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A STUDY ON SALES, SCHEDULING AND RESOURCE PLANNING IN PROJECT ENVIRONMENTS

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TIIVISTELMÄ

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Myynnin, aikataulujen ja resurssien suunnittelu projektiympäristöissä

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Suuren kokoluokan toimitusprojektien toteuttaminen vaatii tyypillisesti lukemattomien työntekijöiden työpanoksen. Tämänkaltaisia toimitusprojekteja toteuttavat yritykset tekevät usein useita projekteja samanaikaisesti, ja samalla organisaation on kyettävä varmistamaan uusien projektisopimusten solmiminen organisaation tulevaisuuden toiminnan turvaamiseksi. Projektitoimittajaorganisaatioissa onkin koko ajan kyettävä suunniteltava organisaation toiminta onnistuneesti myynnin ja toteutusorganisaation rajapinnassa olemassa olevien projektien läpiviennin onnistumiseksi ja organisaation strategiaan ja organisaation tilanteeseen sopivien uusien projektien löytämiseksi.

Moniprojektitilanteissa korostuvat yksittäisten projektien onnistunut ja aikataulun mukainen läpivienti, organisaation resurssien hallintatekijät, kuten projektiin tarvittavan resurssimäärän ja -osaamisen sekä kriittisten resurssien tunnistaminen ja varmistaminen toteutettavien projektien käyttöön. Onnistuneiden projektitoimitusten mahdollistamiseksi projektien selkeä aikatauluttaminen, työtehtävien priorisointi sekä työtehtävien kohteena olevien tuotteiden määrittely ovat avainasemassa.

Organisaation on tunnistettava oikeankokoinen markkina ja arvioitava projektimahdollisuuksien välillä kaikkein parhaiten organisaation strategiaan ja tilanteeseen sopivat projektit. Tällä varmistetaan projektien toteutusvaiheessa riittävät ja oikeanlaiset resurssit ja mahdollistetaan yrityksen pitkän aikavälin strategisten tavoitteiden ja menestyksen toteutuminen. Projektien myyntivaiheen onnistuminen on tärkeä edellytys onnistuneelle projektitoteutukselle. Tärkeimmät asiakasvaatimukset on pystyttävä viestimään myynnin ja projektia toteuttavan organisaation välillä.

ABSTRACT

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A study on sales, scheduling and resource planning in project environments

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The implementation of major supply projects is a complicated endeavour typically requiring the workload of countless human resources. Companies undertaking the planning of these projects are often organizations with several of these types of projects planned and implemented concurrently, and at the same time they must be able to enter into new project contracts to secure the future of the organization. Project supplier organizations must therefore plan the operations in the interface of sales and project execution to be able to successfully finish existing process and to find new projects that fit the strategic goals and internal situation of the organization.

In a multiple project situation, it is important to successfully manage single projects according to planned schedules and resource utilization. Resource management factors such as resource amount and their competencies and critical resource for each project should be identified and secured for the use of the projects. In order to enable successful project delivery, key factors are clear project schedules and task scheduling, determined task priorities as well as well-specified task deliverables.

Successful project sales phase is an important prerequisite in guaranteeing successful project execution. Most important customer requirements must be communicated between the sales function and project executing organization. The project supply organization must identify a right-size market and evaluate project prospects so that the fit of the projects to the organization's strategic goals and internal situation is optimal and adequate resources and competencies can be secured to enable the fulfilment of long-term strategic goals and long-term success.

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1. INTRODUCTION

The implementation of major supply projects is a complicated endeavour typically requiring the workload of countless human resources. Companies undertaking the planning of these projects are often organizations with several of these types of projects planned and implemented concurrently. Their customers in wide variety of different fields of business are expecting their projects to be completed in time and on budget. At the same time the organizations must execute several projects concurrently to bring enough revenue to the organization meaning that there are also several customers with their own requirements and demands which need to be satisfied simultaneously.

1.1 Background of the thesis

The dependence of utilizing the same limited human resources in multiple projects concurrently poses significant difficulties for organizations basing their business in the execution of projects, especially as there is a need to constantly acquire new project contracts in order to secure cash flow into the organization and keep the organization's resources at efficient utilization level.

Well-defined project marketing process, successful project scheduling activities and effective management of resources between multiple projects will result in more efficient project execution and optimal utilization of the organization's resources and therefore is a central matter in delivering projects on budget and on schedule.

1.2 Objectives of the thesis

The purpose of this thesis is to explore and identify applicable practices for project sales and planning in multiple project situations. Additionally, the thesis will explore the problems arising from executing multiple projects at the same time and the most evident pitfalls that the organization should avoid in executing multiple projects concurrently with the same limited resources. As projects are always complicated endeavours, there is also a requirement for an organization to identify its constraints in selling its services to possible clients and balancing the amount of services sold with the organizations ability to execute the work with resources available.

The main research question is as follows:

Q1: What measures can a project-oriented service business organization utilize in project operations planning in order to efficiently execute projects sharing the same resources concurrently?

Additionally, the thesis attempts to answer the following questions:

Q2: Which methods can be utilized for battling unsuccessful integration of sales-operations-interface in project-oriented service organizations in multiple project situations?

Q3: Which methods can be utilized in the sales process of a project-oriented service business organization to enable successful project execution in multiple project situations?

Projects can be diverse in their nature. Types of projects include in-house projects and external supply projects. Inhouse-projects can also be categorized into internal development projects such as product development, organizational development, process development. This thesis addresses issues regarding external supply projects and the problems arising in such

environments. One delimitation is therefore that this thesis considers only issues in external supply projects and inhouse projects and their characteristics are omitted.

One delimitation of the thesis is that it is made from the viewpoint of the organizational planning of project executing organization performing customer work. The project executing organizations performing customer work must always work to satisfy customer demands and adapt to customer requirement changes across the whole during the life cycles of the projects they are executing, the operations planning must take into account the organizational flexibility and constant supervision of projects required to adapt to the changes in projects.

Generally, project resources can be divided into five groups: people, meaning the workforce of the organization; facilities; equipment; money and materials (Wysocki 2009, p. 154; Artto et al. 2006, p. 141). One delimitation chosen in this study is that the resources have been limited to comprise of workforce, that is human resources, executing the projects in the project executing organization. This delimitation is based on the workload of human resources and managing and planning the work of these resources generally being the main project-related planning complication in project-oriented engineering service business.

1.3 Execution and structure of the thesis

The thesis begins by introducing the background, research objective and definitions as well as the research methodology in Chapter 1.

Chapter 2 presents the basic concepts and terms. The definitions of terms in this research is made “so that the readers to understand their precise meaning” (Creswell, p. 142) and “add precision to the study” (Creswell, p. 143). These definitions of the basic concepts are then utilized throughout the study.

Chapter 3 presents a common life cycle of a design engineering project and the different phases of executing an engineering project. The chapter concentrates especially on the front-end of such a project, that is the sales and marketing process, and the aim is to clarify what measures

should be taken into account already in the sales of a project organization executing external supply projects in order to successfully initiate the project execution phase.

Chapter 4 introduces basic concepts of operations planning to present how capacity is planned in an organization and what the main concepts of capacity planning are in a project environment.

Chapter 5 introduces the project planning concepts of project scheduling, resource planning and change management. The interdependencies between project scheduling and resource planning are discussed and the importance of change management and preparing for inevitable change situation in project environments are highlighted.

Chapter 6 introduces the previously introduced project planning concepts in multiple project environments. The implications arising from multiple project situations to the concepts of project sales, project scheduling and resource planning are discussed and measures for successful project planning in multiple project situations are introduced.

Chapter 7 presents the main results of the study and answers the research questions presented in Chapter 1.2 *Objectives of the thesis*. The limitations of the study and suggestions for future research in the area of the study are also presented.

The inputs and outputs of each chapter are presented in figure 1.

Introduction to the study	Chapter 1 Introduction	Background, objectives, execution, structure and research methodology for the study
Basic concepts relating to the research area	Chapter 2 Basic concepts and terms	Project, project management, project portfolio, project program, management of multiple projects
Theory on project sales and marketing	Chapter 3 Project sales	Project marketing and sales process including pre-project, project and post-project phases, linkages between these phases
Theory on operations planning in organizations and project environments	Chapter 4 Operations planning	Concepts of capacity planning in organizations and project organizations
Theory on operations planning of the operations of project organizations	Chapter 5 Project planning	Concepts of project scheduling, resources planning, change management
Theory on project sales, project scheduling and resource planning in multiple project situations	Chapter 6 Planning in multi-project business environments	Methods for successful planning project sales, scheduling and resourcing in multiple project environments
Conclusions of the study	Chapter 7 Conclusions	Main results, answers to the research questions, limitations of the thesis and future research suggestions

Figure 1. The inputs and outputs of each chapter of the thesis

1.4 Research methodology

The thesis is executed as a literature-based study. The author's experiences from real-life project settings in industrial environments are also shared to reflect the issues identified in the thesis. By mirroring the author's own experiences in the field of project-based business, the author aims to bring observational nature to the thesis. Utilization of this "observation method" means that phenomenon or people under research is researched in its "natural" context often during a longer time period and the aim of the research is to understand the experience-based world of people (Vähämäki & Paalumäki 2011, p. 102). This observational method can be utilized to comment the suitability of the methods suggested in literature to practice.

2. BASIC CONCEPTS AND TERMS

This chapter introduces some basic terms and concepts that are instrumental in understanding the contents and linkages of the later part of the thesis. These concepts are presented to create a background to the thesis and introduce the most important concepts regarding the subject matter and research topic under investigation.

The basic concepts presented in this chapter are project, project management, project portfolio, project program and management of multiple projects.

2.1 Project

The concept of project is defined by the Project Management Institute as follows:

“A project is a temporary endeavour undertaken to create a unique product or service.”

Temporary in this definition means that every project has a definite beginning and a definite end. With *unique*, the difference of the product or service is being distinguished from all other products and services. (Project Management Institute 2000, p. 4)

Pelin (2008, p. 33) defines project as:

“Project is the work that is performed to accomplish a defined one-time outcome.”

Pelin’s definition differentiates the project itself from the outcome of the project. As an example, the building and commissioning of an industrial plant is a project, whereas a completed plant is not.

Pelin (2008, p. 33) also introduces the following definitions that are related to a project’s outcome:

- the technical definitions of the outcome (scope)
- the qualitative definitions of the outcome
- the schedule-based definitions

- the resource-based definitions (money, personnel, machinery).

Turner and Müller (2003, p. 7) define a project as:

“A project is a temporary organization to which resources are assigned to undertake a unique, novel and transient endeavour managing the inherent uncertainty and need for integration in order to deliver beneficial objectives of change.”

According to Hans et al. (2007, p.563), a project is defined as follows:

“A project can be informally defined as a unique undertaking consisting of a complex set of precedence-related activities that have to be executed using diverse and mostly limited organization resources.”

A project can also be identified by its three baselines, *scope, time and cost*, which are used to measure the progress and performance in the project.

- The *scope baseline* is the sum of the deliverables in the project and as such represents all the work that is needed to complete the project.
- The *time baseline* is the *time schedule* that presents the work in a time frame needed to complete the project, that is to produce the scope baseline.
- The *cost baseline* is the *budget* of the project. The budget represents the cost of work in the project schedule as time phased. (Newell & Grashina 2004, p. 10)

For the purposes of this thesis the following definition of a project is utilized:

“A project is a complex temporary undertaking to achieve a unique product, service or a design and has a defined and independent scope, time schedule and budget.”

2.2 Project management

Project Management Institute defines project management as:

“Project management is the application of knowledge, skills, tools and techniques to project activities to meet project requirements. Project management is accomplished through the use of the processes such as: initiating, planning, executing, controlling and closing. The project team manages the work of the projects, and the work typically involves:

- Competing demands for: scope, time, cost, risk and quality
- Stakeholders with differing needs and expectations
- Identified requirements.” (Project Management Institute 2000, p. 6)

Lester defines project management as:

“The planning, monitoring and control of all aspects of a project and the motivation of all those involved in it, in order to achieve the project objectives within agreed criteria of time, cost and performance” (Lester 2007, p. 5)

According to Hans et al. (2007, p.563-564) project management “deals with the selection and initiation of projects, as well as with their operation, planning and control.”

For the purposes of this thesis, the following definition is utilized for project management:

“Project management is the act of planning, monitoring and planning of projects, in order to fulfil the demands of stakeholders, the requirements set for the project as well as executing the project according to the scope, time schedule and cost estimation set for the project. Project management is in charge of creating the project schedule, allocating the resources required to execute the project task as well as supervising that the necessary tasks are performed to complete the project”

2.3 Project portfolio

A project portfolio is defined by Archer and Ghasemzadeh (1999, p. 208) as:

“A group of projects carried out under the sponsorship and/or management of a particular organization. These projects must compete for scarce resources (people, finances, time, etc.) available from the sponsor, since there are usually not enough resources to carry out every proposed project which meets the organization’s minimum requirements on certain criteria such as potential profitability.”

Turner and Müller (2003, p. 7) offer another definition for a project portfolio as:

“A project portfolio is an organization, (temporary or permanent) in which a group of projects are managed together to coordinate interfaces and prioritize resources between them and thereby reduce uncertainty.”

A project portfolio is often recognized as being:

“a collection of projects that are grouped together to facilitate effective management to meet strategic business objectives. The projects in a portfolio are diverse in size and importance, may be at any point in their life cycle, and may not necessarily be interdependent or directly related.” (Patanakul & Milosevic 2009, p. 217)

For the purposes of this thesis, a project portfolio is defined as:

“a group of projects with necessarily no interdependent goal or no direct relation to each other that are competing for the same scarce resources. These projects are grouped together in order to prioritize and optimize the utilization of available resources to meet the requirements of chosen criteria.”

2.4 Project program

Project program differs from a project portfolio in such a way that in a program the projects are mutually dependent, share a common goal and lead to a single deliverable or service. (Patanakul & Milosevic 2009, p. 217-218) Project program management is a very special case of multi-project management because of the single and common goal or purpose, and therefore differs from the multi-project management situation, where the projects usually aim for independent and multiple goals. (Wysocki et al. 1995, p. 268)

For the purposes of this thesis, a project program is defined as:

“a group of projects that share a common goal, are mutually dependent and lead to a single deliverable that are executed by the same scarce resources. The projects are grouped together in order to prioritize and optimize the utilization of the available resources to achieve the single deliverable according to chosen criteria.”

Figure 2 illustrates the aforementioned concepts of project management in single-project settings, project portfolio management and program management.

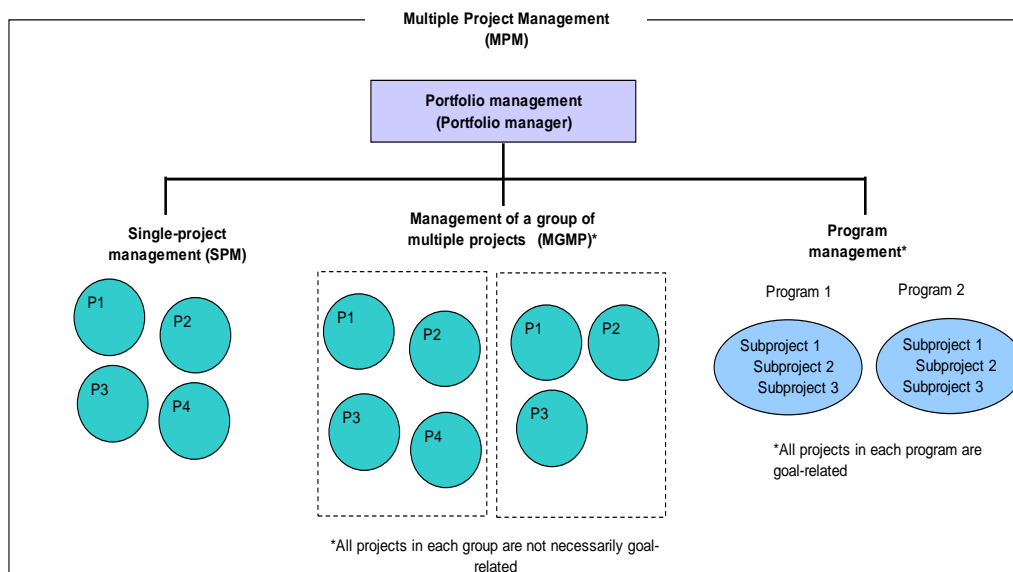


Figure 2. Differences between various grouping types of projects. (Patanakul & Milosevic 2009, p. 217)

2.5 Management of multiple projects

Project portfolio management (PPM) and *multiple project management or multi-project management (MPM)* are often used by experts convergently to stand for the management of a business environment, in which multiple projects are managed concurrently and according to the resource constraints in existence. (Patanakul & Milosevic 2009, p. 217) According to Pelin (2008, p.158), *multiple project management or multi-project management* can be considered as a management principle in an organization, in which several projects load common resources and expert groups.

Table 1 elaborates on the main differences of different project-based management concepts and the scope of each management level.

Table 1. Differences between project management, program management, portfolio management and management by projects (Köster 2010, p. 56)

	Project Management	Program Management	Project Portfolio Management	Management by Projects
Main Content of Concept	Managing a single project efficiently within given organizational constraints and context	Clustering projects pursuing the same objectives into a program to increase flexibility and support alignment with overall strategy of the organization	Clustering portfolios to ensure alignment with organization's strategy. PPM supports coordinated resource allocation, increases flexibility of the whole organization and leads to sustainable project success	Managing the whole organization as a bundle of projects based on a supportive organizational culture. At the extreme, the organization consists of one complex project
Scope	Limited to a set of objectives linked to a single project	Business-unit or organization-wide, depending on the content of the program	An organization-wide management system	A management approach affecting the whole organization, also interorganizational

The problem with many project-based organizations is their concentration on individual projects without considering the impact of individual projects' changes on the implementation of the organizations' other projects. Successful multiple project management tries to overcome following drawbacks that are often encountered, if project-centric tools are utilized in an organization where one or more of the following conditions are prevalent:

- the organization has multiple projects ongoing at any one time
- different parts of the organization must compete for the same limited set of resources with one another
- the project progress is severely affected by the availability of resources with given skills
- time schedules of the project's vary based on their complex nature
- requirements from the clients are constantly changing. (Rajegopal et al. 2007, p. 67)

It is therefore important that the line management of a project-based organization supports project managers in providing adequate number of suitable resources for the execution of each project- There should be a continuous interaction between the line management of a project-based organization with the project management function in order to be able to prepare for change situations in the ongoing projects.

3. PROJECT SALES

The characteristics of projects (uniqueness, temporary nature and complexity) result in many consequences that have to be taken account in project sales processes:

- high degree of uncertainty for the parties concerned
- specific buying process for project customers
- a long transaction with many delimited phases
- fragmented structures of buying centres and sales centres (Cova et al. 2002, p. 23).

Selling and implementation of project services entails careful planning of concurrent and related activities combined to achieve an end product, a finished project. The following chapters present concepts for project sales and marketing.

3.1 Sales and marketing process in projects

Managing the sales process of a service supplying project organization in such a way that the organization has all the work to keep its business running but avoids the situations in which it has made contracts for more work that it has the resources to deliver in a satisfactory manner is extremely difficult. In order to achieve this balance in a project organization, the sales and project operations functions must be integrated and knowledge must be shared between them. In practice this means that the sales function(s) must present adequate amount of finalized project contracts to the project implementation organization to guarantee sufficient level of work for the resources at the operational function(s) but at the same time avoid a situation where too many finalized project contracts have been entered into which cannot be executed by the resources available to the organization. (Cooper & Budd 2007, p. 175)

Project marketing and sales cover all phases before the signing of a project contract, and also includes the marketing and customer relations work independent on a single project. In a single project the tasks of project marketing and sales functions are to prepare for the project before

the actual bidding phase. This includes preparations for possible bidding contests, preparation and submission of the bids as well negotiations with the customer in order to acquire a project contract as attractive as possible. (Artto et al. 2006, p. 55)

The strategic marketing process of projects must consider the strategic priorities of the organization. The target market segments and key accounts as well as the perimeter of the organization's and its partners supply need to be identified. After these analysis, the organization must ensure that the it has the ability to create offers that take the individual characteristics of identified project prospects into consideration (functional development) and also is able to identify these project prospects already in advance, as the customer is still developing the project opportunities. (Cova et al. 2002, p.52-53) The strategic process of project marketing is presented in figure 3.

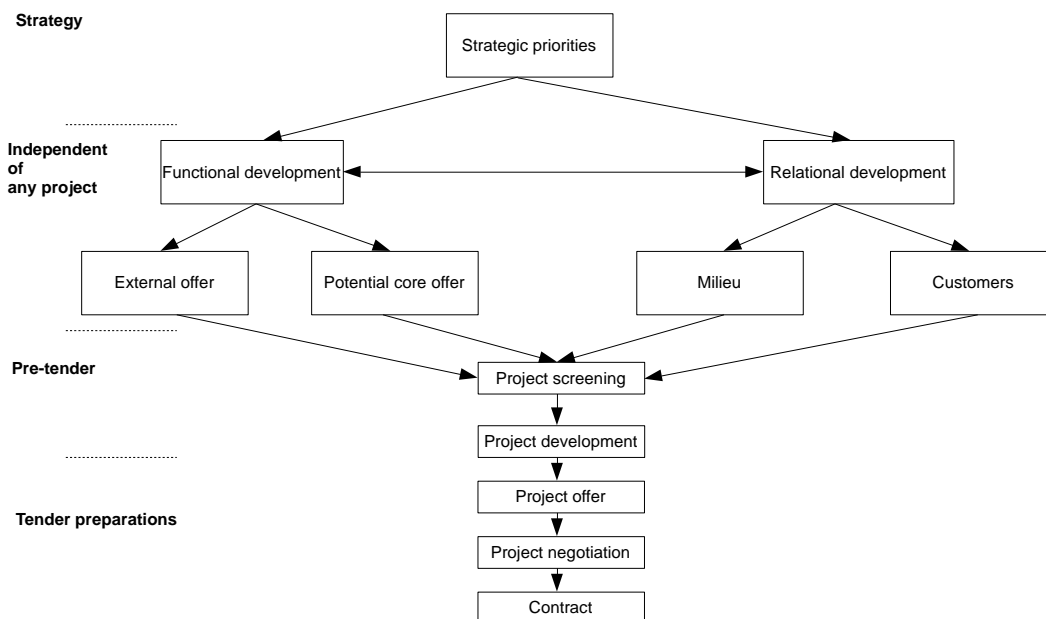


Figure 3. Project marketing process as a strategic process (Cova et al. 2002, p. 52)

Even though each project is a unique undertaking, existing literature has identified a project marketing process which can be applied to external supply projects through their relatively identical stages. This process consists of six stages, four of which precede the actual commencing of the project and can be called the sales phase. The sales process can be considered as the pre-project as depicted in figure 4. (Savolainen & Ahonen 2015, p. 94)

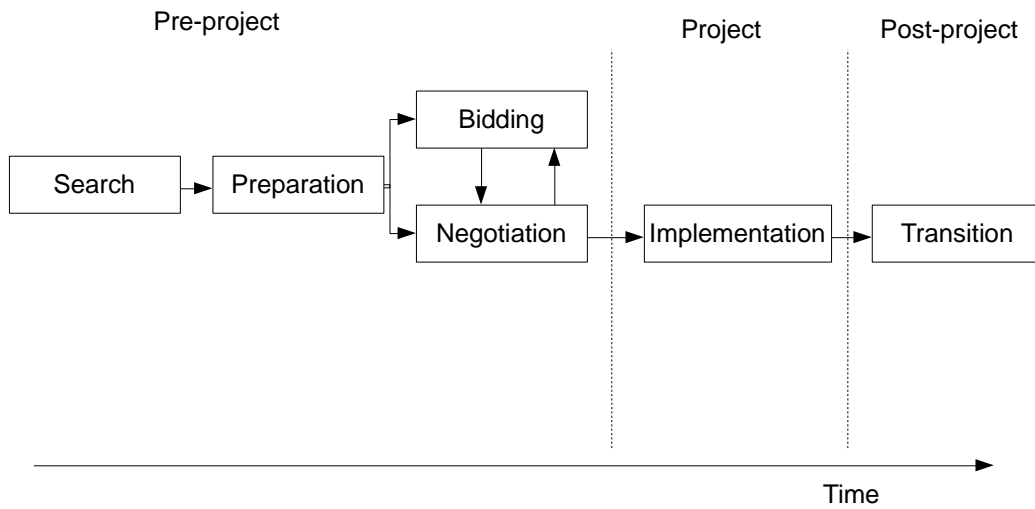


Figure 4. Project marketing process in a single project setting (Savolainen & Ahonen 2015, p. 95)

The pre-project phases of the project marketing process include following main activities:

Search phase: Identifying possible project prospects and opportunities and relevant industry developments;

Preparation phase: Performing a feasibility study, preparing for the project bidding process, creating contacts with customer(s), evaluating the competitive situation;

Bidding phase: Creating the bidding documents after receiving an invitation to bid, decision making regarding price and utilization of internal/local resources;

Negotiation phase: Commencing with the project supplier/seller making a preliminary offer for the project and ending with signing of the project contract. (Savolainen & Ahonen 2015, p. 95)

After the pre-project phase, the actual project execution phase, implementation, is begun. This phase begins after the customer has submitted an order. When the implementation phase has ended and the project execution has been approved by the client, the Transition phase begins. In this phase the project organization is dismantled and the resources executing the project are made available for other projects. As the name Transition phase suggests, there are often still project-related tasks in this phase, which might make the transition of the project executing

resources to other projects challenging. These include project outcome utilization support and other project-associated services as depicted in figure 4. (Savolainen & Ahonen 2015, p. 94).

The project and post-project phases of the project marketing process include following main activities:

Implementation phase: Delivering and supervising the project execution, training buyer's personnel, possibly setting up after-sales systems;

Transition phase: Project evaluation as an entirety, building knowledge for possible future offer opportunities, sales and supply of additional services to the customer. (Savolainen & Ahonen 2015, p. 95)

Figure 5 specifies the project marketing and sales in the lifecycle of a project from the viewpoint of a project supplier organization. After a project prospect has been identified, the customer-specific sales process begins. This sales process can be divided to three phases: 1) preparation for a bidding contest, 2) bidding, that is preparation of the commercial and technical terms of the bid, and 3) bid finalization in the negotiations aiming for a contract. (Artto et al. 2006, p. 55)

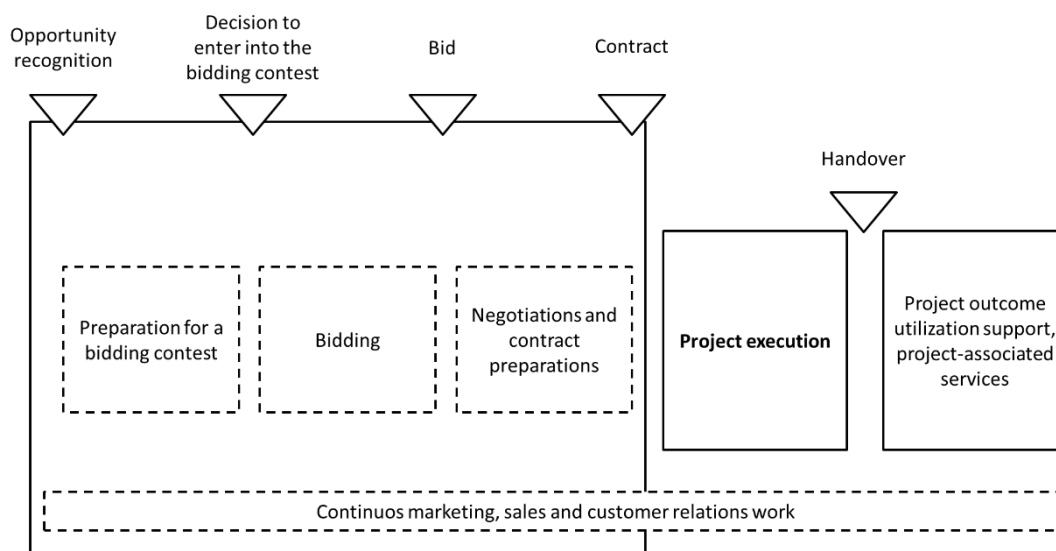


Figure 5. Project marketing and sales in the delivery project life cycle from a project supplier's perspective (Artto et al. 2006, p. 55)

Cooper & Budd (2007, p. 174) voice their finding, that in the marketing of projects, it is important to not only focus on external marketing efforts targeted to customers and the management of customer practices, but also to remember to integrate the external efforts to the project production capabilities of the organization. According to Meredith & Mantel (2006, p. 240) it is a very common problem in projects executed for outside clients that the marketing/sales function has promised deliverables to the client which the engineering function will not be able to produce according to the schedule promised.

Several important decisions regarding a supply-project implementation are made already prior to its actual commencement. Often already as a part of the project marketing and sales process, the technical execution and scope, schedule and most important tasks related to the project execution are agreed upon. The sales phase is especially important from the project-cost - viewpoint and therefore significant decisions in regard to project's eventual profit margin are made already at this phase. The requirements definition of the project phase, which in supply projects generally done in negotiations with the client, requires the project supplier to identify customer needs and the cost effects from fulfilling those customer needs. The project supplier should never promise the customer additions to the scope without knowing the effects on project's costs and project's profit margin. (Artto et al. 2006, p. 55)

Even though the project sales and marketing process aims to bring as profitable as possible project contracts into the organization, it also serves a function of avoiding unfavorable projects. If during the sales work the project supplier's sales representatives find out that the project shall be impossible to execute due to project supplier's internal resource shortage or customer's excessive requirements and expectations, it is better for both parties to abort the sales process. (Artto et al. 2006, p. 56) This also protects the project supplier from unprofitable project and possible financial and reputation forfeits resulting from inability to execute the project work as agreed.

3.2 From project sales to project implementation

During the sales phase of the project requirements from the client-side are communicated to the project supplier(s). The project supplier(s) then make the planning for these projects based on these customer requirements, including scoping the project, project scheduling and resource allocation decisions.

Loss of knowledge in the interface of project sales and operations

After a successful sales phase of the project marketing and sales process, a bid has been won and the actual project phase and project task execution will be commenced. Even if the project manager in charge of the project execution has been a part of the sales team of the project, and will carry on with in the project execution phase, it is rather unlikely that the project manager in question has all the information accumulated during the sales process. (Artto et al. 2006, p. 91) Some of this sales phase information is tangible, and therefore has been registered in written documents, but some of it is intangible and originates from discussions and meetings with the clients. (Savolainen & Ahonen 2015, p. 96)

It is also possible that the project manager who has been part of the sales phase activities must be changed for the project execution phase which affect the availability of the project manager for the execution phase for a multitude of reasons: sales process being prolonged or halted and project contract signing therefore delayed or project manager's earlier project's being delayed or finishing early leading to non-availability of the project manager due to another project's commitments from project manager-side. (Savolainen & Ahonen 2015, p. 99) Because of the aforementioned reasons it is important to have discussions and transfer knowledge between the sales manager in charge of the project sales phase and eventual project manager in charge of the project execution.

When transferring the project from the sales phase ("pre-project") to the implementation phase ("project") all sales documents need to be examined between these two parties and these documents need to then be handed over to the project manager. Also, the intangible information in regard to the expectations of the customer, the agreed operating principles in the project and

promises granted to the customer, if not part of the contract documents, need to be clearly communicated to the project manager and if possible to the project team in charge of the execution phase. (Artto et al. 2004) These intangible information pieces can be of significant worth in speeding up the project work and creating trust and good-will between the customer and project supplier, as the customer realizes that the information has been transferred inside the supplier organization and the foundation for the start of successful project execution has been created.

Clearly defined project scope and requirements

The task of project scope control can be defined as “*ensuring that adequate, but no greater, amount of work has been performed to reach project goals*”. Project scope control is critical in project supply projects to ensure that specified and contractually agreed work will be performed, surplus work shall not be performed without agreed upon compensation and work performed for the project furthers the realization of project goals and business targets. (Pelin 2008, p. 201)

Project scope and customer requirements defined in the sales phase must therefore be internalized by the project manager in charge of the execution of the project, and to the extent possible also the project executing team, in order to execute the project according to the requirements from the customer. Internalizing the scope also facilitates the identification of change situations and management, as the project executing team is able to detect which tasks have been contractually agreed upon and which work can be considered surplus and must be renegotiated with the customer.

4. OPERATIONS PLANNING

In project-based business, it is essential to find a balance between the maximum capacity of the organization and the resources it possesses. If such a balance will not be found, the implications will be severe to the project and project-executing organization: major cost overruns, schedule delays, unfinished work as well as possible repercussions after the project has been finished in the form of fines, lost client accounts and loss of reputation in the industry.

This chapter introduces the concepts of capacity planning which is essential to every organization's business planning. The capacity planning concept is then set to the world of projects and steps of capacity management in project-oriented organizations are introduced.

4.1 Capacity planning

Capacity can be explained as the “maximum level of value-added activity over a period time that the process can achieve under normal operating conditions” (Slack et al. 2004, p.359) Capacity can also be explained as the “throughput”, that is the number of units that a facility or a production unit can produce in a certain period of time (Heizer & Render 2006, p. 286).

The objective of capacity management is to fulfil the level of demand, both in quantity (how much is being produced) as well as in capability (determining the skills needed to meet the service specifications). Meeting the aforementioned requirements concerns issues regarding uncertainty (forecasting future demand is difficult and uncertain), timescales (from daily scheduling to long term capacity planning of months and years), alternatives (deciding the most optimal resources to meet demand) and execution (going through with the plans). (Hill 2005, p. 270)

One of the most strategic and difficult decisions that managers face is the determination of the “correct” level of capacity. If there turns out to be too much capacity in relation to the needed capacity for producing to fulfill the market demand, excess costs are incurred for the unused capacity. Then again, having too little capacity to meet the market demand means being unable to fulfil the demand of some customers. This may lead to these customers searching an

alternative source of supply and sticking with the new source of supply in the future. (Horngren et al. 2009, p. 339)

The steps that organizations and their capacity planning staff should take when planning and controlling capacity are illustrated in figure 6. In typical environments, the organization has a forecast of demand, not likely to be constant or certain. Also, the organization has some form of idea of its ability to meet this demand (based on the resources it possesses). Based on this quantitative information, following sequence in capacity planning and control is recommended. Firstly, *measure the aggregate demand and capacity levels for the intended planning period*. Secondly, *identify the alternative capacity plans* in order to be able to respond and adapt to capacity fluctuations. And lastly, *choose the most appropriate capacity plan* for the circumstance. (Slack et al. 2007, p. 324)

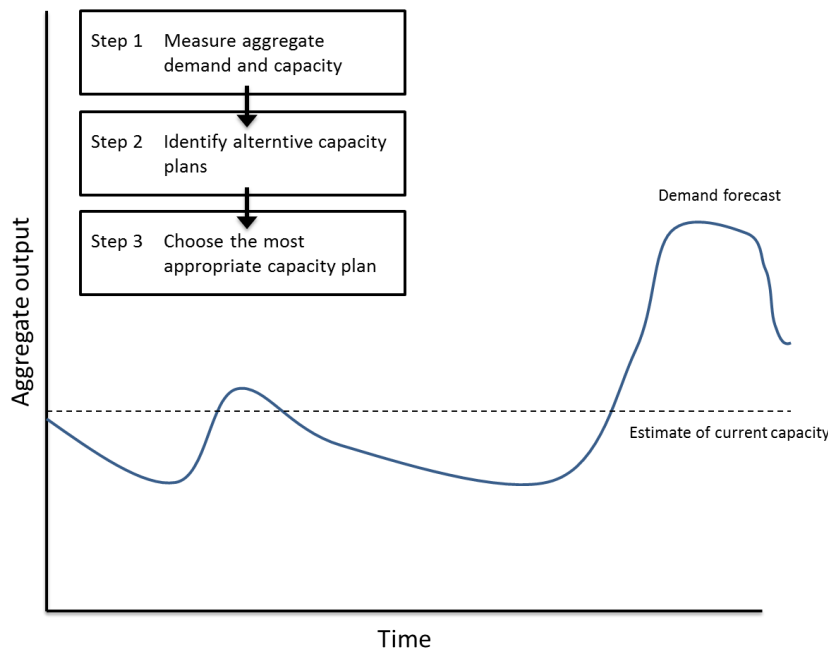


Figure 6. The steps in capacity planning and control (Slack et al. 2007, p. 325)

According to Slack et al. (2004, p. 361), the decisions that managers make while planning capacity affect several different objectives. These include:

- *costs*, due to the balance between capacity and demand. Demand not fulfilling all possible capacity will result in under-utilization of the capacity levels and therefore an increase in costs of produced units;
- *revenues*, because capacity levels that are equal to demand levels mean that all capacity is used and no revenues are lost;
- *quality* of services could be affected by the producer of the services. Using outside production (outsourcing) or work force not accustomed to work they perform can result in growth in errors being made;
- *speed* of satisfying customer needs. If capacity is planned accordingly, there is enough resources to fulfill current workload with no need for queuing;
- *dependability* of supply. Demand levels close to the maximum capacity;
- *flexibility* to respond to increases in demand.

Capacity management is a constant process in organizations. Therefore, both long-term and short-term measures must be taken to ensure adequate capacity for performing committed promises to customers.

4.2 Capacity planning in project environments

Capacity is normally measured by defining the utilization rate for each resource. In a project-oriented service business organization this utilization rate can be defined for each employee, by dividing the average output rate of an employee with the maximum capacity of the same employee.

In a multi-project organisation, capacity relates to the organisation's ability to carry out the multiple projects in providing enough and suitable resources (Payne 1995, p. 164). Payne states that in his experience in a multi-project setting, a balance between resource requirements and resource availability is rarely accomplished. This is due to the fact that organizations are trying to reduce the amount of staff on pay roll to the amount that can be confidently assumed to be occupied by work at all times. However, at the same time, the organizations are constantly trying to acquire additional work, which then results in situations of under capacity in periods of high demand, due to the organizations having reduced the number of staff. There are then various methods of increasing capacity in these under capacity situations, which include:

- current staff working overtime
- seconding of staff from other departments
- temporary employment agencies
- short-fixed-term staff and subcontracting of work. (Payne 1995, s.164).

5. PROJECT PLANNING

A project is an entity defined by its time schedule. Therefore management of time schedules and resources are integrally linked to each other in project environments; a change in one factor has an effect on the other. Scheduling and schedule control are performed in projects so that they can be feasibly executed and finished in the planned time frame. Resource planning and management is performed to secure suitable resources at the right time and at sufficient capacity as well as the efficient utilization of the resources during the process. (Artto et al. 2006, p. 122)

The following chapters present mechanisms in project scheduling and resource planning in single project environments.

5.1 Project scheduling

Project scheduling is a fundamental function of project planning. The process of project scheduling involves detailed project task specification, task duration and order definition and creation of an overall project schedule. (Artto et al. 2006, p.122) The aim of project scheduling is to create a project timetable which determines the start and finish times of different activities required to execute the project for a predefined scheduling objective. The scheduling objectives can vary between projects and their aims; however, generally the most important objective is the minimization of the project lead time. Practical considerations and limitations bring forward other crucial scheduling objectives, such as resource considerations and limitations, resource capabilities as well cost, quality, risk, safety and maintainability criteria associated to the project. (Vanhoucke 2012, p. 109)

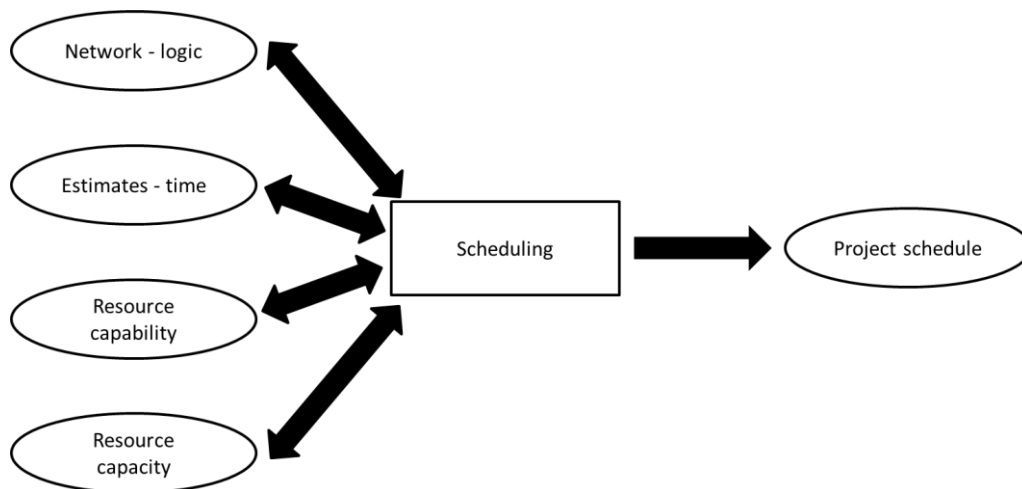


Figure 7. Schedule development process (Maylor 2005, p. 122)

Figure 7 presents the inputs required for the scheduling process of project execution. The scheduling of a project starts by creating a network of activities needed to perform in order to execute the project. The intention of this network is to form a logical consequence for the activities in order to execute the activities related to project execution in the optimal sequence. After the network logic for task activities has been created, time estimates for each activity will need to be introduced to the network graph. After introducing the time estimates, there is a possibility that the project will take more time than has been agreed upon in the project contract. Therefore, there may be a need for reconsideration of the network logic of the task activities or the time estimates made for task duration. (Maylor 2005, p.122-123) The problem of time insufficiency can also be solved by the resource planning, which will be discussed in Chapter 5.2.

Scheduling a project involves scheduling the work packages required to be executed to achieve the final project goal. In essence, the scheduling of these work packages involves knowing the following factors:

- previous work upon which each subsequent work package depends
- estimated duration of work package
- available “float” for the work package, that is whether the work package must be carried out at/within a certain time or whether there is a possibility of scheduling the activity between two known extremes, that is utilizing float for this work package.

(Harpum 2007, p. 20)

5.2 Resource planning

Resource planning is an essential strategic decision, as it is the key with which a organization can respond to the future demand in terms of its size (associated volumes) as well as the nature (the service mix). In resource planning, three key dimensions must be taken into account:

- **amount** - what is the correct amount of resources required
- **timing** - when the resources should be available
- **location** - where the needed capacity should be located. (Hill 2005, p. 271)

The essential difficulty in resource planning is that there are time schedules that must be taken into account as well as the fact that the aforementioned dimensions must all be taken into account, they are not unaffiliated questions. (Hill 2005, p. 271)

According to Pelin (2008, p. 147), the objectives of resource planning in projects are:

- assurance of the availability of the resources estimated in the project schedule (right amount at the right time) and thereby the realization of the schedule
- optimization of key resources, the usage load should be constant and continuous
- reduction of the resource costs (optimization)
- overall control of corporate-level, that is adapting organization's personnel capacity to correspond to the needs of project, analysis of resources available and fitting to the projects and their schedules and the prioritization of the projects according to resources

The process of resource planning in a single-project situation, can be divided to five phases:

- 1) *planning resource allocation*, which starts by identifying the types of resources required to perform the types of tasks required to be executed,
- 2) *allocating resources*, where the availability of the identified resources for project is secured and the resources are bound to the project and project work,
- 3) *optimizing the schedule* based on resource availability, where resources levelling is utilized to balance the schedule with the availability of resources for the project,
- 4) *monitoring resource allocation*, where the resource utilization is supervised and possible conflict situations in project and/or resource availability change situations are resolved,
- 5) *reviewing and revising resource allocation* and modelling the changing resource utilization on project schedule and budget. (Harpum 2007, p.22)

One of the main goals of resource planning is to level resource utilization evenly throughout the project. In resource planning, task and resource interdependencies should always be considered. Also, resource planning should always take into account the fact that having the project be heavily dependent upon one resource, causes this resource to be a bottleneck to all project tasks. Resource leveling means the division of workload and project tasks in such a way that the workload and project tasks can be dealt reasonably, and that no resource experiences major overload or underload situations during the project. (Artto et al. 2006, p. 144)

Prioritization of project work

One area causing problems for resources working in project-based project businesses is the prioritization of project work (Elonen & Artto 2003, p.399). Projects always include different types of tasks from tasks directly connected to creating and delivering project deliverables to tasks relating to information exchange, such as negotiations and project status reporting. In projects performed for clients, there is always a demand from the client-side on reporting on the progress of the project tasks and project progress in general. This reporting requirement is rather constant throughout the project, that is weekly or monthly progress reports are expected. This requirement always creates time management pressures to the project executing team, as they must at the same time promote the main project tasks aiming to the creation of required deliverables as well as divide their time also on reporting of the completion of these tasks.

Subcontracting

Subcontracting refers to the act of buying capacity from other organizations in order to meet demand in periods of high demand. Subcontracting is a method for an organization to meet temporary rises in demand without having to increase in its own capacity by investing in new capacity which will not be needed after the period of high demand has passed. While it is a good way to respond to sudden peaks in demand, subcontracting has also its downsides. Subcontracting might be very expensive, as the entity offering its resources to an organisation for subcontracting, wants to make a sufficient profit out of the activity. Also, a subcontractor might not be as motivated or as capable to deliver the services in time or to the same quality levels as the organization it is servicing. One possible outcome from subcontracting may be that the subcontractor organization decides to enter the markets of the organization which it was servicing via the ordering organization, which in turn leads to more competition. (Slack et al. 2004, p. 377)

5.3 Change management

Change management means the reaction to an unforeseen deviation occurring in a project (Artto et al. 2006, p. 243). Changes in projects during their lifetime are a frequent and also a well-documented phenomenon in project business literature (Wysocki et al. 1995, p. 230; Cooper & Sklar-Reichelt 2004, p.745). Reasons for project changes can be caused by multiple factors in project business environment. These factors include changes in competition and market situations, customer, authority or other stakeholder related factors, technology development as well as a number of supplier related situations, such as delays, resource changes and misunderstandings. (Wysocki et al. 1995, p. 231; Artto et al. 2006, p. 243) These factors can appear as design changes, work-scope changes, late receipt of important technical information, diversion of key resources from project client or subcontractors, changes in standards and regulations as well as schedule changes or acceleration (Cooper & Sklar-Reichelt 2004, p.745). The common principles of change management are illustrated in figure 8.

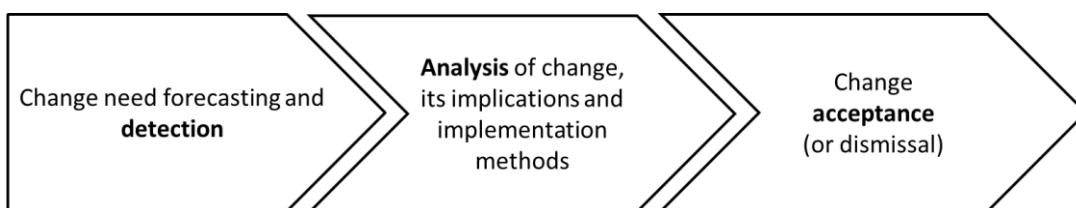


Figure 8. Change management progress (Artto et al. 2006, p.244)

Changes to the scope of a project very likely increase the project costs and delay its completion moment. Altogether, the changes to the scope are identified as *scope creep*, and if not sufficiently prepared to or if such changes are of sufficient quantity, will cause a project to fail, whether in the form of a delayed completion or actual costs incurred exceeding the planned costs of the project. (Krajewski et al. 2010, p. 75) However, as change in projects is a frequent, if not constant phenomenon, a good project management methodology will have a change management process in place. Adequate change management practice also ensures that after the changes have been approved, everyone working on the project is working on the same plan, meaning that everyone in the project has the scope of work and project requirements clearly digested (Leach 2005, p. 125).

Project scope change requirements should be clearly documented. Project change request and project impact statement are possible alternatives can be utilized in the documentation of the scope changes. Change request collects the changes to the project scope requested by the client or possibly originating from other supplier's activities. A response document to the change request is the project impact statement in which the project manager should define the alternative courses of action from which the customer can choose the best alternative. (Wysocki 2009, p. 225)

After the evaluation of the change request, the impacts of the change to the project work can be evaluated and it can be assessed whether the change can be accommodated and what kind of actions are required for the accommodation of the work. These accommodation actions can include extensions to the deliverable schedule, utilizations of additional resources, significant changes to the project plan or completely new project plan (and possibly a new project) or in the best-case scenario accommodation can be done within the project resources and timelines. (Wysocki 2009, p. 225-226). Other documents that can be utilized in project scope change collection include plus/minus -lists, in which add-on and omitted work and deliverables are documented, as well as change orders.

6. PLANNING IN MULTI-PROJECT BUSINESS ENVIRONMENTS

A multi-project situation is from the management-perspective a very demanding situation. The big picture is not in the hands of single project managers, but instead a holistic/all-encompassing project and resource management system is required. Scheduling conflicts are mirrored from one project to another through the mutual resource utilization, and too often in organizations with no holistic planning system, the project prioritization fall on the lowest level, that is to the resource executing the project activities. (Pelin 2008, p. 158)

Therefore, it is integral to have a unified planning and steering practice in order to have common scheduling and schedule maintenance methods, resource pool and resource pool maintenance, resource loading level throughout all ongoing projects as well as management meetings and decision (support) system. (Pelin 2008, p. 159)

6.1 Project portfolio and multi-project management planning

The arrival of new projects in a multi-project environment can happen at any time (Leach 2005, p.161). Every time a project-oriented organization is contemplating on undertaking a new project, it must carefully analyze the fit of the project into the existing project portfolio. Each new project brought into the project portfolio changes the mix of the existing project portfolio. Therefore, a thorough consideration and optimization is necessary when a new project is introduced to the project portfolio. The newly introduced project requires a project owner, and adequate number of available executing resources, meaning the key personnel from inside the organization as well as when necessary external partners and contractors, to carry out the necessary tasks for the project completion. (Gareis 2004, p. 133)

Compared to a single project situation, in project portfolios the exchange of information, management of resources available and coordination of the collection of projects becomes increasingly more important. (Teller et al. 2012, p. 599)

6.2 Project sales and marketing in a multi-project setting

There is a significant difficulty in balancing the sales and project operations in a multi-project environment, as noted by Cooper & Budd (2007, p. 174). This difficulty relates to the organization's ability to fulfill existing contractual obligations and ensuring the future of the organization by securing new project contracts and bringing in new business into the organization.

Cooper & Budd (2007, p. 174-175) have proposed the following model for integration of the sales process and project operations interface. The model aims to consider the interdependencies between the project sales and implementation phases and connecting the project leads, prospects and agreed contracts, that is the sales funnel, to the availability of the critical project resource(s).

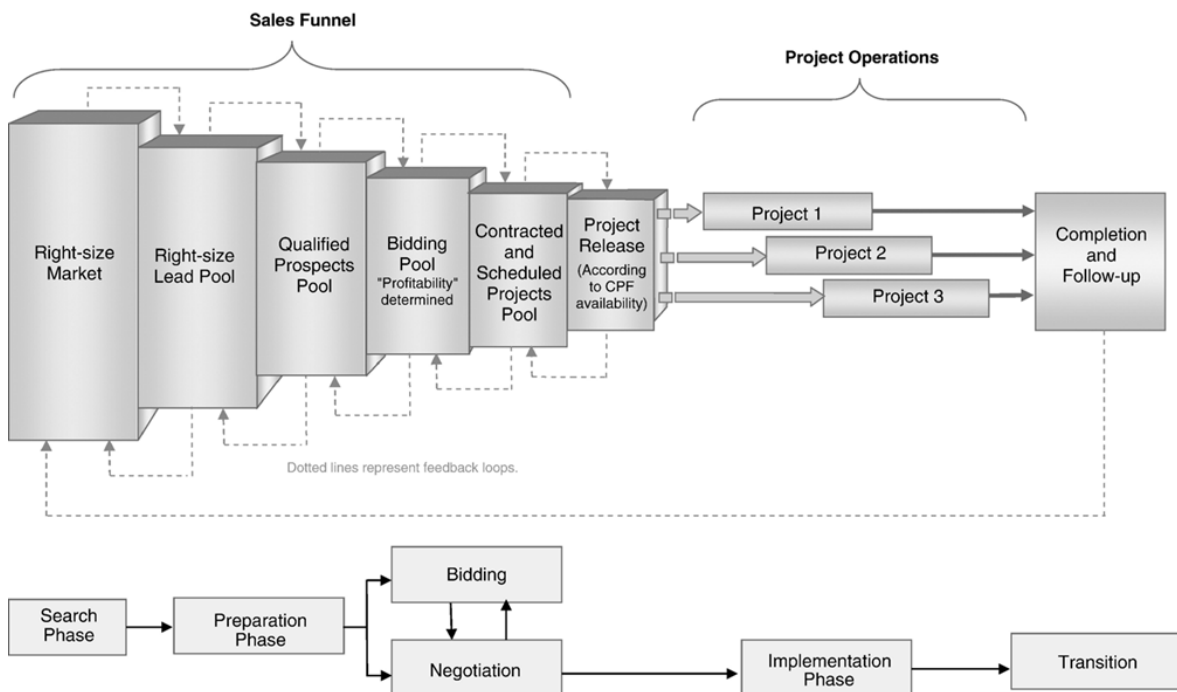


Figure 9. Project marketing cycle in multi-project situations. (Cooper & Budd 2007, p. 74)

A key success factor in multi-project environments is the ability to control the flow of customers (that is signed project contracts) into the actual project operations phase. Having too many projects will overload the organization, which will then result in troubles in scheduling and ultimately delays in project and project task completion. Having too few project contracts will leave the organization's capacity underutilized resulting in compromises for the organization's income and revenue flows. (Cooper & Budd 2007, p.179) Therefore it is vital to find a right-sized market, especially for organizations executing multiple external supply projects concurrently, as these companies are always battling with capacity-related matters, where balance of available and required resource levels are rarely achieved and the cost of sustained underutilized capacity has serious consequences on the organization's business. Finding a right-size market also helps a company in achieving a better market position or even a dominant position in the market, which in turn helps the company to leave unfavourable projects on the table and select those projects which have the best profit margins, fit the organization's core competencies and have the best financial incentives, in the form of higher project bonuses for early project completion or exceeding project targets as well as lower penalties for schedule delays. (Cooper & Budd 2007, p.178).

Building an efficient project marketing cycle in multi-project situations depicted in figure 9 is important for multi-project organizations for multiple reasons. By planning the sales process in this way, a sales process can be created in which the qualification of project prospects a continuing process. Each subsequent stage requires that the preceding step has been successfully executed (Cooper & Budd 2007, p.175). This forces the organization to evaluate its operations and the project prospects from a multitude of different angles: the beginning of the sales process requires the organization to carefully analyze its strategy and position in the market, leading to the financial and overall evaluation of possible project prospects and onwards to the fit to the organization's resource and competence pool.

When a project-oriented organization wins a project bid and signs a contract with a client for the execution of the project, the client expects the organization to start working on the project without a delay (Cooper & Budd, p. 174). It has been studied, that in practice few projects are started immediately upon arrivals (Yang & Sum 1996, p. 140) This is due to the fact that the organization executing the project generally has other projects already in the pipeline, and

therefore does not necessarily have enough resources or the right resources for the tasks required in the project at that stage. In order to start working on the project, the organization would need to reassign existing resources already working on other projects, which could jeopardize the schedules of the projects that are already being worked on. (Herroelen & Leus 2004, p. 1600)

In order to be able to evaluate the project prospects during the sales phase, an organization-wide project portfolio selection process should be implemented.

Project portfolio selection process

Project portfolio selection in organizations is usually performed by a designated committee, which evaluates the proposed projects (“project prospects”) by utilizing a set of objective criteria including financial, strategic and operational indicators. This selection process should be constructed to be a flexible and logical set of activities, where the attractiveness of each project prospects is calculated based same set of indicators is qualified. (Archer & Ghasemzadeh 2004, p. 245-246) Project portfolio selection process is depicted in figure 10.

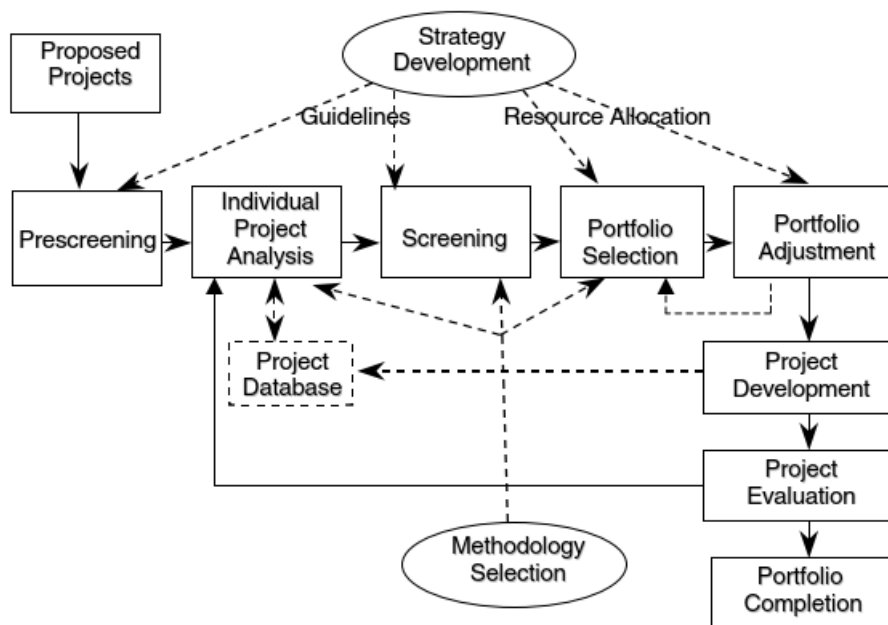


Figure 10. Project portfolio selection process (Archer & Ghasemzadeh 2004, p. 246)

The project portfolio selection process is preceded by organization's strategy development and strategic decisions. These strategic decisions affect the portfolio selection process, because they define the marketplace and organization's strengths and weaknesses. The project portfolio process begins by pre-screening, where project leads are evaluated based on their fit to the organization's and therefore project portfolio's strategic focus. After the strategic fit has been confirmed, the projects deemed suitable are evaluated individually through a common set of parameters, which include financial indicators, such as return on investment and profitability, project risk factors, resource requirements etc. Based on individual project evaluation, elimination of projects that do not match the strategic focus and/or are outperformed by other projects in the individual project analysis stage are eliminated for future development in the screening stage. (Archer & Ghasemzadeh 2004, p. 247-249)

In portfolio selection stage the interactions between the remaining projects not eliminated in the screening phase are considered and optimization of the project portfolio is performed. These interactions include interdependencies in resource requirements and schedules as well as possible interdependency-related benefits from choosing two related project prospects. There are a number of tools that can be utilized for the optimization of project portfolio, including scoring models, portfolio matrices and comparative approaches. Through these stages a portfolio of projects is created which should meet the objectives of the organization as optimally as possible. In the final stage of the project portfolio model, portfolio adjustment, judgemental adjustment, for example based on customer preference or possibility to broaden the business-base of the organization, could be made by the decision makers of the organization. Therefore, it may be necessary to recalculate the portfolio parameters such as project schedules and resource requirements even after the final stage. (Archer & Ghasemzadeh 2004, p. 249-251)

It is vital in the project portfolio process that all project prospects and project requirements are centrally managed in a project database. This database offers easy access to project information in project selection process when analysing individual projects and comparing them against each other and can also be utilized in the execution phase of the project's when defining the project scope, schedule and resource requirements.

In the project selection process, it is also important to maintain a suitable balance between strategic long-term goals and operative short-term goals when choosing projects based on different selection models. Often, there is a risk of choosing options emphasizing short-term benefits in both project-specific and financial at the expense of long-term continuing success of the organization. (Artto et al. 2006, p. 97)

6.3 Scheduling in multi-project setting

Because the schedules of projects in multi-project environments in project-oriented companies and project execution organizations where resources are shared are, at least partly, dependent upon each other, knowing the amount of availability of resources and time to execute the remaining tasks is crucial for the progress of the project (Caniëls & Bakens 2011, p. 164). Instead of scheduling projects the resource scheduling should be done task-oriented to allow the allocation of resources to be based on the priority of single tasks inside the projects; allocation of resources on the project-level is not adequate (Fu and Yang 2014, p. 167) Single task-level resource allocation for each project in multiple project situation is required, because a project can have critical tasks elemental to the progress of the project as a whole or tasks that require higher resource load for a specified time window. The scheduling decisions in a multi-project environment should also consider the project order priorities as a necessary factor, including delivery date, importance of customer, magnitude of penalties and importance of the project order in regard to payoff or profitability (Tonchia 2008, p. 28).

In order to maximize the output of projects in multi-project situations, Cooper & Budd (2007, p. 180) offer following three measures:

1. *Leveling of individual projects*, meaning that resources must be scheduled to perform only one task on a project at the same time.
2. *Identification of the longest series of dependent tasks*, that is *identification of the critical chain* of the project. The delay on these critical chain tasks will, by definition, delay the completion of the entire project. That means that the schedules are constructed such that possible delays in the critical chain tasks are appropriately buffered by adding safety time at the end of the project.

3. *Introducing time buffers for project tasks not identified as part of the critical chain at the point where they enter the critical chain of the project.*

Resource leveling

Four different measures exist for resource leveling with each one having their own effects on the execution of the project:

- **Utilizing buffers**, which enables the leveling of resource utilization by capitalizing on task buffers. Starting a task earlier than scheduled is an example of buffer utilization.
- **Stretching the tasks**, the starting and ending dates can be adjusted in the realms of the earliest starting point and latest ending point providing opportunities for resource leveling and momentary reduction of resources.
- **Dividing tasks in parts**, which enables the task to be divided into two or more parts with breaks between these parts, which enables the resource assigned to the task to work on other assignments or projects during the breaks.
- **Utilizing substituting resources**, which is especially applicable if there exist competency-wise suitable resources and the project is experiencing an urgency situation. The drawback of utilizing substitute resources is that substitute resources need to get acquainted with project situation and requirements and therefore it can result in lower efficiency as someone from the project team is required to instruct the substitute resource, this instructor often being the resource who is being substituted. (Artto et al. 2006, p. 145, Wysocki 2009, p. 240-241)

Critical chain process

The critical chain process is based on applying the theory of constraints concept, which is founded on the idea that every system has a constraint that limits its output (Leach 2005, p. 44). The critical chain can be defined as the longest duration path through the project, when considering both the task dependencies and resource constraints (Wysocki et al. 2009, p. 370). In project environments, this constraint is usually the availability of people either by amount or by the skills that they possess (Wysocki et al. 2009, p. 369).

The critical path scheduling method is based on defining the sequence of schedule activities defining the duration of project, that is the longest path through the project. However, this method does not consider possible resource constraints which always exist in an organization (Leach 2005, p.84-85). As mentioned earlier, the critical chain method takes this resource constraint into account and the first step of creating a schedule based on utilizing the critical chain process should be to identify the longest path through the project considering the task logic and resource constraint. After this the resource contention from the project plan should be removed and mean task duration estimates (with for example 50 % probability of success) should be introduced with added buffers at the end of task chains as well as the project. The project tasks not along the critical chain should be subordinated to the critical chain and feeding buffers to the subordinated tasks should be added to the point where they enter the critical chain. Project resource availability should be secured especially for the tasks along the critical chain in the planning phase. The buffers along the project and subordinated task should then be exploited as measures for project control. (Leach 2005, p. 83-105; Wysocki 2006, p. 370-378)

When utilizing the critical chain process in multiple project environments, an organization-wide constraint should be identified. This organization constraint resource is the resource that affects the critical chain duration of projects the most and can be identified as being generally the resource in highest demand inside the organization or constantly needing to work overtime. The process then continues by creating a critical chain project schedule for each project independently, determining the project priorities as per the access to the constraint resource and then resolving the possible resource contentions between the projects to maximize the project throughput (in order to complete most projects early). In multiple project environments, each

project should then be subordinated based on this constraint-resource schedule and capacity-constraint buffers should be placed between the use of the constraint resource in its prior project and the first use of the constraint resource in the following project it is scheduled to perform. In order to efficiently manage the utilization of the constraint resource, it must have input to work on, so a feeding buffer called drum buffer, must also be considered preceding the utilization of the constraint resource in the project. (Leach 2005, p. 153-160)

The advantages of critical chain process include reduction of bad multi-tasking by requiring all resources of the project to devote 100 % of their time to the task at hand and providing resources information on which task to work on next (Leach 2005, p. 99), allowing the resources to solely contribute to the promotion of tasks leading to project completion. Utilization of buffers creates flexibility in the tasks leading up to the critical chain as well as the project in general and also acts as a project control and monitoring tool as well as a decision tool in order to determine the next tasks to work on in projects (Leach 2005, p. 185).

6.4 Resource planning in multi-project setting

Resource-constrained project scheduling problems that frequently occur in multi-project environments come up whenever there are multiple projects that require the use of the single or limited amount of resources at the same time. One or more projects are delayed because the resource is already allocated to another project or can only be allocated to one of the projects at a certain time. (Cooper & Budd 2007, p. 176)

Resource management is especially demanding and therefore a significant part of the project management in multi-project situations in multi-project settings, where several projects place load on common, shared resources. In these situations, the schedule (resource allocation) changes affect the execution of other projects. (Pelin 2008, p. 146) Therefore, in a multi-project environment, booking key resources in advance may be important to guarantee their availability. (Herroelen & Leus 2003, p.550)

The process, in which a project schedule with limited amount of resources available to the project is constructed, has been identified as resource-constrained project scheduling. Resource-constrained project scheduling requires careful planning and examination of the organization resources in order to avoid situations of resource over-allocations, that is situations where there are resource conflicts. (Vanhoucke 2012, p. 107)

In a multi-project setting, the task of a project manager is to allocate resources to various projects on a short-term basis in order to maximize the progress of each project (Caniëls & Bakens 2011, p. 163). Also, on a strategic level it can be even more important to advance the entire project portfolio of the organization, even if this would mean that a single project's progress might not be optimal.

Any organization executing multiple projects that are sharing common resources needs to take into consideration the needs of the all organization projects in scheduling of each individual project. Therefore, in the scheduling of the organization's resources the allocation of the resources over the total organization workload must be evaluated, and while doing so the priority of each project and inside each of those projects, the priority of each activity must be

carefully evaluated. (Lock 1996, p. 273) In a multi-project environment, the task of the project managers of a project-oriented organization is to utilize several pools of limited resources, which are shared amongst other projects of the organization. (Caniëls & Bakens 2011, p. 164)

Resource pools

Creating a resource pool of the resources available is an important tool for project organizations executing multiple projects. Resource pools are utilized for centrally managing the most important attributes related to the resources the organization possesses such as previous work and project experience, industry knowledge as well as related related courses and education which could be useful for performance of project duties. An efficient resource pool in a multi-project organization also introduces real-time and future resource loading status for each resource. (Pelin 2008, p.158-161)

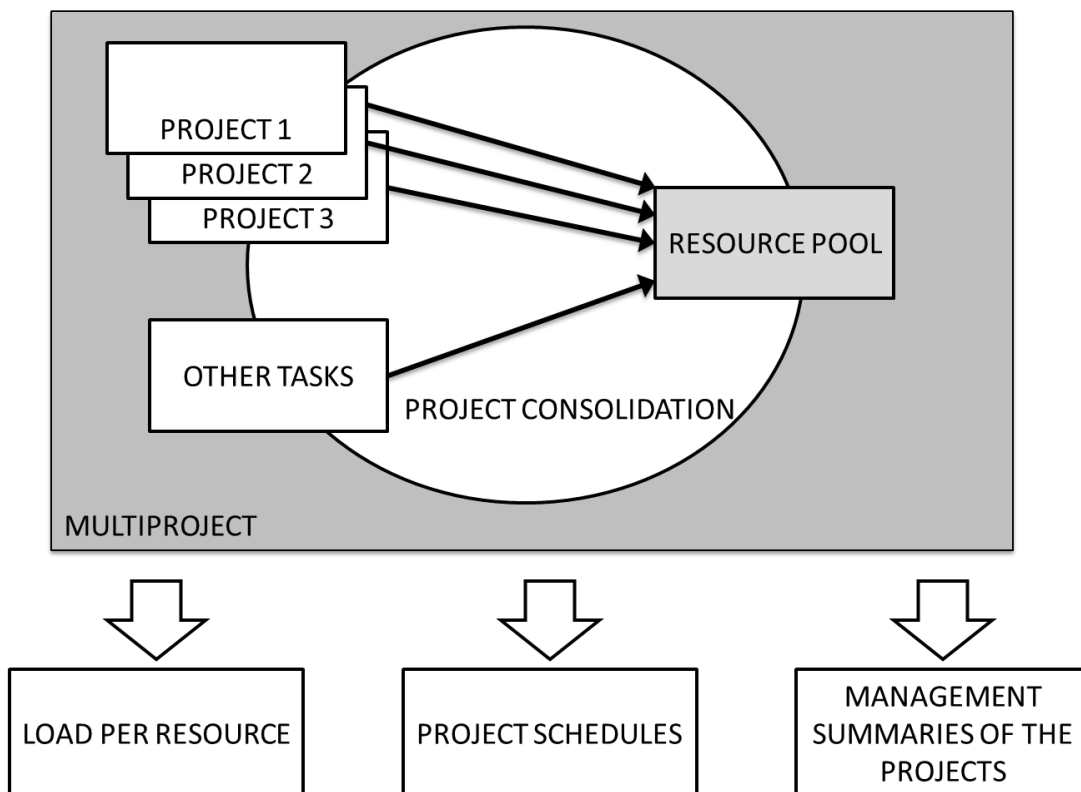


Figure 11. Project consolidation and resource pool (Pelin 2008, p. 159)

Figure 11 presents the advantages of resource pool utilization for an organization operating in a multi-project environment. Utilization of resource pools in multi-project organizations facilitates the planning of future business opportunities as resources with suitable work experiences can be centrally found and resource loading status for each resource as well as the organization can be evaluated. This in turn supports the planning of the organization, as right resources can be found for each project in each situation. Also in situations where there is limited capacity to take on more project work or project tasks require certain competencies, which the organization does not possess or are not available at that moment, the project organization utilizing an internal resource pool can avoid unfavorable bidding decisions through utilizing information found on resource pools.

7. CONCLUSIONS

This study explores project sales, project scheduling and project resource planning in project environments, focusing on the problems experienced in organizations executing multiple projects concurrently. This study has brought forward problems identified in literature relating to the problems in project sales, scheduling and resource planning and an observational method has been utilized to bring the context to the practical world via the author reflecting on the issues and commenting on their suitability to practice. Main results of the study and answers to the research questions as well as limitations in the thesis and suggestions on future research are presented in the following subchapters.

7.1 Main results of the study

The problem of the sales and marketing functions in several project organizations is the lack of input between the sales function and the project-executing functions. The main task of the sales and marketing functions is to attract new contracts inside the organization in order to generate revenue and profit to the organization. This chapter summarizes the main results found in the study. The main results are presented through answering the main research questions presented in Chapter 1.2 *Execution and structure of the thesis*.

In order to efficiently execute projects in multi-project environments, where the projects are sharing same resources, a number of measures are required. Single projects must be managed efficiently. Information on all project prospects as well as project's already in execution must be centrally managed in the organization and the organization should have a central resource pool that can be utilized in mapping the current resource utilization as well as all the competencies of each organization resource. Critical resources for each project must be identified and their work in the project must be secured and scheduled. The project scheduling should be clear regarding task scheduling, task priorities as well as task deliverables so that resources executing the tasks do not need to do these decisions themselves.

In order to successfully transfer from the project sales phase to the project execution phase, a number of measures are required in the interface of these two functions. The information and

requirements gathered during the sales phase of the project must be transferred from the sales organization to the team in charge of project execution in order to enable successful project execution. Sales function of the organization should always observe the fit of the project prospects to the organization's internal situation and strategic goals, in order to ensure that there are enough resources to execute the projects and that the long-term strategic goals and continuing success of the organization is ensured.

Pre-project activities in the sales phase contribute greatly to successful project execution. The organization should position itself in a right-size market and the information of the project leads, prospects and agreed contracts as well as projects already underway should be transparent inside the entire organization. The organization should constantly update its centralized database of project leads and project prospects with links to the organization's resource pool. New project prospects should be evaluated against each other already at the sales phase by utilizing uniform set of indicators, including financial, strategic and operational measures. This evaluation supports the bidding priority decisions of the projects. The evaluation should also consider the project's fit to the organization's strategic goal and current capacity situation.

Figure 12. presents the main results of the study by addressing the main research questions presented in the

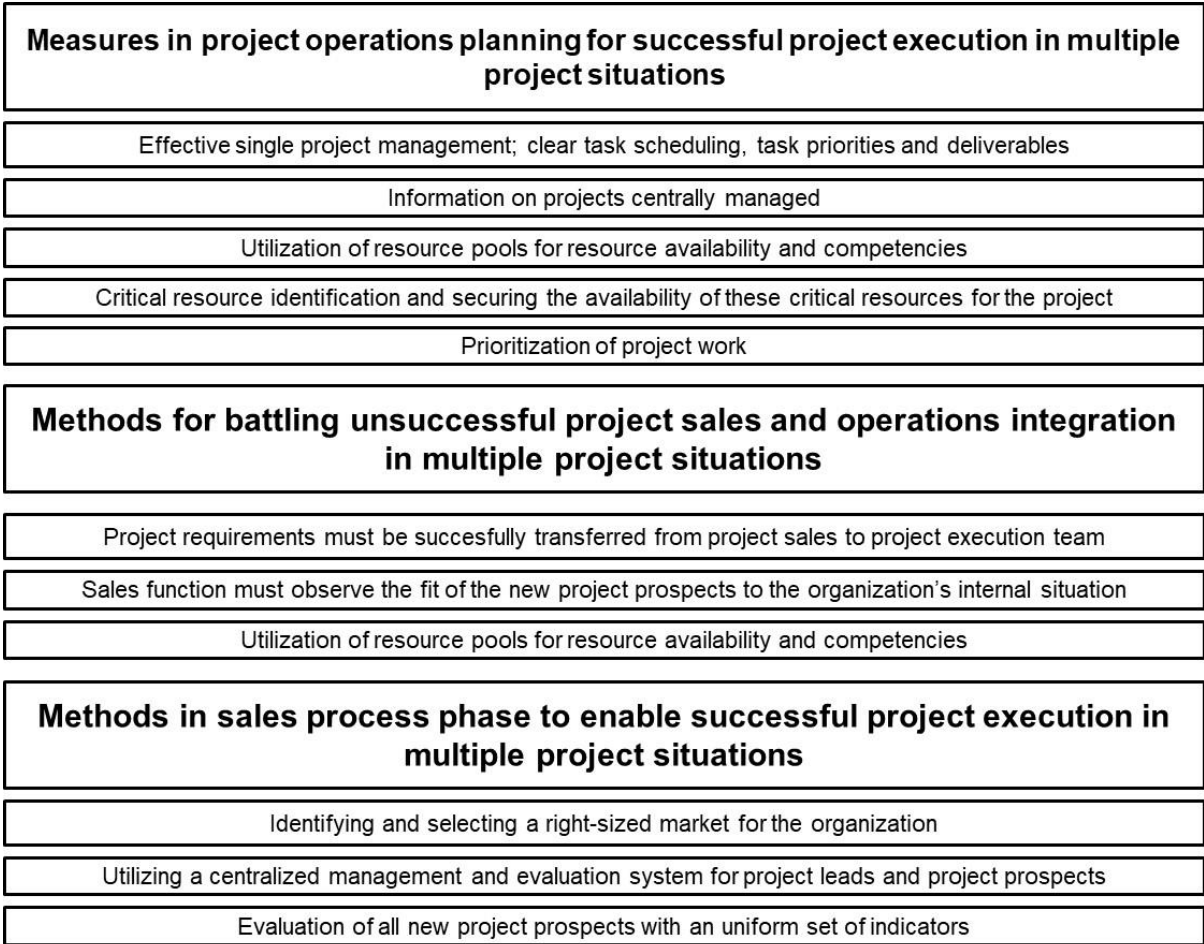


Figure 12. Main results of the study

7.2 Limitations and future research

Due to the nature of the thesis as a literature study, there exists limitations in its application to real-life practical project management situations. Theoretical best practices presented in this study are often difficult to implement in the chaotic and hectic project environments. In practical situations, the project planning and information exchange time is often limited as the project managers and resources are transitioning from one project to another and the customers are expecting the project work aiming for deliverables to begin immediately after the signing of the project contract.

Projects vary in size, duration and nature: there exists giant infrastructure projects employing thousands of employees and lasting for years to small-scale development projects employing only few people and lasting for a few months. Due to the complexity of these different-scale

projects, universal project planning tools are difficult to create to fit each project type. Therefore before utilizing the tools and methods presented in the thesis a careful assessment of the validity to each project type is necessary.

For future research the applicability of presented solutions in different industries for project supply organizations could be researched to identify whether different industries have developed industry-specific project planning tools in multi-project situations. Continuous research and development is required in both academia and in project service supply organizations as the project complexity increases and project management tools advance.

8. SUMMARY

The implementation of major supply projects is a complicated endeavour typically requiring the workload of countless human resources. Companies undertaking the planning of these projects are often organizations with several of these types of projects planned and implemented concurrently, and at the same time they must be able to enter into new project contracts to secure the future of the organization. Project supplier organizations must therefore plan the operations in the interface of sales and project execution to be able to successfully finish existing process and to find new projects that fit the strategic goals and internal situation of the organization.

In a multiple project situation, it is important to successfully manage single projects according to planned schedules and resource utilization. Resource management factors such as resource amount and their competencies and identification and critical resource for each project should be identified and secured for the use of the projects. Project scheduling should be clear regarding task scheduling, task priorities as well as task deliverables so that resources executing the tasks are not in charge of these decisions themselves.

Successful project sales phase is an important prerequisite in guaranteeing successful project execution. Most important customer requirements must be communicated between the sales function and project executing organization. The project supply organization must identify a right-size market and evaluate project prospects so that the fit of the projects to the organization's strategic goals and internal situation is optimal and adequate resources and competencies can be secured to enable the fulfilment of long-term strategic goals and long-term success.

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