite et al. (2017) simulate different strategies and metrics for resource allocation of multi-skilled staff in multi-project environment and conclude that there is "no golden rule" to be used for the purpose and that the staffing depends heavily on the organization's context.

Any process can eventually be as effective as the information it utilizes. To ensure that the results of resource planning are reliable in an uncertain multi-project environment, the plans should be updated regularly to keep them up-to-date, and all activities should be entered into the planning system with the required level of detail, including activities of new projects that might be activated in the project portfolio in the future (Hendriks et al. 1999). Such projects could be, for example, upcoming R&D projects or customer delivery projects waiting for bid approval from customers, which, if realized, affect the organization's multi-project resource allocation.

2.3.4 Multi-project resource management challenges

Different resource allocation problems tend to occur in organizations that use projects as the main principle for organizing (Jerbrant 2013). Engwall and Jerbrant (2003) claim that resource allocation is the main managerial challenge for organizations with multiple projects using, at least partly, the same scarce organizational resources. In multi-project

environments, the use of and competition for the same, usually scarce organizational resources, make the projects interdependent on each other. This makes resource allocation complex and extremely important in multi-project environments, as managerial decisions regarding resources in one project may impact other projects as well. (Ponsteen and Kusters 2015; Payne 1995) The projects' dependency of the same resource pool results that problems and delays in one project can affect other projects directly either due to personnel redistribution or unavailability of initially scheduled technical solutions (Engwall and Jerbrant 2003). Thus, when implementing resource management in a multi-project setting, it is essential to understand the challenges and problems that may emerge.

It is important to consider multiple projects as a whole and thus evaluate the effects of the addition of a project to the existing portfolio (Payne 1995). Overlooking the impacts of project portfolio decisions on resource capacity in multi-project settings can have serious negative consequences for an organization's delivery performance and profitability (Hans et al. 2007). The uncertainty of future resource needs in project-oriented companies is common. For example, contract companies may have ongoing projects at different stages and several bids out, which may or may not be won (Huemann et al. 2004). Companies commonly tend to undertake as many projects as they possibly can (Elonen and Artto 2003; Hans et al. 2007), although it is challenging to evaluate the effects of each new project on the usage of shared resources and, therefore, the overall performance of the multi-project organization (Hans et al. 2007). Additionally, to win bids and acquire projects, companies tend to promise as early dates for delivery as possible. If these decisions and actions are made without sufficiently assessing the impacts on the capacity of the resource pool that the multiple projects of the organization share, it typically leads to an overload of resources, thus having a damaging effect on the performance of all the projects, and therefore, the performance of the organization. (Hans et al. 2007) In addition to a sufficient assessment of the impact of project portfolio decisions on resource capacity, Huemann et al. (2004) argue that to cope with this uncertainty of future workloads, it is also essential for these organizations to use a certain amount of contract staff to add flexibility to their resource management.

Reallocation of resources from concurrent projects to another might help a troubled project when additional resources are not available. Reallocating resources from other projects has been observed to be a popular way to obtain additional resources for a project desperately needing them (Engwall and Jerbrant 2003). However, continuing this policy

in a multi-project environment might become a vicious circle leading to a decrease in all projects' performance (Yaghootkar and Gil 2012). When project management is schedule-driven and a business-critical project, such as a project associated with an agreed delivery contract with a third party, is in danger of not delivering on time, the organization may be tempted to reallocate skilled and scarce resources to the project from simultaneous projects. In short term, this ensures that the business-critical project finishes on time. However, in long term, this kind of policy decreases the organization's other projects' ability to meet planned milestones if available resources are used in full capacity and more resources are not hired or acquired. (Yaghootkar and Gil 2012). Engwall and Jerbrant (2003) observed in their study of two multi-project organizations that the redistribution of resources from other projects to support an ongoing project in trouble usually negatively affects the other projects, leading to a situation where the management is engaged in constant firefighting, short-term problem solving, and reactive behavior. Aalto (2001) argues that the policy to borrow resources from concurrent projects for new projects may also lead to an ineffective project culture, as project leaders might start to increase their hidden reserves in project budgets to carry on the project work even if some of the resources initially allocated to their projects are later reallocated to another project.

In multi-project environments, employees work in multiple projects simultaneously, resulting in switches between simultaneous projects and different types of tasks. This allows employees' special skills to be utilized in several projects in an efficient manner. (Zika-Viktorsson et al. 2006) However, there are also disadvantages associated with allocating resources to several simultaneous projects, as an increase in the frequency of switching from one project to another decreases employees' work productivity, resulting in deterioration of the organization's capability (Yaghootkar and Gil 2012). Furthermore, at the project level, an increase in the size of a project team due to part-time employees decreases the devotion and efficiency of work in each project (Hendriks et al., 1999). Hendriks et al. (1999) evaluate this with "a project scatter factor", which is calculated by dividing the number of the project members with number of person work-years used for the project: the higher the "project scatter factor" is, the lower is devotion of an individual employee to a project, although the flexibility enhancement of scarce resources between projects is higher.

An imbalance between resource capacity and resource demands may have severe consequences that the management should be aware of when making plans and decisions

regarding resources in a multi-project environment. According to Zika-Viktorsson et al. (2006, p. 385), work in a multi-project environment is typically "*characterized by tight schedules, multi-tasking, increased coordination expenditures, and a large amount of set-up time when alternating between tasks"*. Scarce time resources, insufficient routines, lack of opportunities for recuperation, and participation in a large number of projects are factors that may cause exhaustion for individual workers who switch between tasks in separate parallel projects (Zika-Viktorsson et al. 2006). Deslisle et al. (2020) observed that when faced with an overload of work in a multi-project setting, workers try to cope with it by extending their working hours, managing boundaries between work and life, prioritizing tasks that seem to be the most urgent, and negotiating expectations, work, and deadlines to be able to handle several priorities. Thus, in situations of work overload, workers become exhausted, make more mistakes, neglect less urgent tasks, and focus on those that have ultimately become emergencies (Delisle et al. 2020). Using overtime as a method to increase capacity instead of bringing additional resources to the project has advantages but also disadvantages: the workers' already attained knowledge and familiarity of the project is a significant asset, but working overtime also causes a decrease in productivity, conflicts between project work and life outside it, and in the long-term builds negativity towards the management that uses overtime working as a primary aid to increase capacity instead of acquiring needed additional resources. (Payne 1995) Ultimately, continuous work overload and working overtime may even cause a multi-project organization to lose some of its valuable resources due to their burning out (Delisle 2020) or resigning (Payne 1995).

2.4 Synthesis of the literature review

There are three general organizational structures that can be used for housing projects in an organization: a functional structure, a projectized structure, and a matrix structure. The latter can be categorized into three types: functional, project, and balanced. Organizational structures differ in how responsibilities and authorities over project work and resources are divided in the organization, typically more specifically between a project manager and a functional manager. Although earlier papers indicate some differences in effectiveness between the forms, there is still no single organizational structure that would be suitable for all organizations and projects due to their different contexts and circumstances.

Project-oriented organizations use projects as a strategic choice to implement strategies and achieve their goals. The project-orientation in organizations varies, as some of them, for example, might implement almost all their operations with projects, and others use projects to realize only a certain part of their operations. Project-oriented organizations require different resource management approaches, as compared to traditional functional organizations with a quite straightforward process of selecting, employing and then releasing human resources, they also have a continuous project-level sub-process where human resources are assigned to, employed, and dispersed from projects. In project-oriented organizations, project managers, resource managers, and an HRM department are generally the parties that take part in the human resource management, but there are a variety of ways in which the roles, responsibilities, and authorities are eventually combined. Resource management and allocation in project-oriented organizations are among the most critical managerial tasks, and also areas the organizations tend to have challenges with.

When there are multiple projects in an organization that share at least partly the same resource pool, specific management approaches and practices must be adopted to implement adequate resource management. The centralized management of multiple projects in this multi-project environment has typically been discussed in the literature under the topics of project portfolio management and multi-project management. In this study, these two terms are understood at a high level as different processes, although both are concerned with the management of multiple projects. Project portfolio management is usually a responsibility of upper management, which aims to create and maintain the right balance of projects in a portfolio, and thus focuses on project selection and prioritization on a strategic level with long-term or medium-term planning emphasis. Multi-project management, on the other hand, relates to the management of the multi-project environment with a short-term planning emphasis, focuses on resource allocation for multiple projects, and is generally the responsibility of project managers and functional managers.

Frameworks introduced in the literature for resource planning and allocation in a multi-project environment seem to emphasize that the planning should be executed on different levels, starting from the strategic planning level's broad plans, continuing to roughly detailed plans on a tactical planning level, and ending with the operational planning level's detailed plans. The planning processes at each level must be linked; thus, it is

important to agree on what kind of information is transferred as an input to the lower planning levels and as feedback back to the upper planning levels. The overall multi-project resource planning process and its significant factors and agents identified in the literature are summarized in Figure 10.

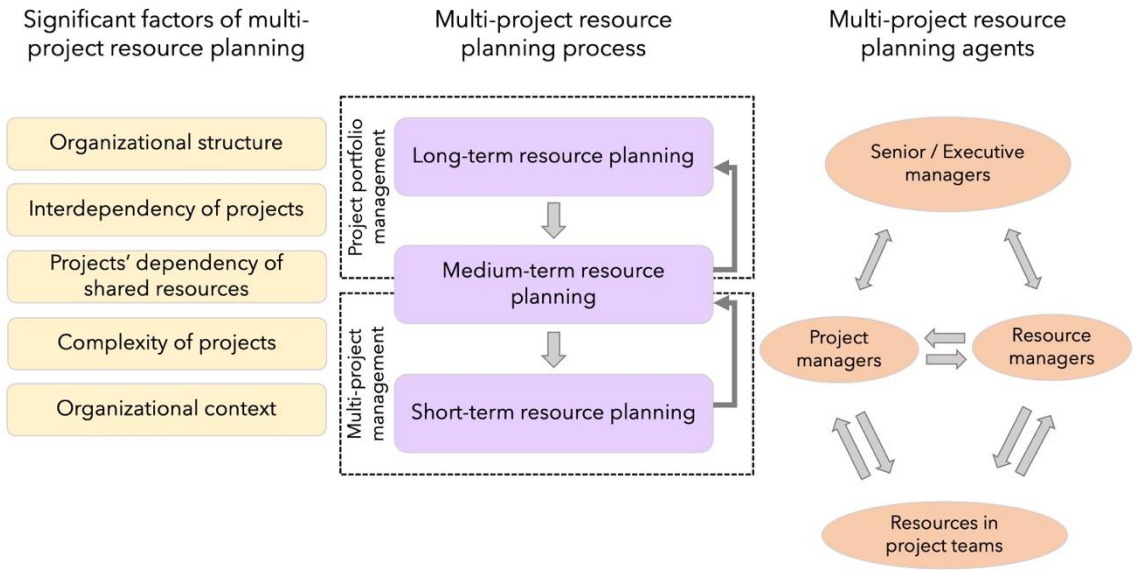

Figure 10. Multi-project resource planning process, factors, and agents.

In a complex multi-project environment, it is challenging to plan, allocate, and manage scarce resources in a way that is best for the organization. When making decisions regarding resources, possible problems that might emerge must be acknowledged to find the best solutions that are often also compromised. There are different guidelines, models, and methods intended to improve and foster better decision making in multi-project resource management. However, not all of them fit every organization; in the end, the practices, organizational structures, and processes for the multi-project environment and its resource management should be selected by considering the context and special circumstances of the organization in question.

3 CURRENT STATE ANALYSIS

3.1 Research design and data collection

Research is a process with a purpose to find out things by systematically collecting and interpreting data (Saunders et al. 2016, p. 5). This study employs a case study as a research design to study the phenomenon of resource management in a multi-project environment. According to Patton and Appelbaum (2003), the process of conducting a case study can be summarized into five steps: (1) determination of the study's object, (2) selection of the case, (3) initial theory building by conducting a literature review, (4) organizing the data gathering and collecting the data, and (5) analysis of the data and reaching conclusions. The case context of this study is a project-oriented company that operates multiple simultaneous and successive projects using resources from a common resource pool. This study focuses on the management of the case company's R&D and engineering human resources in a multi-project environment.

At a high level, research is commonly divided into quantitative research and qualitative research. These terms describe the used research method types: quantitative research methods are based on a set of numerical data, whereas the qualitative research methods are based on data that consist of documented or spoken words and images. (Bell et al. 2019, p. 18) This study employs qualitative research methods to understand the case company's resource management in the multi-project setting. To thoroughly understand phenomena, it is typical for case studies to use multiple data-gathering methods (Eisenhardt 1989). To get a comprehensive understanding of the current state in the case company, multiple data collection methods were used in this study as well. These data collection methods included interviews, surveys, company documentation, and observations made in meetings, emails, and conversations in the company.

The significant sources of data for the current state analysis were the surveys and qualitative interviews. A total of 14 persons from R&D and Engineering, Project Management and Service departments were interviewed between December 2021 and January 2022. The interviewed persons worked mostly in managerial positions and included, for example, functional managers, project managers, and senior managers who were responsible for the project management and R&D and engineering departments. Information about the interviewees is presented in Table 2.

Table 2. Interviewees' roles and experiences in the case company.

#	Role	Experience
1	Project manager	1–5 years
2	Senior manager, Project management	1–5 years
3	Senior manager, R&D and engineering	1–5 years
4	Functional manager, R&D and engineering	More than 5 years
5	Project manager	1–5 years
6	Functional manager, R&D and engineering	More than 10 years
7	Functional manager, Service	More than 10 years
8	Chief design engineer, R&D and engineering	1–5 years
9	Functional manager, R&D and engineering	Less than 1 year
10	Project manager	1–5 years
11	Chief design engineer, R&D and engineering	More than 10 years
12	Chief design engineer, R&D and engineering	More than 10 years
13	Functional manager, R&D and engineering	More than 10 years
14	Project engineer	1–5 years

In each interview, the survey questions were first asked and then continued to the interview questions. Each person was interviewed separately on a video call. The interviews lasted approximately 45–75 minutes and were conducted in Finnish as semi-structured. A list of pre-selected questions was used as a base for the interviews, but additional questions were asked as well as the conversation continued. The pre-selected questions asked in the interviews are listed in Appendix 1. Each interview was recorded and analyzed more thoroughly afterwards. Notes were written during interviews and were used as a basis for the current state analysis in addition to the recordings of the interviews.

In addition to the interviews and surveys, data were drawn from the company's documentation on which it provided access. The documentation data included, for example, data from different IT systems. Furthermore, observations of the current state of the case company were made from emails, and by attending several formal and informal meetings as a participant and having conversations with different people in the company. The participants in these meetings and discussions were aware that the research was being conducted.

3.2 Case company

The case study company is a large Finnish project-oriented industrial company with over 500 employees. The company offers integrated life-cycle solutions: they design their products based on customer requirements, manufacture the products in their own local

plant, and offer maintenance services for the products after delivery. The company operates in a specific field, meaning that there are not many companies that offer similar products and services in Finland or in Northern Europe. The company is a subsidiary of a larger multinational company, having been acquired a few years ago, and is still undergoing a change process of integration into a functioning part of the parent company.

Customers of the case company are mainly public organizations and governments, which means that public decision-making and bureaucracy can affect schedules of offer acceptances, project contract signings, start of projects, and project schedules, even after a project's execution has started. These circumstances increase uncertainty and therefore add difficulties in planning resource usage for multiple projects.

The sizes, lengths, and values of delivered customer projects vary. At its largest, a project's price tag can be up to tens of millions of euros, and to conclude such a project, contributions might be needed from hundreds of people during its lifetime, which can span up to several years. Owing to these circumstances, planning and making a project offer can also take a significant amount of time and effort from various people in the company. At the time of this thesis, the case company had several projects in execution and tender phases.

The company has its own in-house R&D and Engineering department with approximately 40 engineers. The R&D and Engineering department makes its main contribution during the projects' design phases by designing the products based on customer requirements. After the design phase, the department's resources provide support for the ramping up of designed products to production and later on during the project's lifetime, if necessary. In addition, the R&D and Engineering department contribute to the estimation of engineering work during project tender phases and provides resources for the parent company's needs on their request. To address changing project needs, the company also uses a substantial amount of external workforce or buys design work from external design providers. The in-house engineers' expertise mainly covers the core engineering areas of the company's product development, and external design work is usually used for certain specified and general tasks.

The case company experienced difficulties in resource management in their multi-project setting and proposed a topic for a master's thesis to improve its resource management and

planning processes. The focus of this study is on the case company's R&D and engineering resources and their management.

3.3 Results of the current state analysis

The aim of the current state analysis was to understand the current situation, challenges, and managerial practices and processes regarding resource management in the case company. The focus of the analysis was on the case company's R&D and engineering resources. Thus, the organizational structure for project management and the circumstances of the resources were analyzed. The analysis further focused on the challenge areas that emerged from the data, particularly from the interviews. The challenges that the participants highlighted the most were related to the resource planning process and practices. Additionally, problems concerning roles and responsibilities, communication, and information management were also encountered.

3.3.1 Survey results

Prior to the other interview questions, the interviewees were asked to evaluate six statements relating to resource management on a scale of 1-5, where 1 is "I completely disagree" and 5 is "I completely agree". The arithmetic means of all the survey results are presented in Figure 11.

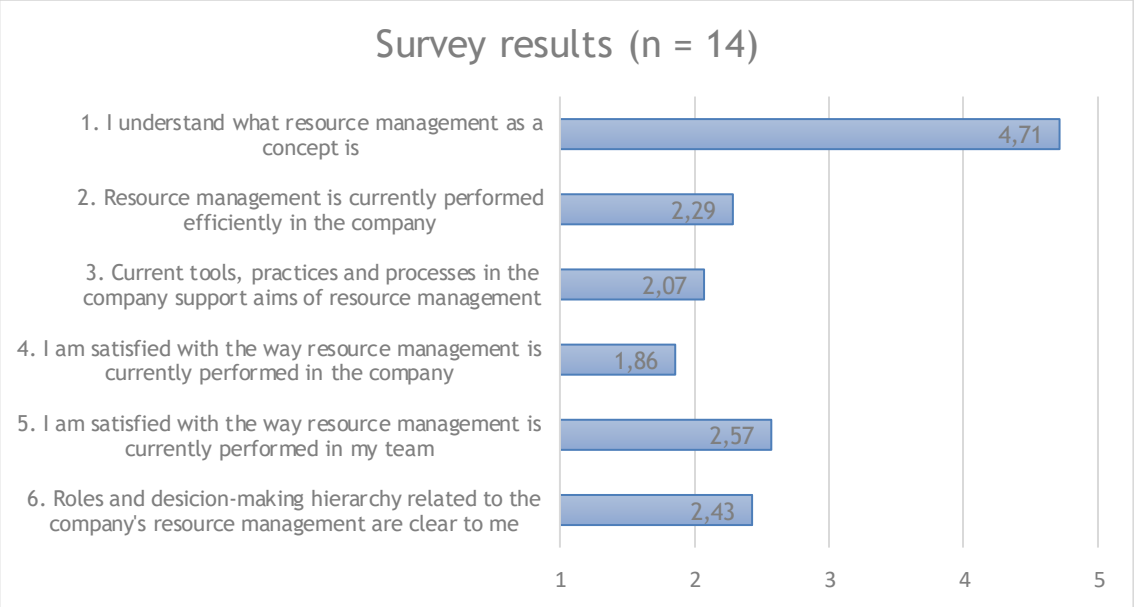

Figure 11. Survey results.

Based on the survey results, the interviewees evaluated their knowledge of resource management as a concept to be sufficient. The survey results indicate that the interviewees see current resource management in the company as inefficient and that the currently used practices, tools, and processes are not fit for it. The interviewed people were not satisfied with the way resource management was performed in the company or in their own teams, although the latter was experienced to be better than the firstly mentioned. In addition, the roles and decision-making hierarchy regarding resource management in the company were generally unclear to the respondents.

3.3.2 Organizational structure for project management

The project-oriented company uses a project matrix as an organizational structure for their customer projects' management. This organizational structure, with a focus on the R&D and Engineering, and Project Management departments, is shown in Figure 12. In addition, the company employs the functional organization form for its internal R&D projects, which are implemented mostly inside the R&D and Engineering department with their own resources.

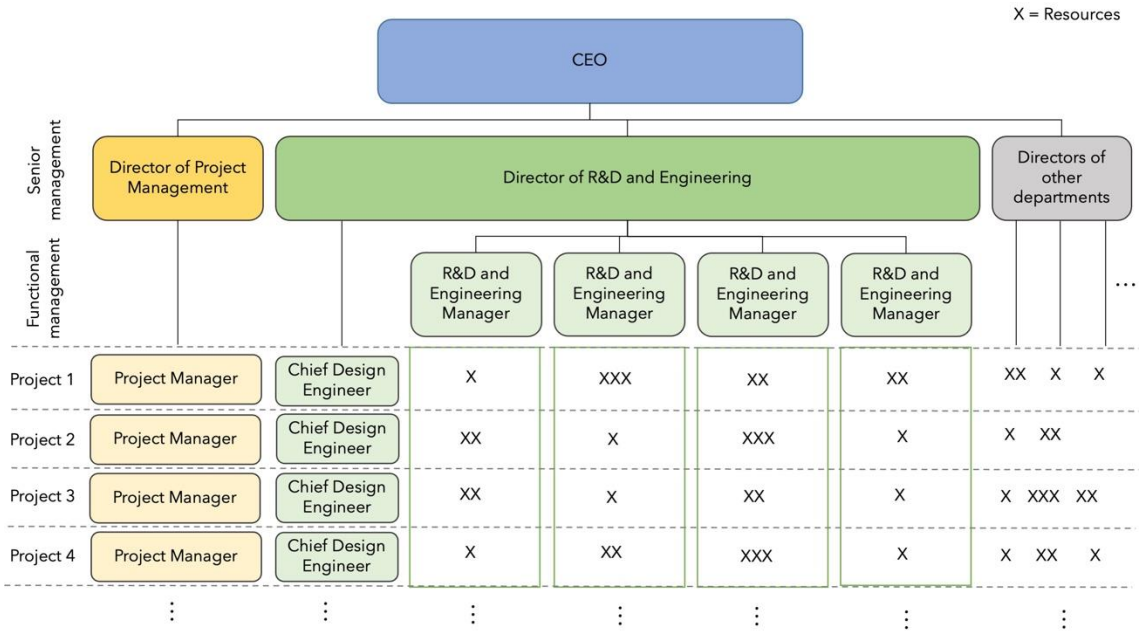

Figure 12. The case company's project matrix organizational structure.

In the company, *project managers* oversee, schedule, manage, and monitor customer projects with high authority; each of them usually has one project they are responsible for and in which they work full time. Based on the project needs, project managers request

resources from organizational functions, and these functions are expected to provide them.

In addition to project managers, *chief design engineers* are assigned to every project to work full-time. The chief design engineer designs and oversees the engineering work of the project, and thus works closely with the project manager. Despite planning and overseeing the overall engineering work in the project, the chief design engineer's authority over the entire project is minimal; for example, project engineers' work hours and project costs regarding engineering are approved and monitored by the project manager. The chief design engineers work as a communication link between the project manager and the R&D and Engineering functions, as they request R&D and engineering resources from the functional managers, mainly based on the project plan. Under the R&D and Engineering department, the chief design engineers report directly to the Director of R&D and Engineering.

In the R&D and Engineering department, engineers are divided into teams based on their engineering areas, with each *functional manager* managing their own team of engineers. The functional managers manage the allocation of their function's resources, but they do not have any authority over project management or participate in the projects' work unless they happen to work in some of them themselves as project workers. Regarding resource management, functional managers communicate with projects mainly through the chief design engineers of the projects, and the communication between project managers and functional managers remains minimal.

3.3.3 R&D and engineering resources

The company has an R&D and Engineering department that consists of approximately 40 engineers. The engineers have been divided into different teams based on their general engineering expertise, such as electromechanics or software engineering. The engineers are managed by R&D and Engineering managers, referred to here as functional managers, each of which manages their own team. In addition to their own personnel, the company also uses external workforce and buys engineering work from design providers. When some parts of engineering work for a project are outsourced, the progress of the work and its quality are monitored by an in-house engineer specialized in the engineering area in question. Although the use of external workforce allows great flexibility, the interviewees

also recognize that relying too much on the usage of external suppliers is a risk, and it should be ensured that the core engineering expertise is maintained in-house.

Employees of the Project Management department and R&D and Engineering department may work in different roles either simultaneously or periodically. For example, an R&D and Engineering manager may work as a project worker in a project, an engineer may work as a project worker in a customer project, but also as a project leader in an in-house R&D project, or a project manager may shift to a chief design engineer position after (the active part of) the project they were managing has ended.

The R&D and Engineering department's functional managers have mostly been promoted to their current positions from their former technical positions. It appears that the functional managers have not quite internalized their responsibilities and tend to concentrate on leading their group of engineers as team leaders rather than comprehensively managing their function and resources. Furthermore, most of the functional managers also work as experts in customer projects, in addition to their managerial positions, which results frustration as the project work takes away time to efficiently perform the managerial responsibilities of functional managers.

The R&D and Engineering resource pool consists of multi-skilled personnel. Each engineer has their own areas of expertise and responsibilities regarding the company's product development. In some cases, there are only two or even one engineer for single special engineering area in the company. Expertise from each of the special engineering areas is needed in every customer project at some point, meaning that the projects of the company are highly dependent on the shared R&D and engineering resources. This inevitably leads to a situation in which sometimes some engineers are overloaded with work as they are needed at the same time in several projects, meaning that they may act as bottlenecks in the project design phases. These experts with desperately needed knowledge are thus highly valuable, and their departure from the company can cause serious delays and other problems in the projects.

Just hiring more engineers may seem to be a simple solution, but it is not quite that. As the company's products and the field of operations are very specific, there are not many experts on the employee market available that would have the required level of expertise to be able to work as efficiently in the engineering tasks as engineers with a high level of expertise. Therefore, when hiring new employees, they must be familiarized and taught,

even for a year, to gain the desired level of knowledge in the engineering area. This familiarization phase takes time from the experts to teach new employees. In addition to regular financial costs related to recruitment, hiring a new employee thus requires reasonable investment and effort from the company and does not immediately provide as much relief to the projects' work overloads as wished.

Fluctuation of workloads is a reality in R&D and Engineering department and in the entire project-oriented company, and some people experience periodic, even long-term, work overload. In addition to work overloads, there have been times when there is not enough work for everyone, and even layoffs have been carried out in the company in the past years. Sometimes, the distribution of work has been radically uneven between employees of a function but also between organizational departments: when other departments have been lacking work, at the same time another department might have been lacking staff, for example, for administrative work that could be done by people from other departments, even if it is outside their initial job description. However, persons lacking work have not been allocated to work on tasks in the other departments, possibly because the departments do not know each other's situations well, there is reluctance to assign persons to these tasks, or the persons are themselves unwilling to work for tasks that are too far from their original job description.

A high turnover of employees in the company is recognized as a problem that has continued for a while now. Many interviewees stated that several long-time experts with valuable expertise have left the company in recent years and believe it to be caused, at least partly, by work overloads that the departed employees had experienced. In addition to work overload, general uncertainty about the continuum of work in the future and lack of career opportunities are mentioned as possible reasons why employees have left the company in the past.

3.3.4 Multi-project resource planning practices

Decisions regarding business plans, budgets, and project portfolios are made by senior management of the company. The most significant portfolio decisions relate to adding new customer projects to the project portfolio. Once an offer for a project is made for a customer, it strongly binds the company to deliver the project if the customer accepts the offer. Making an offer is a process of cross-functional cooperation with people from different organizational departments and functions giving their effort to plan work

segments and schedules and estimate the costs and resource needs of the project. Decisions regarding project selection are made by the senior management and the CEO of the company.

Many of the interviewees seem to think that the foundation for sufficient resource planning often goes off track at the very beginning when project offers are made with too optimistic calculations of schedules and needed resources. In their desire to sell, the company may end up making a customer an offer based on calculations of a project plan where there is no room for any bigger delays, obstacles, or errors. This puts pressure on the project manager and project workers to conclude the project tasks with very limited time while still trying to maintain good work quality.

The company's projects rely heavily on the common resource pool. Thus, when new projects are added to the company's project portfolio or there are schedule changes and delays in ongoing projects, other projects that use the same scarce resources might also be affected. However, the portfolio's project interdependencies regarding resources in the company are not frequently evaluated in a defined manner; in general, the focus of management seems to be more on the management of individual projects rather than on the set of projects and how they are managed together.

After a project is agreed to be implemented with a customer, a project manager pointed for the project is expected to manage the project from there and request resources from the functions to ensure that all the project work segments are executed in the schedule. These functions are expected to provide resources for the project tasks, as requested. If additional resources outside the current resource pool are needed, the HR (human resources) department is contacted to acquire the required resources either by recruiting new personnel or ordering design work from external service providers. If the need for work from external service providers is significant, the request to acquire resources must be formally handled in the HR department and may ultimately require separate management approval. The process of handling resource acquirement requests is mentioned to be slow by several interviewees; according to them, it takes too long from the moment of reporting a need for more resources to the point when a resource acquirement process is ultimately started.

"There is no prioritization of projects."

"Sometimes it seems that when a resource conflict occurs, whoever is there to 'yell the loudest' gets the resource."

The fundamental idea is that the needs of all customer projects are expected to be fulfilled by the company functions in all situations. However, resource conflicts do occur because there are not always enough resources available for every need. The senior management selects customer projects to bid for or internal projects to be executed, but does not prioritize the projects, nor do they provide any predefined decision rules for functional managers to follow in resource conflicts. As a result, in situations where the same resource is wanted for several tasks at the same time, the prioritization of tasks is made ad hoc by the engineers themselves, by the functional managers, or the issue is brought up to the senior management or even to the CEO to decide which project task receives the resource first in the situation. According to several interviewees, during these resource conflicts, it seems that whoever "yells the loudest", that is, strongly implies that their task is the most urgent, gets the resource. When a resource is needed at the same time in several places, tasks related to customer projects are typically first in line to receive the resources, while the needs of internal R&D projects, which could also benefit the company in the long run, are often sidelined.

The reality in the R&D and Engineering department is that resource conflicts occur almost daily when requests to do something urgent outside the pre-planned work emerge. If the urgency of the requests is considered significant, these "emergencies" are handled first at the expense of other works, thus ultimately delaying the progress of the planned tasks.

3.3.5 Multi-project resource planning process

There are no clearly defined strategies for resource planning in the company. Furthermore, there is no strictly defined process for resource planning for all multiple projects with the aim of connecting the company's business plan to its daily resource usage. For a long-term horizon, resource plans are not made at all in the company.

Regarding the medium-term planning horizon, there is no defined process in the company where all the resources needed for multiple projects are roughly and adequately planned together. The projects request resources from the departments and functions, and each of the departments presumably takes care of their own resource planning. In the case of the R&D and Engineering department and its resources, there is a process possibly intended

for rough-cut-capacity-planning, but it is done inside the department without directly including the project managers in the discussion or giving them access to the composed plan. More precisely, instead of a plan, it is more of a summary of all the project resource requests and is in fact called in the R&D department "a workload excel".

The R&D department's process of checking future workloads (see Figure 13) consists of monthly meetings attended by the R&D director, R&D and Engineering managers (functional managers), and chief design engineers. In the meetings, information and status of current, upcoming, and potentially actualizing projects are intended to be checked from status reports received from the sales department. In addition, a Microsoft Office Excel file representing the current and future workload situation of R&D and Engineering human resources is intended to be updated and then checked in the meeting. The workload Excel file includes all internal and external projects in which the department's employees are expected to work. The project workers needed for each project are named, and the proportion of their full capacity needed for the project is evaluated and marked for each month as further in time as possible. Sometimes, it is specified in the file what the person is expected to do in the project, but many times, only the name of the employee is marked as a resource request for a project. For each project, the resource requests on the file are expected to be updated by the person knowing best of it: by the chief design engineers of each of the customer projects, the functional managers named for internal projects' leaders, or by the R&D director regarding the parent company's resource requests.

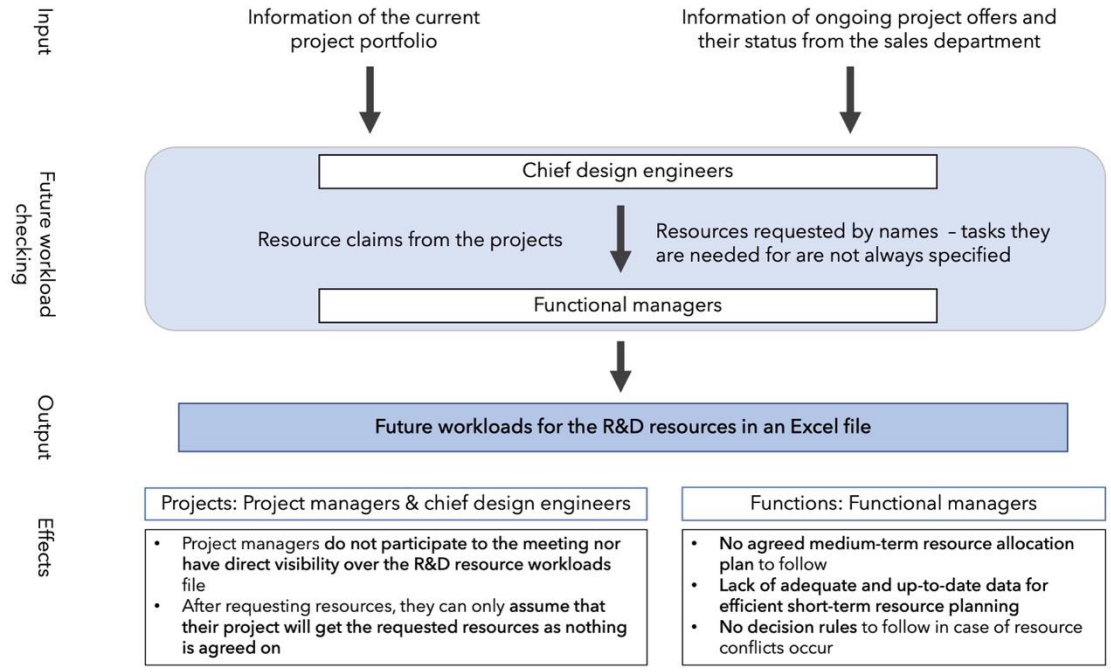

Figure 13. The current process for checking future workloads.

Although there are the monthly meetings in place regarding the R&D and Engineering resources workloads, they seem to be somewhat unorganized. For example, there are no exact dates agreed when the file should be updated before the meeting, and usually the file is not up to date in the meeting to be checked; thus, the time of the meetings is used to check which project resource requests in the file are up to date instead of using the time to evaluate and talk about resource planning in general. In addition, the sales department's file about the status of upcoming and possible future projects that are checked in the meeting is not always up-to-date, thus bringing no real value to the meeting. After the meeting, outdated information is expected to be corrected by a certain date by persons knowing the best of the projects' needs, but these are not checked again until the next meeting, where the information in the file is usually again not up to date.

Even though the workloads were collected and checked, barely anything was done with the information. After the resource needs of the projects are inserted and updated in the file, future work overloads for certain employees are seen, along with the fact that if their work overloads continue and are not fixed, all the projects do not get the resources they need. As the projects via the chief design engineers only request the multi-skilled resources by name and do not always specify what is the task they are wanted for in the project, it can be challenging for the functional managers to level the work amounts between the employees. Not knowing the exact expertise needed in the future is also problematic, for example, in evaluating when a hiring process for an engineer with certain expertise should be started so that the future needs of the projects could be satisfied. In addition, the resource needs of the projects whose execution is still uncertain are not often included in the file in sufficient detail, thus leaving out information relevant to resource management. Furthermore, there is no pre-agreed method for evaluating the point when, for example, a recruitment process should be started. Ultimately, decisions to start the resource acquisitions are often put off for too long to answer the resource needs of the projects on time.

"We are supposed to update the Excel file, but after that it is left there untouched and checked again in the next meeting – it seems that nothing is really done with the information."

Overall, the workload meetings seem to be a place where resource requests of multiple projects are collected, but there is no consensus on the allocation of resources between

the projects. As a result, chief design engineers are left with uncertainty regarding whether the project they work for will get all the requested resources at certain points in the project's schedule, and functional managers are expected to fix the predicted work overloads of certain people pointed by the file with inadequate data on their own. What kinds of exact expertise are needed by the projects in the future and when more resources with certain capabilities should be acquired is not clear to the functional managers, thus resulting in failure to acquire resources at the right time and leaving some of the projects without the resources they depend on when planning project schedules.

For the short-term planning and allocation of resources (that is, for the next months and weeks), there does not exist any agreed common process or methods to be used in the company nor in the R&D and Engineering department. The employees of the R&D and engineering functions are self-regulating, planning their daily work themselves. In addition, each of the department's functional managers applies different practices to short-term resource planning and keeping track of what the engineers are doing. This results that there is not clear visibility over all the resources' short-term planning in the department: as all the functional managers handle the planning in varying ways on their own and the information of these plans is not at any point collected together, a comprehensive image of the short-term allocation plans of all the R&D and engineering resources does not exist.

3.3.6 Roles and responsibilities

Roles and responsibilities regarding resource management in the company seem to be somewhat unclear. Although there is a consensus among the responders that the R&D and Engineering functions are responsible for providing the required R&D and engineering resources for the projects, it appears to be often unclear who to contact when the need for resources emerges, and in case there is a lack of resources, it is unclear when and by whom the process of acquiring the resources either by hiring employees or buying external workforce is started and carried through.

There is no clearly defined and widely communicated process that considers whom the requests regarding R&D and engineering resources should be addressed. This results that the resource requests from the projects, from the other functions and from the international parent company are received by the functional managers, the R&D director, and the engineers. Pre-estimated and planned project needs regarding R&D resources are

usually brought up to the attention of functional managers in a quite organized manner. However, if urgent resource requests appear on a short notice, the requesters tend to contact the engineer(s) directly to get them to perform the required tasks. The engineers also learn about resource needs and receive resource requests from the project during their work in there and may communicate these further to the functional managers. As some of the resource requests come to the functional managers through the engineers and not directly from the requesters, a delay in the exchange of information usually occurs. The functional managers feel frustrated that many times they do not have up-to-date knowledge of the resource needs their function is expected to fulfill, and their engineers are experiencing unwanted interruption of their work caused by the frequently received resource requests that stop the task in hand.

When a need for resources arises and currently available resources will not be able to meet the demand, it seems to be unclear who is responsible of acquiring the resources and starting the hiring process or the process of buying external resources. In the past, the processes have been initiated by the R&D functional managers, the R&D director, and even by the chief design engineers. This unclarity also sometimes results in an unwanted delay in the resource acquisition process when no one seems to take responsibility for the resource acquisition right away.

3.3.7 Communication

In general, communication inside project teams, functions, and departments is seen as sufficient. However, communication between these units was experienced to be limited. The departments are moderately siloed, meaning that they are mainly doing their own things without knowing what is going on in the others. For example, there are no frequent meetings or other communication points where departments or even the line managers of different departments would briefly share what they are currently working on.

During the design phase of each project, the experts from the R&D and Engineering department communicate and work together with representatives from different departments, such as Production and Service, to limit errors in the product design and to make the product's production and maintenance as efficient as possible. However, the number of errors that emerge after the project's design phase has been concluded is significant, and it many times appears that the errors could have been avoided during the design phase, with the other departments being more involved. The errors spotted after

the initial design phase usually emerge as emergencies that must be solved as soon as possible, thus binding R&D and engineering resources and interrupting other work.

As mentioned earlier, projects and engineering functions do not communicate directly in an organized manner regarding resource planning and allocation. Functional managers are not involved in the projects' work if they do not work as experts in them themselves. Generally, information on the project's work and status is brought to the functional managers via the chief design engineers and engineers working in the project teams. By contrast, project managers do not receive information on the functions' situations directly in an organized manner, but usually via project team members working in their projects. As the persons in charge of the projects' execution and the persons in charge of the resources and their allocation do not frequently share information about their situations and communicate directly about the resource planning, it is possible that important data are lost, or things are misunderstood during the process of indirect communication.

As there is a lack of communication, there are also situations where time is wasted on pointless communication to ensure that things are done. For example, when unplanned and many urgent tasks where R&D and engineering resources are needed appear, just sending a resource request forward is not enough – the requesters usually have to ask after the request multiple times to ensure that their request is noticed and put forward, as they are not automatically kept updated on the matter by the person they requested the resources from.

The company uses mainly Intra and e-mails to share information with all its employees. However, the information shared by these channels is somewhat fragmented. Frequent information meetings where information about the company's current operations and situation would be shared with all employees are not organized by the management. Outside the projects they are working, the employees receive information for other projects mainly from their supervisors or colleagues. Overall, there appears to be unclarity among the employees about what the company is currently working on and whether there will be new projects and enough work in the future as well. The lack of agreed medium-term resource allocation plans makes it also difficult for the functional managers in R&D and Engineering department to communicate to their employees which tasks and projects they will probably work on next.

During the interviews, it also came up that frequent development discussions between each supervisor and their employees have not been required by the management in recent years; thus, it has been dependent on the supervisors whether and how often such discussions have taken place. If the supervisors have not held development discussions or discussed the topics of work situations and professional development needs and wishes with the employees frequently in other ways, it might be possible that the supervisors are lacking information that could be used to support employees' careers, skills, and well-being.

3.3.8 Information management

The company uses several information systems for purposes related to the management of R&D and engineering resources. As mentioned earlier, the R&D and Engineering department uses Microsoft Excel to collect information on workloads for the upcoming months and years. An Enterprise Resource Planning (ERP) system is used to record engineers' workhours. Microsoft Project software is used by project management to plan the project schedules. A product lifecycle management system is used for product lifecycle documentation, and it includes a feature for sending engineering change requests if the need to change already done engineering designs arises, for example, during the production phase or later. These systems are not integrated with each other, and thus, for example, using the work records from the ERP system for project planning in Microsoft Project would require manual work as the data should be first retrieved from one system, then possibly modified before using them in another system.

Siloed data seem to be somewhat of a problem in the organization: information that is created in different organizational units is not always shared openly with others that could also benefit from it. Furthermore, others may not even know such information exists, and if they happen to know about it, they need to ask for the information separately to get the current version of it. Siloed resource management related data include, for example, the sales department's data on the project bids and the R&D and Engineering department's estimations of future project workloads of the resources, which are not shared outside the departments if not requested.

The lack of adequate data for resource management purposes is another problem in the organization. Data that could be beneficial for the resource management were neither created nor collected during the processes. For example, as mentioned earlier, the projects

often request resources only by their names without specifying in their request what competencies they need from the resources and what are the tasks they are planned to do in the projects; thus, this lacked information cannot be utilized later for decision making. In addition, the data that have already been collected are not always sufficiently detailed; therefore, they cannot be properly used for resource management. For example, the working hours for each cost center (e.g., projects) are recorded in the ERP system by each engineer, but the system allows them to specify their activities only on a rough level (for example, "Design work"). This results that checking of the work record data does not provide sufficient insight into what activities the engineers have exactly used their working time for, thus limiting the data's utilization possibilities for monitoring and feedback purposes.

3.4 Synthesis of the current state analysis

This empirical study focused on researching the management of the case company's scarce R&D and engineering resources. The case company is a project-oriented company which uses primarily projects to operate and implement its strategy. The company uses a project matrix organization structure to house its projects, meaning that project managers are responsible for project execution and competition, while functional managers have authority over resource assignments and provide resources to the projects based on their requests. These projects are mainly independent customer projects and internal R&D projects, all of which are highly dependent on shared scarce R&D and engineering resources. The specific field of operations and customer base bring uncertainty to resource planning: unsure availability of capable workforce on the market results in a need to put significant effort into orientation and teaching of new employees in order for them to reach the required level of expertise, and on the other hand, emphasizes the importance of attempting to keep current employees with the needed expertise in the company. Additionally, public sector customers' bureaucratic decision-making and circumstances can affect estimated schedules, and thus, resource planning.

The main multi-project resource planning agents in the case company include senior management, project managers, functional managers, and resources in project teams. The functional managers also work as project workers in some of the projects. In addition, there are chief design engineers who work full-time for each project in cooperation with a project manager, plan projects' overall engineering work, and report to the R&D and

Engineering director. However, they do not have authority over project management or resource assignments, and are thus comparable to project workers based on their authority.

The multi-project resource planning processes and practices in the company are currently fragmented and inadequate. There is no long-term resource planning, and medium-term resource planning is insufficient and does not produce any agreed upon rough resource allocation plans or decision rules for resource conflicts. Short-term resource planning in the company is associated with constant resource conflicts in which prioritization of tasks is made ad-hoc, as prioritization of projects is not made beforehand. Furthermore, the information exchange between the different resource planning processes is insufficient. The multi-project resource planning process, factors, and agents of the case study company are shown in Figure 14.

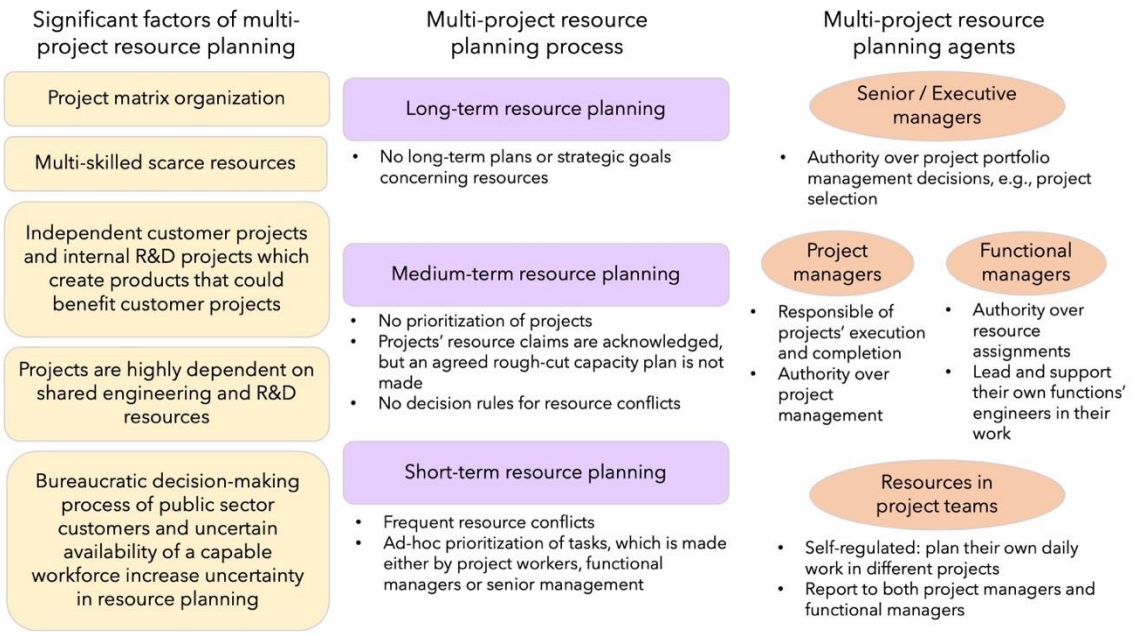

Figure 14. The case company's multi-project resource planning factors, process and agents.

According to the results of the current state analysis, the project-oriented case company faces several difficulties related to the management of its R&D and Engineering department's resources in a multi-project environment. These challenges include the inability to meet the projects' resource needs on schedule, high fluctuations in workloads, and a daily work environment characterized by firefighting and ad-hoc task prioritization. It appears that these problems stem from the company's failure to plan the use of its R&D

and engineering resources efficiently and systematically. In addition to the lack of an adequate multi-project resource planning process and practices, the situation is further exacerbated by unclear roles and responsibilities, insufficient communication, and inadequate information management within the company. The current resource management challenges of the case company are summarized in Table 3.

Table 3. The case company's current resource management related challenges.

Challenges related to resource management	
R&D and Engineering resources	▪ high fluctuation of workloads ▪ work overloads ▪ a trend of rising resignments of longtime experts ▪ new employees do not stay in the company
Multi-project resource planning process and practices	▪ no prioritization of projects ▪ no predefined decision rules to be utilized during resource conflicts ▪ inadequate resource planning process, especially on the medium-term planning level ▪ no agreed rough-cut capacity plan ▪ inability to meet project resource needs on time ▪ constant resource conflicts ▪ frequent firefighting ▪ ad-hoc prioritizing of tasks by the engineers, the functional managers, and the senior management
Roles and responsibilities	▪ unclarity of who is the person the resource requests should be addressed to ▪ unclarity of roles ▪ unclear responsibilities ▪ one person may have multiple roles
Communication	▪ lack of organized communication between the project managers and the functional managers ▪ siloed organizational units ▪ lack of companywide communication ▪ time wasted on asking after things to ensure that they are done ▪ possible lack of employee-focused communication between supervisors and employees due to not organizing development discussions in the company
Information management	▪ lack of adequate data for decision making ▪ siloed data ▪ insufficient flow of information through the organizational units

4 DISCUSSION

In this section, the findings of the literature review serve as the theoretical basis for discussing the resource management challenges identified in the company's current state analysis. Moreover, the results of the literature review are utilized to develop and propose actionable improvement suggestions grounded in theory. However, due to the limited time resources of this thesis, the improvement suggestions do not delve into excessive detail by defining the exact implementation steps; instead, the recommendations provide guidance at a more general level. It is up to the case company to determine which recommendations they will ultimately implement, and how.

It is evident that the challenges and problems faced by the case company are not unique, as previous research has also documented similar issues. In summary, the resource management problems of the case company appear to stem from inefficient resource planning processes and practices. Issues such as insufficient data management, unclear roles and responsibilities in resource management, and inefficient communication contribute also to these problems. If these issues were to be addressed and resource management and planning improved in the case company, it is expected that the fluctuation of workloads and work overload could be reduced, leading to increased employee well-being. Therefore, the subsequent discussion and improvement suggestions primarily focus on addressing these four critical areas, as they require attention to enhance resource management in a multi-project context. As the recommendations are provided on a quite general level for the common challenges, they could be applicable to other similar companies with minor adjustments.

4.1 Multi-project resource planning process and practices

Previous literature emphasizes that multiple projects in an organization should be managed as a set rather than individually, which has been considered the traditional way of project management. Project-oriented organizations operate in a setting characterized with different levels of uncertainty, which itself makes the management of projects challenging to begin with. In a multi-project environment, projects' dependency on shared organizational resources contributes to management challenges, especially resource allocation, which is one of the most important managerial tasks (Engwall and Jerbrant 2003). When decisions are made for one project, their impact on other projects

should also be evaluated (Payne 1995). If the impacts of these decisions on the common resource pool and its usage are overlooked, especially when adding new projects to the project portfolio, resource overload is a likely result (Hans et al. 2007).

Based on the findings of the empirical study, the case company performs project management in a more traditional way by concentrating on planning and managing projects as individuals rather than as a whole. There is no clearly defined adequate project portfolio management process for the overall management of the multiple projects in the company. This also means that the impacts of decisions considering one project on other projects are not properly evaluated. Based on previous literature on the subject, the company's policy to focus on the management of individual projects most likely contributes, at least partly, to the frequent resource overload the company is experiencing.

The case company utilizes a project matrix as its organizational structure, meaning that the organizational functions serve projects and provide them with resources upon request. Although this allows flexible sharing of organizational resources between multiple projects, there is no company-wide process to plan and allocate the resources together for the set of projects. Instead of a common management process that considers the multiple projects and resources they are sharing as a whole, the resource management and planning in the company concentrates on individual projects and resource units: the projects plan their own schedules and resource usage, request resources from the functions, and the functions presumably plan their own resources' allocation to the projects on their own.

In the previous literature, the need to divide resource planning in the multi-project setting into levels with different focus areas, emphasis, and horizons, and to link these levels together, is quite frequently brought up (for example, Dye and Pennypacker 2000; Hendriks et al. 1999; de Boer 1998; Hans et al. 2007). In the case company, in addition to the lack of resource planning in the multi-project environment as a whole, there is no defined process in which the planning of resource allocation is performed on different levels with agreed connection points drawn between them. Regarding the R&D and engineering resources in the company, the workloads for the resources based on the received resource requests are acknowledged: resource needs for every project are roughly outlined during the bidding phase, and from there, rough monthly resource claims for the following months and even years are collected from the projects to stay up to date on the situation. However, nothing is really agreed on the rough allocation of resources.

As medium-term resource planning is not conducted properly, there is no adequate input to guide the short-term planning and allocation of resources. Furthermore, as the general assumption is that all projects receive the resources they have requested, the projects are left with the understanding that their resource claims will be answered, even though that is possible not the case.

The fundamental idea in the case company is that all resource needs of the projects are to be answered by the functions in all situations. This thinking is also reflected in the management's practice of not prioritizing projects and treating them with equally high priority. Although all the customer projects are agreed to be delivered to the customers and should therefore be executed on the demanded schedule, resource conflicts still occur. This pitfall of assigning the same priority to all projects in execution is discussed in the past literature: if projects of a company are not prioritized, there does not exist any clear guidance on which project(s) the limited resources should be allocated to during the resource conflicts, thus placing all the projects in equal positions for the fight over the resources (Dye and Pennypacker 2000).

In the case company, the prioritization of projects is not established beforehand, and there is no predefined guidance available for resolving resource conflicts. Consequently, project and task prioritization are handled ad hoc in each resource conflict situation. Sometimes, the decision regarding which project receives the resources is escalated to the senior management and the CEO for resolution. In these resource conflicts, it is commonly observed that resources are allocated to those who are the most vocal rather than based on a rational assessment. However, making resource allocation decisions based solely on a sense of urgency and the requester's ability to assert resource demands is not a reasonable approach. The lack of prioritization and the absence of predefined guidance may lead to situations where resources are not allocated to tasks that would yield the best outcomes for the firm. Thus, the company's senior management should focus on improving their project portfolio management practices by evaluating, prioritizing, and reprioritizing their projects frequently. As Aalto (2001) states, the evaluation should concentrate on certain decision points, such as certain milestones in a project's lifecycle. The prioritizing of the projects should also guide the multi-project resource planning at the different planning levels and the development of the decision rules for resource conflicts.

As of now, multi-project resource planning in the case company for R&D and engineering resources is fragmented, and its process is not clearly defined. The literature offers frameworks and guidelines for multi-project planning that could be beneficial for the company to improve its multi-project planning process and practices. Based on the frameworks of Hendriks et al. (1999), de Boer (1998), and Hans et al. (2007), resource planning for multiple projects should be done considering the projects as a whole and by dividing the planning into different levels, all of which have different focus, accuracy of plans, frequency, and goals. In addition, links that connect these planning levels should be clearly defined, that is, outlining when and what kind of information is exchanged between the planning levels. Based on these frameworks, adaptation of the multi-project resource management process illustrated in Figure 15 is proposed for the case company.

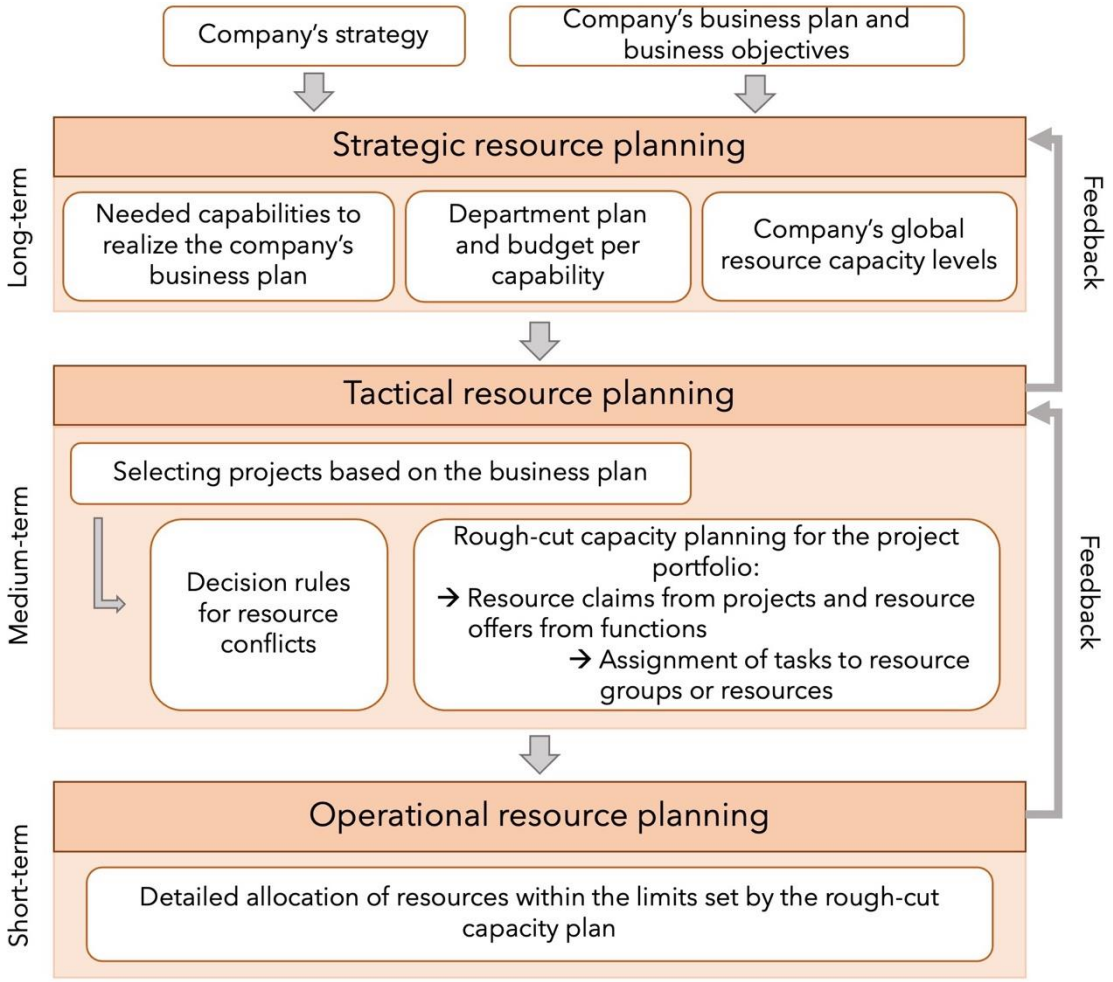

Figure 15. Multi-project resource planning process and its different levels.

The aim of the strategic resource planning process is to plan the company's global resource levels so that the company's strategic objectives can be reached. The planning horizon of this planning process is long term, that is, for the following years. The strategic

resource planning should be conducted approximately yearly, for example, immediately after the company's business strategy is reviewed and updated. The strategic resource planning should use feedback from the lower planning levels to modify the long-term plan, and also share the formed long-term resource plan as an input to the tactical resource planning process.

The aim of tactical resource planning is to plan the actual utilization of resources based on the long-term strategic resource plan. Its goals are to select projects for the project portfolio based on the company's business plan, provide decision rules for functional and project managers to resolve potential resource conflicts, and create a rough-cut capacity plan for the selected project portfolio based on realistic evaluations. The planning horizon for tactical resource planning should extend at least for the following six months or up to a year, and even further if possible. In the planning framework by Hendriks et al. (1999), the frequency of medium-term planning is every three months, and de Boer (1998), on the other hand, recommends that tactical planning should be done during a new project's bidding phase or when new relevant facts are known. Due to changing situations in the case company, it would be advisable to review the rough-cut capacity plan, for example, monthly, to stay on track of the situation. Feedback from the operational resource planning level should be used in this review. The rough-cut capacity plan and decision rules are transferred as input information and guidance for operational resource planning.

The purpose of operational resource planning is to assign resources to tasks and activities in more detail, within the limits set by the rough-cut capacity plan. The planning horizon is short-term, such as a week, several weeks, or a month or two. The decision rules created during tactical resource planning provide guidance for functional managers in short-term resource assignment, in which resource conflicts can occur.

The circumstances and contexts of projects and organizations should always be considered when defining the information exchange between the planning levels. For multi-project organizations in which projects are highly dependent on shared resources and utilize the matrix organization form, such as the case company, Hans et al. (2007) emphasize that at the start of each project when there is only rough project information, the most important data to be transferred from the tactical to the operational planning level are the estimated required resource capacity needs, due dates, and milestones. With this information, operational planning and preparation, such as recruitment, can be

started, and as more information comes up later, the plans can be made more detailed. In addition to the agreed upcoming and ongoing projects, it is important to also include those projects in the planning that have not started yet but may start in the future (Hendriks et al. 1999). Based on these, the case company should utilize rough information of the upcoming projects for tactical resource planning purposes as early as possible, including information of the projects with bids still out, even though their realization is not certain. This way the resource planning would have a clear picture of the possible future projects and their needs with at least rough information to guide the preparation for them.

To improve multi-project resource planning in the case company, efforts should be made to make the medium-term resource allocation process with rough-cut capacity planning effective and adequate, as it is the important part connecting strategic resource plans to short-term resource allocation (Dye and Pennypacker 2000). According to Hendriks et al. (1999), the rough-cut-capacity-plan with resources roughly allocated to different projects for the following months or years should be composed in agreement with the functions and projects. As of now, the case company acknowledges the R&D and engineering resource requests from all projects, but the allocation of the different resources is not clearly agreed upon. Furthermore, project managers do not participate in this planning process or are shared any information of it, at least directly, on a regular basis. To compose the best allocation of the R&D and engineering resources, the rough-cut-capacity-plan should include collection of the resource claims for project tasks, rough allocation of the resources for the different tasks by the functional managers, and a discussion to make possible edits to the plan and to reach a mutual agreement of it. Even if the chief design engineers represent projects during planning by laying out the projects' resource requests, it is recommended that project managers be included in the discussion at some level and share the final rough-cut capacity plan with them directly. In addition, the decision rules to be used as guidance in the case of resource conflicts should be composed alongside the rough-cut-capacity plan. The decision rules should reflect the prioritization of projects made by senior management to ensure that in case of resource conflicts, the resources are allocated for those projects and tasks that produce the best outcome for the firm. Overall, this tactical, medium-term resource allocation should be guided by a long-term strategic resource allocation plan formed by the senior management of the firm.

With the adequate medium-term resource allocation, the rough allocation of the resources in the near future would be clear to all involved parties, the rough-cut-capacity plan would work as a guide for the short-term resource allocation, and the resource conflict situations would probably be solved smoother and without the upper management's frequent involvement when there would be the predefined decision rules to lean on. A suggested model for the rough-cut resource planning for the case company, primarily based on the model described by Hendriks et al. (1999), is presented in Figure 16.

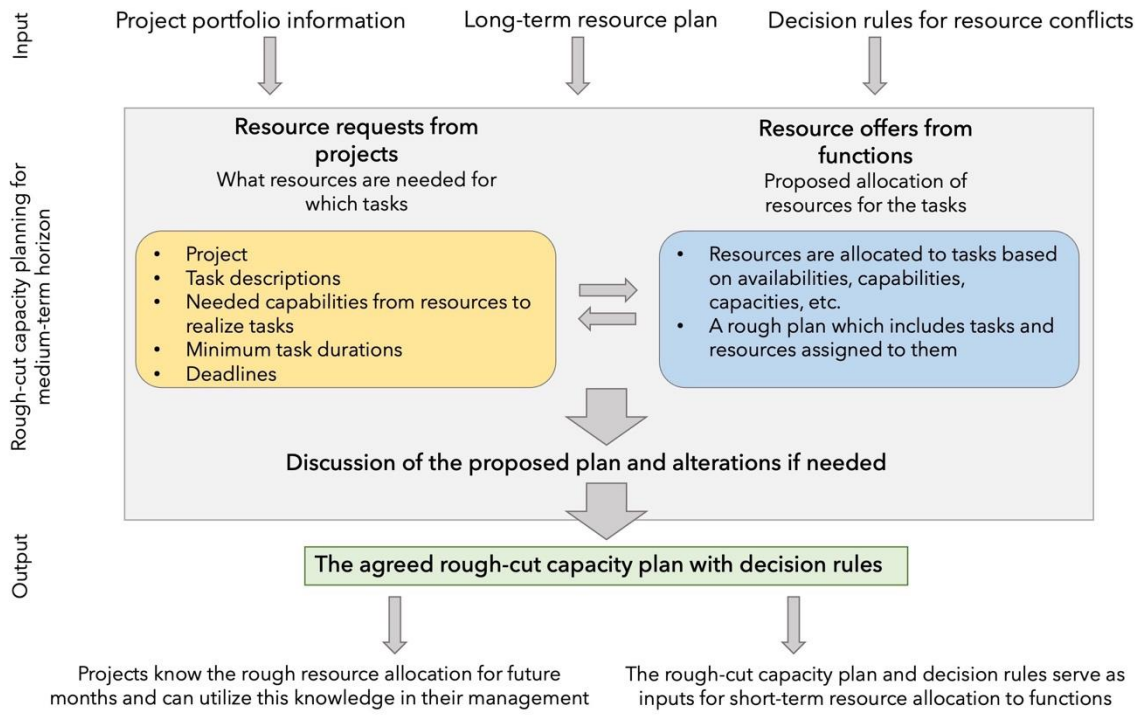

Figure 16. Proposed model for rough-cut capacity planning.

Although the matrix organizational structure allows scarce resources and valuable skills to be utilized across multiple projects simultaneously, past literature shows that an increase in the number of switches between tasks in different projects can decrease employees' work productivity (Yaghootkar and Gil 2012). Additionally, studies have found that overly large project teams can reduce team members' productivity and dedication to project work (Hendriks et al. 1999). These aspects should be considered when planning and allocating resources for each project and task in the case company. It is advisable to minimize employees' switches between tasks and keep the project team sizes as small as possible. For example, if feasible, individuals who are already familiar with a project and their tasks should remain in the project team for future similar tasks rather than being replaced by someone else later.

4.2 Clearly defined roles and responsibilities

In a project-oriented company, multiple actors typically participate in resource management. In such complex environments, roles and responsibilities revolving around resource management might be experienced and understood differently by different individuals, such as managers and employees. This ambiguity and unclarity can cause ineffectiveness in resource management in project-oriented companies (Keegan et al. 2012); for example, one may not know who to contact with a specific issue or request, or there could be unclarity of who should make a decision in a certain situation. Based on the empirical study, there appears to be unclarity of roles and responsibilities considering resource management in the case company as well: roles and decision-making hierarchies regarding the resource management are not always clear to everyone, not even for the managers. Furthermore, responsibilities are often understood differently by different individuals. These unclarities have also caused ineffectiveness to the company's resource management; for example, there have been unwanted delays in decision-making, as it has not been unambiguous who should take the lead and make decisions in certain situations, such as starting the acquisition of more resources.

To reduce the ambiguity surrounding roles and responsibilities related to resource management in the company, it is essential to explicitly define and communicate these roles and responsibilities to all involved parties. When there is a clear definition of each person's authority and responsibilities, individuals have a better understanding of what is expected of them, who is in charge of specific resource management areas, and who should be contacted for specific issues. Clarifying roles and responsibilities helps minimize confusion and delays in communication and decision-making processes within the company. With well-defined responsibilities, individuals can be entrusted with fulfilling their assigned tasks without the need for constant progress checks.

In a project-oriented company operating within a complex and ever-changing multi-project environment, it is unnecessary, and even unwise, to delve into excessive detail when defining roles and responsibilities to allow for flexibility. Nevertheless, establishing roles and responsibilities at a broader level would likely improve the current situation within the case company. By clearly defining these roles and responsibilities, individuals can focus on their essential tasks. Moreover, it would provide a clearer understanding of

the decision-making hierarchy specifically related to resource management in the company, benefiting the overall coordination and allocation of resources.

The proposed role and responsibility descriptions for the case company are shown in Figure 17. This suggestion builds on findings from the literature, while considering the company's current situation. Thus, in addition to senior management, project managers, and functional managers usually discussed in the past literature, the roles and responsibilities of chief design engineers are also included in the suggestions. As resource management is an important managerial task, especially in a multi-project setting with scarce resources, it is recommended for functional managers to focus more on their roles as managers rather than as project workers in projects to ensure that they have enough time to perform the required management activities adequately and effectively.

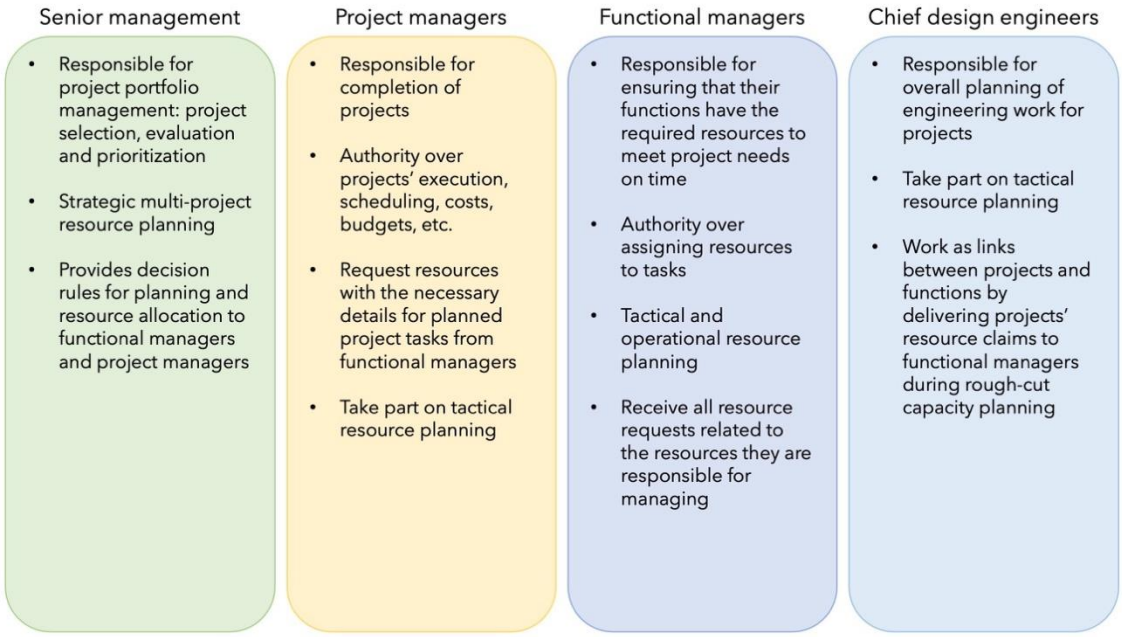

Figure 17. Proposed rough descriptions of roles and responsibilities regarding multi-project resource planning.

4.3 Creating, using and sharing relevant data

To adequately plan and manage resources, sufficient information should be available to guide decision making. To best utilize data, there should be enough of them, and they should be relevant and of adequate quality for the intended purpose. Additionally, the data should be made available to those who need it and be shared appropriately. Based on the past literature, relevant data for resource management in project-oriented organizations and multi-project environments include, for example, resource data, project

data, and data on internal and external factors and processes that may impact it. Furthermore, the resource planning activities generate information that can be utilized in other resource planning processes or elsewhere within the organization.

In the case company, the lack of adequate data, siloed data, and insufficient flow of information through the organizational units are recognized as central information management problems that contribute to resource management challenges. The lack of sufficient resource planning processes and practices can be seen as one source of these problems. Because such practices and processes are not in place, it also means that adequate data are not being created in them. Consequently, these data cannot be shared and utilized, for example, as guidance or feedback in other resource planning processes. Furthermore, current resource management processes and activities lack data, or the available data do not meet the required quality standards for efficient decision-making. For example, the data may not be up-to-date or sufficiently detailed. Additionally, there appears to be siloed data in the case company, as the data relevant for resource management created by organizational units is not always openly shared with those who could benefit from it. It is evident that if someone frequently needs data and has to ask for it to get it, resulting in others sending it to them, time is wasted in this transaction compared to the situation where the person has direct access to the data on their own. Moreover, if one does not even know that such data exists, they do know to ask for it, and the benefits of using the data are lost.

To improve their R&D and engineering resources' management in a multi-project environment, the case company should focus on creating and gathering information relevant to decision-making considering resources. Because planning is rendered useless if the data are not up-to-date (Hendriks et al. 1999), it is essential to ensure that all necessary information is created and collected at a detailed level and updated with required frequency. Additionally, the company should establish and promote efficient ways of sharing data with those who need it.

To plan the use of resources effectively, it is essential to have adequate data on the resource pool and sufficient information on what resources should be planned for. Thus, the fundamental data that should be available and used for resource planning decisions include, for example, information on resources such as their capabilities, capacities, and availabilities; information from the projects, such as projects' estimated resource

requirements with task descriptions, schedules, and task durations; sales information such as possibly upcoming projects and project bid status; and the company's strategy and business objectives. In addition, detailed information on the work hours of each resource for each task and project should be available for feedback. Information created during different resource management and planning processes should also be shared openly and directly with those who will benefit from it, thus enabling the best utilization of the data. Figure 18 summarizes the significant data related to the multi-project resource planning process.

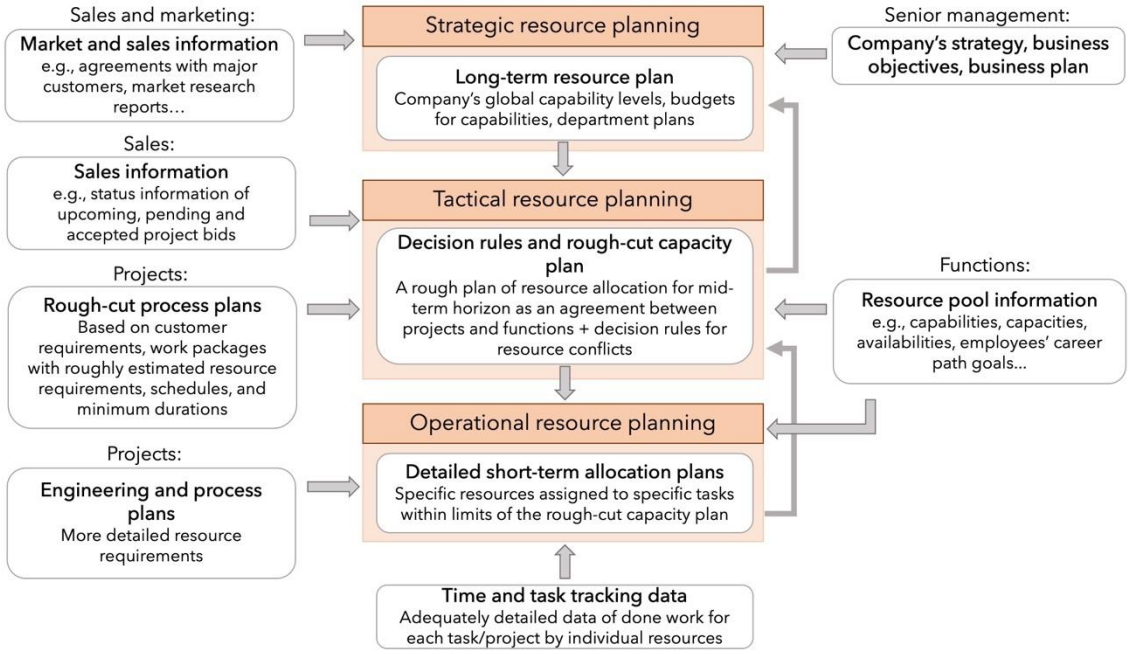

Figure 18. Significant data regarding multi-project resource planning.

4.4 Open and effective communication

Communication-related resource management challenges identified in the case company during the empirical study included a lack of organized communication between project managers and functional managers, siloed organizational units, lack of company-wide communication, unnecessary frequent communication to ensure task completion, and lack of company-initiated development discussions between supervisors and employees. The absence of communication between projects and the R&D and Engineering functions leads to inefficient resource allocation planning, leaving each party uncertain about future plans. Furthermore, the lack of communication and information sharing between the organizational units and across the entire company results in individuals not having a clear understanding of what is happening in other units or within the company as a whole.

The absence of company-led development discussions between supervisors and employees may result in supervisors not having all the valuable information to support their employees' careers and well-being. As resource allocation has a direct impact on employees' career paths in project-oriented organizations (Keegan et al. 2012), it would be especially essential for functional managers to have information about their employees' career goals and capabilities in mind when planning resource allocation for multiple projects and tasks.

To address the first problem, a defined resource planning process that encourages frequent communication between project managers and functional managers (i.e., projects and functions) would be a solution (Hendriks et al. 1999). Furthermore, defining the resource planning process would facilitate communication related to resource management between different organizational units. It would provide guidance on the expected exchange of information between units at different stages of the planning process. Moreover, the defined planning process combined with the clearly defined roles and responsibilities discussed earlier would most likely reduce the need for unnecessary communication by explicitly assigning tasks to specific individuals. Additionally, the resource allocation plans created during this process could be used to clearly communicate employees' upcoming tasks and projects, thus reducing the pressure caused by uncertainty about future work that employees in project-oriented organizations have been identified to experience (Turner et al. 2008).

In an organization, organizational units and individuals are the building blocks that collectively shape and contribute to the organization's strategy. To understand the meaning of one's work for the whole company, it would be beneficial to know what others are doing and the overall direction of the company. Furthermore, frequently sharing information about the situations and activities of each organizational unit, even at a general level, can allow others to benefit from it. For example, they can incorporate the acquired knowledge into their own unit's plans. Additionally, to ensure that valuable resources remain within the company, supervisors should effectively communicate with their employees to acquire necessary information and feedback from them. Thus, promoting open and effective communication throughout the company would likely benefit the company's resource management and foster an overall more open organizational culture, potentially resulting in additional benefits.

4.5 Synthesis of the improvement recommendations

The suggested improvement recommendations to address the company's current resource management-related challenges are summarized in Table 4. The most important improvement recommendation for the case company is to implement a multi-project resource planning process with strategic, tactical, and operational planning level activities. The multi-project resource planning process acts as a base for several other solutions, as it guides how roles and responsibilities, communication, and data management should be defined and arranged around it to effectively connect the company's strategy to its everyday assignment of resources.

The resource management challenges identified in the case company are challenges that have been discussed in the literature before. Even though the solutions were formed by considering the case company's circumstances, they are still presented on a general level and could thus be applicable to other companies struggling with similar challenges.

Table 4. Summary of the proposed solutions to the case company's resource management challenges.

Area	Challenges	Solutions
R&D and Engineering resources	▪ high fluctuation of workloads ▪ work overloads ▪ a trend of rising resignments of longtime experts ▪ new employees do not stay in the company	▪ Improve resource management and planning (see the other solutions below)
Multi-project resource planning process and practices	▪ no prioritization of projects ▪ no predefined decision rules to be utilized during resource conflicts ▪ inadequate resource planning process, especially on the medium-term planning level ▪ no agreed rough-cut capacity plan ▪ inability to meet project resource needs on time ▪ constant resource conflicts ▪ frequent firefighting ▪ ad-hoc prioritizing of tasks by the engineers, the functional managers, and the senior management	▪ Implement the multi-project resource planning process with strategic, tactical and operational planning levels ▪ Implement better project portfolio management practices, including prioritization of projects
Roles and responsibilities	▪ unclarity of who is the person the resource requests should be addressed to ▪ unclarity of roles ▪ unclear responsibilities ▪ one person may have multiple roles	▪ Clarify roles and responsibilities regarding resource management

		▪ Give functional managers time to adequately carry out their managerial responsibilities
Communication	▪ lack of organized communication between the project managers and the functional managers ▪ siloed organizational units ▪ lack of companywide communication ▪ time wasted on asking after things to ensure that they are done ▪ possible lack of employee-focused communication between supervisors and employees due to not organizing development discussions in the company	▪ Use the multi-project resource planning process to guide and encourage adequate communication concerning resource planning ▪ Promote open communication throughout the company ▪ Arrange frequent development discussions between supervisors and employees
Information management	▪ lack of adequate data for decision making ▪ siloed data ▪ insufficient flow of information through the organizational units	▪ Use the multi-project resource planning process to identify relevant data and guide creation, gathering and sharing of data ▪ Share and give access to data for those who could benefit of it

5 CONCLUSION

5.1 Key results

The objective of this study was to research and improve the management of the case company's R&D and engineering resources in a multi-project setting. This study aimed to develop solutions that can be implemented in the case company to enhance its multi-project resource management. The overall focus of this study was to identify the current challenges occurring in the case company and provide justified improvement recommendations for solving them in order to achieve adequate multi-project resource management.

The following three research questions were used to guide and support the research process of this master's thesis:

1. How to manage resources in a multi-project environment?
2. What is the current state of multi-project resource management in the case company regarding its R&D and engineering resources?
3. What kind of management approach would be suitable for the case company to better manage its R&D and engineering resources?

The first research question was answered by conducting a literature review of the past literature on the subject. In multi-project environments, several projects are executed in parallel and in succession and use resources from the same resource pool. Resource management is one of the most critical and challenging tasks for organizations operating in such settings. The ultimate goal of resource management in multi-project environments is to manage, plan, and allocate resources to multiple projects in a manner that optimizes the overall success of the organization. How resource management in a multi-project environment eventually comes together depends on several factors, including the adopted organizational structure, interdependencies among projects, projects' dependency on shared resources, projects' complexity, and the overall organizational context. To align an organization's strategic objectives with its daily work in projects, the literature highlights the need to consider and evaluate the set of projects as a whole, rather than treating them individually, when planning resources. In addition, the resource planning frameworks introduced in the literature emphasize that multi-project resource planning

should consist of several planning levels with different planning horizons, frequencies and data requirements. Furthermore, these planning levels should exchange information to ensure that the overall resource planning is as effective as possible.

The second research question was answered by conducting a current state analysis. The aim of the current state analysis was to research the case company's current situation, processes, and practices regarding multi-project resource management and identify the challenges associated with it. The empirical study was conducted as a qualitative case study, and its focus was on the company's R&D and engineering resources and their management and planning in a multi-project environment. It was found that resource management in the company was generally experienced to be ineffective, and the current processes, tools, and practices were not fit for the purpose. Fluctuations in workloads and work overloads were norms in the company, and daily work was associated with frequent resource conflicts and the ad hoc prioritization of tasks. The major issue in the company seemed to be the lack of adequate multi-project resource planning processes and practices: the management's focus was more on the individual projects rather than on the projects as a set, and the resource planning for multiple projects was fragmented and insufficient. In addition, the lack of clarity of roles and responsibilities regarding resource management, inadequate information management, and insufficient communication practices contributed to these problems.

The third research question was answered by discussing the results of the current state analysis in the light of the findings of the literature review. Furthermore, the findings of the literature review were used as a theoretical basis to propose recommendations for improving the current challenges of the company. The improvement recommendations for the case company focused on four crucial problem areas identified in the empirical study (see Figure 19).

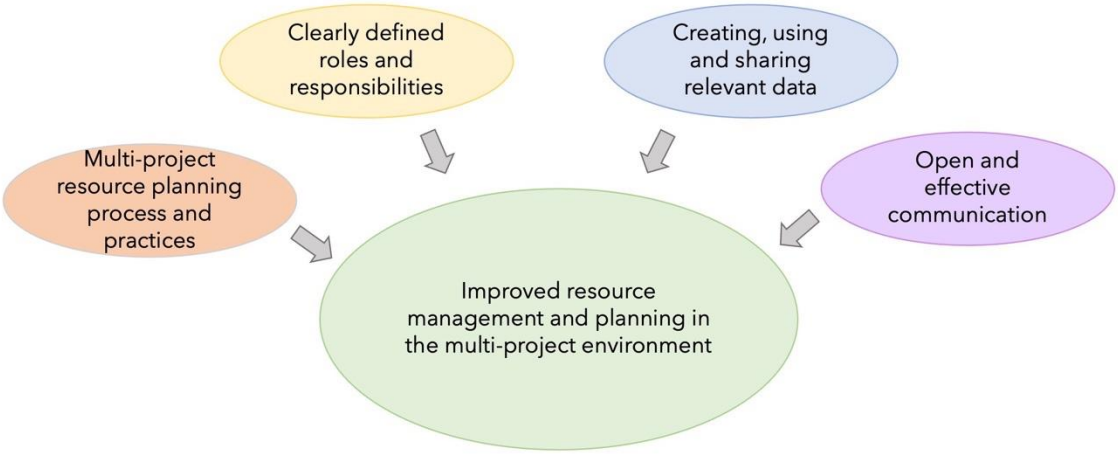

Figure 19. Improvement recommendations for the case company's R&D and engineering resources' management in a multi-project environment.

The most significant recommendation was the implementation of a well-defined multi-project resource planning process and resource management practices tailored to the context of the case company. The multi-project resource planning process should be divided into strategic, tactical, and operational planning levels, all of which have different focuses, planning frequencies, and data needs. Each of these planning levels exchanges information with others and cannot work properly without one another; however, together they form an overall resource planning process that connects the company's short-term resource assignments to its strategic business plan.

The clearly defined roles and responsibilities are proposed as the second improvement suggestion. Considering the case company's organizational structure, the proposed explicit descriptions of roles and responsibilities aim to support the recommended multi-project resource planning process and clarify the decision hierarchy and authorities regarding resource management to everyone involved. Furthermore, by reducing the ambiguity of the roles and responsibilities with the clear definitions, resource management effectiveness is promoted as it is clear who should take the lead or make decisions in certain situations.

The third improvement recommendation focused on creating, using, and sharing relevant data. Adequate data should be available to enable effective decision-making regarding resource management and planning. Furthermore, the best utilization of data should be ensured by identifying those who could benefit from it and giving them access to it. Data and its sources significant for the proposed multi-project resource planning process were

described, emphasizing where the actions of data creation, gathering, and sharing should be focused to facilitate effective decision-making in resource planning.

The fourth and final improvement recommendation considered open and effective communication practices. By promoting a culture of open communication and increasing communication within the company, between organizational units, and between supervisors and employees, individuals' understanding of the overall situation of the company and their part in it could be increased, and valuable information for resource management and planning could be gathered and utilized. Furthermore, the proposed multi-project resource planning process encourages efficient communication between organizational units and individuals by defining the points where and what kind of communication is required between the parties.

5.2 Managerial implications

This study gathered fundamental knowledge on how to manage resources in multi-project environments. In addition, the study provided justified actionable improvement recommendations for resource management-related challenges that have occurred not only in the case company, but also in other organizations, based on the literature. Therefore, this study is beneficial for any organization or manager operating in a multi-project setting as it outlines what should be considered when aiming to implement resource management efficiently. The study would most likely be valuable especially to multi-project organizations similar to the case company, as the improvement recommendations were made by considering the case company's circumstances. However, the improvement recommendations were still presented at a fairly general level and could therefore be used as a guiding basis by any multi-project organization wishing to address similar challenges.

5.3 Scientific contribution

This study combined knowledge of organizational structures, resource management in project-oriented organizations, and multi-project resource management to provide improvement recommendations to the project-oriented case company. By studying the earlier literature, this study synthesizes the fundamentals of the multi-project resource planning process, its agents, and significant factors affecting the process. In addition, this

study complements the earlier research by identifying similar multi-project resource management challenges in the project-oriented case company as has been discussed in the previous literature, such as unclarity of roles and responsibilities (Keegan et al. 2012) and lack of project prioritization (Dye and Pennypacker 2000). Furthermore, this study contributes to emphasizing the need to divide resource planning in a multi-project environment into different planning levels with different planning focuses, horizons, frequencies, and data accuracies to connect companies' strategic aims and business plans to day-to-day work assignments.

5.4 Critical evaluation of the research

This study has a number of limitations. First limitation concerns the qualitative nature of the research. In qualitative research, especially semi-structured interviews, the researcher is in a significant position on how the gathered information is interpreted. The researcher of this study aimed to be objective and not lean into any assumptions that were not supported by the collected data. However, the fact that this research was conducted by only one person should be acknowledged when examining the validity of the results.

Furthermore, as only qualitative data were used to analyze the current situation in the case company, it is possible that what the interviewed individuals perceived or what was observed may not precisely reflect the reality. For instance, the interviewed individuals expressed that they experienced current resource management practices as ineffective. However, since there were no quantitative data available to determine, for example, the extent to which these practices impacted project delays, these experiences cannot be further confirmed and must be understood as they were conveyed. Nevertheless, multiple qualitative data sources were utilized in the empirical study to enhance the credibility of the results, and the participants' responses were rather consistent, as many individuals raised similar issues and challenges.

As the scope of this study mostly concerned managers' actions and approaches, it was reasonable to interview mainly persons who were in managerial positions. However, it is still possible that some information could have been added if regular project workers were interviewed. However, it could be said that the project workers' perspective was at least on a certain level brought to the study because some of the functional managers also worked as project workers.

Finally, since the empirical part of this research relied mostly on the interviews, it is possible that some significant observations were missed due to not following more everyday practices regarding resource management in action. Thus, to confirm and define the findings of the current state analysis, everyday resource management practices must be explored over time in the case company.

5.5 Future research

As the scope of this study did not include the implementation of the suggested improvement recommendations, the implementation process in the case company could be seen as an interesting topic for future research. Studying the implementation of the improvement suggestions would confirm whether they have a positive impact on the multi-project resource management and the overall situation in the company. By thoroughly documenting the circumstances in the company and its projects before and after the implementation of improvement recommendations, the initial and resulting states could be compared, thus gaining knowledge on how much the implemented suggestions enhanced the situation in the company, for example, in terms of decreasing project delays, project costs, or fluctuation of workloads. Another possible research topic for future research would be to expand the focus of the research to the management of the case company's overall resources, thus including other departments and functions that provide resources for the projects.

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Appendix 1. Survey and interview questions.

Background of the participant

1. Current job title/role:
2. Team:
3. Experience:
   - Under a year
   - 1–5 years
   - Over 5 years
   - Over 10 years

Survey

Evaluate the following statements on a scale of 1–5, in which 1 = "I completely disagree" and 5 = "I completely agree"

1. I understand what resource management as a concept is
2. Resource management is currently performed efficiently in the company
3. Current tools, practices and processes in the company support aims of resource management
4. I am satisfied with the way resource management is currently performed in the company
5. I am satisfied with the way resource management is currently performed in my team
6. Roles and decision-making hierarchies related to the company's resource management are clear to me

Interview questions

1. Describe your current job and work assignments. How does resource management relate to them?
2. Who participates in resource management in the organization and to whom does it have an effect?
3. What the resource management process is like from your perspective? What tools are used to implement it?
4. What factors affect the resource management and its success?
5. What kind of communication is related to resource management? Is it sufficient in your opinion?
6. Are there any strategies or objectives for the resource management? Is their realization monitored, and if so, when and how often?
7. What is the organizational culture like in the company? What kind of view and attitude do the individuals in your team/organization have towards resource management?
8. Do you and individuals in your team/organization have all the skills, knowledge, experience, support, and information required to implement resource management?
9. What are the things that the resource management currently succeeds or fails in?
10. If you think that resource management is currently not performed adequately and as efficiently as needed, what are the things that should be changed in the current resource management?
11. Do you have concrete suggestions on how to improve the resource management?