

Master's thesis

Project Management

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INCREASING PROJECT PORTFOLIO MANAGEMENT TRANSPARENCY



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The present Master's thesis focuses on studying project portfolio management both at a general level and in Alfa Laval Aalborg Boiler Product Development. In addition, the objective is to develop a project portfolio management tool which can be used for collecting information about projects and to manage the portfolio. The implementation of the tool was left outside the scope of the study.

During the past decades, portfolio management has been implemented in all business areas. The importance of well functioning portfolio management to the success of companies has been widely recognized in scientific articles. Portfolio management is a way to ensure that corporate strategies can be implemented effectively. The scopes in which different companies have implemented portfolio management vary, but the overarching and most important factor for portfolio success is the commitment of the management to it.

Different measuring factors can be used in the evaluation of a project portfolio. The balance and the updating of the portfolio are, however, the most important ones. There are multiple ways to analyze the balance, for example the project size and duration can be used or the evaluation can be based on the extent the projects contribute to the development of the organization. The portfolio should be updated so that it will support the company's strategy and the projects which do not support it can be discontinued or frozen.

When the portfolio tool development was started, the first step was to study the commercial tools available. The analysis conducted on them, however, showed that it was better to develop an Excel based tool for the company's own use. The tool allows information from all projects in the portfolio to be collected on one table. With the automated visualization tools, this information can be easily presented to the management. Visualization has been extended to start already in the table where the information is filled in. Automatic highlighting colors have been added. In addition, to ensure the comparability of the information and projects, as much information as possible is filled in using drop-down menus.

At the end of the thesis, there is a chapter discussing the findings of the study

KEYWORDS:

Project portfolio, project portfolio management, project management

Markus Tauriainen

PROJEKTISALKUN HALLINNAN LÄPINÄKYVYYDEN LISÄÄMINEN

Tämän opinnäytetyön tavoitteena oli tutkia projektisalkun hallintaa yleisesti ja erityisesti Alfa Laval Aalborgin höyrykattiloiden tuotekehityksessä. Lisäksi tavoitteena oli kehittää työkalu projektitietojen kokoamiseen ja projektisalkun hallitsemiseen. Projektisalkun hallintatyökalun käyttöönottoaminen ei ollut osa opinnäytetyötä.

Projektisalkun hallinta on viime vuosikymmeninä laajentunut kaikille aloille. Toimivan salkunhallinnan merkitys yritysten menestykselle on laajasti tunnustettua tieteessä. Se toimii kanavana yritysten strategian jalkauttamiseen. Yritykset ovat ottaneet käyttöönsä salkunhallinnan eri laajuuksissa, yhdeksi tärkeimmistä tekijöistä salkunhallinnan menestyksekkääseen käyttöönottoon ovat tutkimuksissa paljastunut johdon sitoutuminen.

Projektisalkkua voidaan arvoida monelta kannalta. Tärkeintä on salkun tasapainoisuus ja sen jatkuva päivittäminen. Tasapainoisuutta voidaan arvioida monella mittarilla, esimerkiksi projektien koon ja keston mukaan, tai vaikkapa projektin yritykselle tuoman kehittymisen kautta. Salkkua tulee päivittää niin että se tukee mahdollisimman hyvin yrityksen strategiaa. Tärkeää on pystyä poistamaan tai jäädyttämään salkusta sellaiset projektit jotka eivät sitä tee.

Projektisalkun hallintatyökalua rakennettaessa lähdettiin tutkimaan ensin kaupallisesti saatavilla olevia ratkaisuja, mutta opinnäytetyössä kuitenkin päädyttiin rakentamaan ratkaisu itse Excel ohjelman pohjalle. Työkalun avulla pystytään keräämään kaikki projektisalkun tiedot yhteen ja siihen luotujen automaattisten visualisointityökalujen avulla helposti kommunikoimaan edelleen yrityksen johdolle. Visualisointia on ulotettu jo tietojen syöttöön käytettävään sivuun lisäämällä automaattisia värikorostuksia. Työkaluun syötettävien tietojen ja sitäkautta projektien vertailukelpoisuutta on pyritty takaamaan mahdollisimman paljon esitetyt valikoita käyttämällä.

Opinnäytetyön lopussa on kappale havaituista kehityskohteista.

ASIASANAT:

Projektisalkku, projektisalkun hallinta, projektinjohto

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LIST OF ABBREVIATIONS (OR) SYMBOLS

Abbreviation	Explanation of abbreviation
BCC	Best Cost Country
BPDM	Boiler Product Development and Management
BU	Business Unit
CBA	Cost/Benefit Analysis
EPD	Existing-product development
IPMA	Internaltional Project Management Association
NPD	New-product development
NPV	Net Present Value
PMI	Project Management Institute
PMO	Project Management Office
PPM	Project portfolio management
Promal	Alfa Laval project management process
ROI	Return of Investment
VAVE	Value Analysis Value Engineering
WBS	World Breakdown Structure

1 INTRODUCTION

Effective project management (PM) and project portfolio management (PPM) are seen as one of the most important development topics in industry. Success in implementation of PPM processes can be critical for company success. Having processes in place is not enough, project portfolio should always support company's strategy.

Developing project management practices it is aimed to execute single projects more successfully. With project portfolio management goal is to support business objectives and targets as well as possible. There are available plenty of documentation for project management development. Project portfolio management has been only recently started to be studied in the same magnitude as project management.

In next chapters are presented Alfa Laval Aalborg BPDM organization and reviewed the goals and the structure of the thesis.

1.1 Alfa Laval Aalborg Boilers Product Development and Management

Alfa Laval is an international equipment manufacturing company, operating nearly 100 countries and has over 17 000 employees. Alfa Laval is leading supplier of products in heat transfer, separation and fluid handling. Company has strong focus in innovations. Approximately 2.5 percent of its sales have been invested back to research and development. Yearly is launched between 35 and 40 new products. (Alfa Laval, 2018)

Alfa Laval has three divisions, Food & Water, Energy and Marine. Each of these divisions is operating in the specific market. (Alfa Laval, 2017) Division consists of several business units. Business units have independent product management and development functions. Boiler Product Development and Management (BPDM) is part of Marine division. It is concentrating to development of mechanical and automation solutions for boiler applications.

Work in BPDM is organized in multi-project environment and resources are typically part of multiple project teams. Multi-project environment brings a need for effective usage of resources and therefore importance of portfolio management is increasing. Prioritization of projects is essential with limited resources.

In projects management is followed company's processes called Promal model. Processes are a tailor made for Alfa Laval but follows stage-gate practices. Project management and project portfolio management processes are defined more detailed later in the thesis.

1.2 Goals

One of the goals for this thesis is to find and review the latest studies regarding portfolio management, especially in product development environment. As result is developed document which containing summaries of the main main topics in PPM development. Target is that these topics can be then easier taken into account when developing more effective PPM practices. This document could also be used to support decision making when next steps in PPM developments are decided. Finally goal is also to increase the organization knowhow regarding PPM.

Second main goal is to develop a tool for collecting and maintaining portfolio data. The need for this tool was defined in discussions with people working with PPM development. There hasn't been in BPDM tool for collecting relevant data from all projects to one platform and thus allow comparison of the projects easily. There was also expressed need to increase the data visualization and enable automatic visual management report generation.

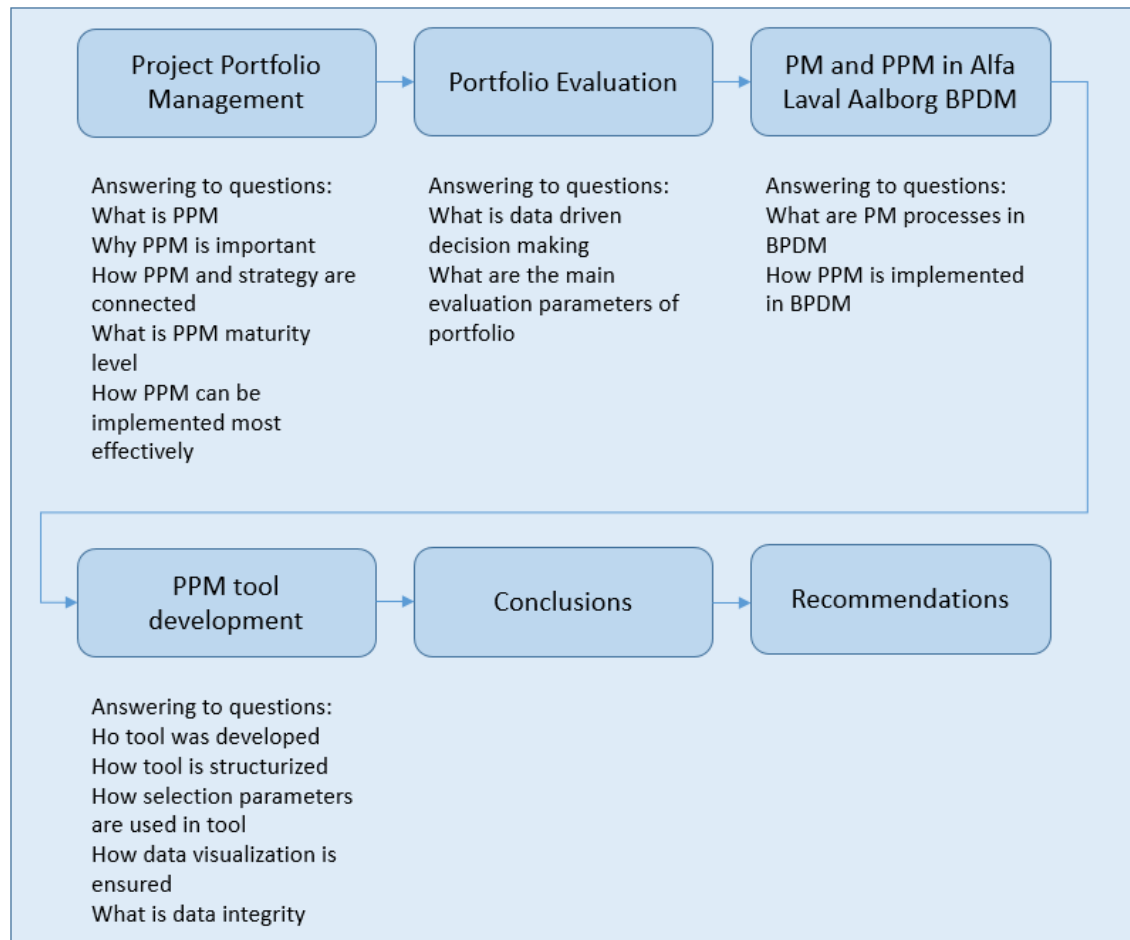
1.3 Structure

The thesis will start with defining project portfolio management in general level in Chapter 2. Importancy of PPM is reviewed, as well as connection between PPM and strategy. There are also own parts for PPM maturity level and implementation of PPM to organization.

From general PPM chapter is transferred to more deep in different aspects that should be taken into account when project portfolio is build. Chapter 3 starts with definition of data driven decision making and continue with different paramenters that should be taken into account when portfolio content is reviewed. There are totally seven different parameters listed and elaborated more detailed.

Chapter 4. contains the current PM and PPM processes in BPDM. Project portfolio tool developments is described in Chapter 5. This chapter starts with tool development and construction. Chapter contains also implementation PPM parameters to portfolio tool and tool visualization. Last part of chapter is about data integrity.

The last chapters are conclusions and recommendations. High level structure of the thesis is presented in picture 1.



Picture 1. Structure of the thesis.

The thesis is a combination of literary research and to applying the theories to the practice via the portfolio management tool.

2 PROJECT PORTFOLIO MANAGEMENT

In this chapter is reviewed project portfolio management generally. History and definition of it, and what are aimed at received with utilizing PPM in organization. PPM importance for organizations is studied, as well as the connection between the implementation of strategy and project portfolio management.

2.1 Portfolio management

History of portfolio management starts in the 1950s. As origin of it can be seen Harry Markowitz's seminar paper Portfolio Selection, released 1952 (J Finance 1952 7). PPM was first taken into usage in the financial sector, after that utilization of it has expanded to all business sectors. (Reyack et al. 2005, 525, Baptestone 2018, 406) During the last decades, project portfolio management has reached the role as the main model to ensure the implementation of a strategy and objectives to projects in multi project environment. Today project portfolio management is implemented into almost all enterprises (Enoch 2015, abstract, Filippov et al. 2010, 648, Vacík et al. 2018, 107).

Project portfolio management is a collection of methods to put strategy into practice in projects and to ensure that projects are aligned with organization's objectives. It is a set of tools for allocating resources according to priorities set up in the constant revisions of all portfolio's projects via using periodic portfolio reviews. (Baptestone 2018, 406 and Enoch 2015, abstract) Other drivers, than improved resources utilization, to implement PPM are capability to increase strategic alignment, possibility to increase project success and decrease projects' complexity (Filippov et al. 2010, 648). Or as Emil Vacík well summarize *"Project Portfolio Management (PPM) deals with the coordination and control of multiple projects that pursue the same strategic goals and compete for the same resources, whereby managers prioritize among projects to achieve strategic benefits."* (Vacík et al. 2018, 107)

With project management methods are aimed to increase quality level of single projects (doing the projects right). PPM is aiming to effect for the whole portfolio of projects. PPM methods also deliver management tools to ensure selection of correct projects to portfolio (doing the right projects) to achieve objectives and support strategy (Filippov et al. 2010, 648).

PPM implementation has effect on project management quality. In the literature review section in their study of PPM impacts on IT projects Bert de Reyck and his group listed following seven elements that PPM will bring to organization:

- Centralized view of the project portfolio
Typically first step of implementing PPM is to collect all active projects and proposed projects to the same database with using a common format. This database is essential for project comparison and thus for portfolio management.
- Projects financial analysis
To enable projects comparison, financial values should be measured the unified way. Organization can select applicable valuation methodology, for example the return of investment (ROI), the internal rate of return (IRR), net present value (NPV) or economic value added (EVA).
- Risk analysis
As one of the main reasons for project failures can be seen unknown or not considered risks. Risk analysis is an effective tool when the balanced portfolio is build and maintained.
- Interdependencies
With PPM can be avoided the competition of resources in organization and avoided unwanted overlaps.
- Priorization and alignment and selection
With PPM can be ensured that all organization's areas in strategy have been taken into account with selected projects. With PPM projects continuation are constantly evaluated.
- Constrains
Constrains which have an effect on projects success are highlighted and the effects of those can be minimized when PPM is used.

- Dynamic re-assessment of the portfolio

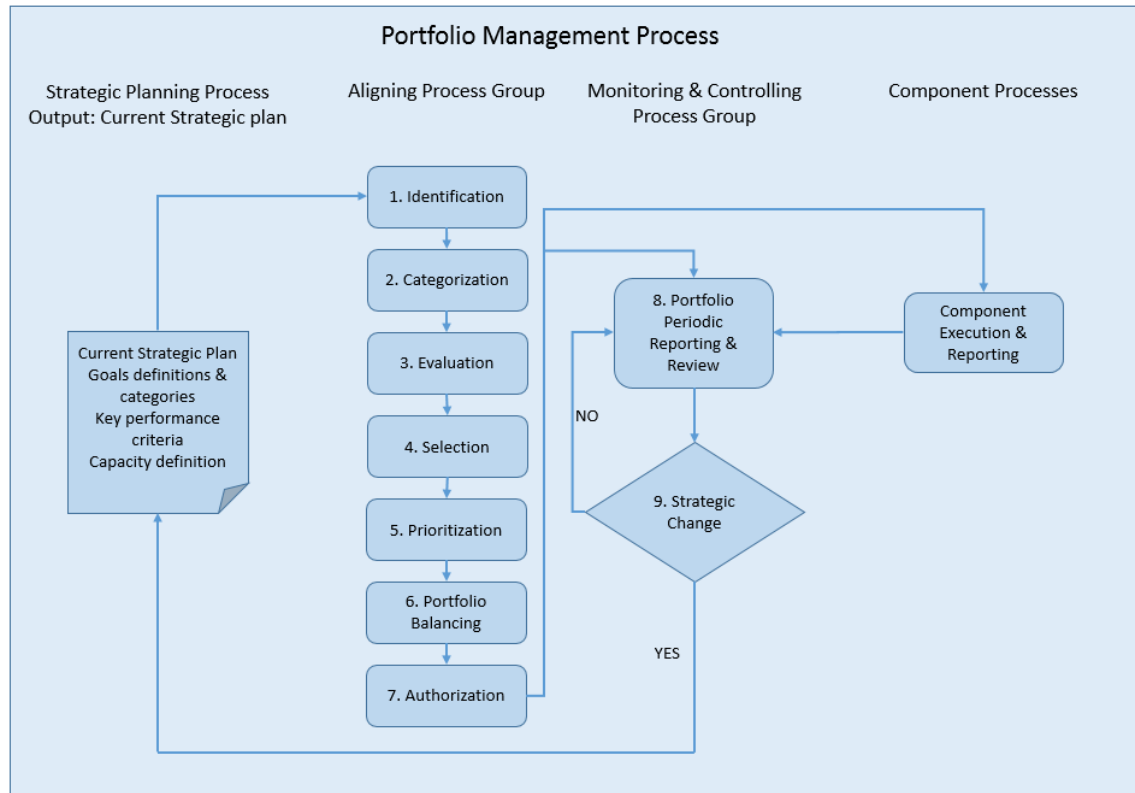
PPM as continuous set of processes should not stop when the portfolio is once created. In effective PPM the constant evaluation of projects is build-in with abandonment of unprofitable and strengthening of successful projects.

(De Reyck et al. 2005, 526)

In the picture 2 is shown portfolio management processes as the Project Management Institute have presented those. Processes can be divided into four sections: Strategic planning, aligning of the projects, monitoring and controlling and execution of projects.

Output from a strategic planning process is a strategic plan. Plan is the starting point for a portfolio process. It is also a document which is not static. It will be updated based on multiple inputs. One of the inputs is feedback from portfolio reviews. Aligning process group contains processes which are aiming to balanced portfolio. First step of these processes is the identification of projects. Both new and existing projects are identified according to selected parameters. It is important that all projects are documented according the same rules. After identification projects can be categorized. Categorization is aiming to grouping of projects. Next steps after categorization are evaluation and selection of projects and project groups. Prioritization of the project follows selection. It can be done according earlier identified parameters. Prioritization based on parameters is not ensuring correct balance of portfolio. Since for the whole portfolio healthiness it is important also find correct balance of different projects, is last step of processes balancing portfolio. (Mathur, S. 2006)

After finalizing all the aligning processes can portfolio be authorized. Projects which has been found applicable to portfolio can continue to execution. Project selected to execution will be followed with portfolio reporting and reviews. As can be seen from the process description portfolio process is continuous and contains several feedbacks. (Mathur, S. 2006)



Picture 2. Project Portfolio Management Process (Modified from Mathur, S. 2006).

2.2 Importance of project portfolio management

Based on the 2015 Chaos report, where is reported widely status of IT projects, 56% of the projects were reported being on target, 44% on budget, and only 40% of the projects were able to kept schedules (CHAOS Report 2015). Similar phenomenon can be seen in other studies and reports. The success rate of projects is not as high as it could be. From product development perspective it is presented by Robert Cooper that 40% of the new products are estimated to fail at launch. Also that top 25% of the companies have 25% higher productivity in new product development compared with the bottom 25% companies. (Cooper 2018, 1 and 5)

Projects are failing and there are great difference between companies. Can success with portfolio management be describing factor? Study of three German constructions companies, which all has implemented successfully project portfolio management,

shows that the growth of these three companies exceeded the construction sector as whole by a large margin (Kaiser et al. 2015, 135).

The success drivers of product development projects can be divided into three categories; The success drivers of individual project, the success drivers at the business level and the success drivers in the systems and methods (Cooper 2018, 1). If PPM is considered in its widest meaning, all of these categories can be affected with efficient project portfolio management. PPM can be used to the implementation of best practices, like VoC (voice of customer), to portfolio's individual projects and thus improve project success.

When discussed about success drivers at business level, with PPM can be affected to organizational and strategic subjects like innovation strategy, focus and management of resources. All of these are seen as classical parts of PPM. (Cooper 2018, 1-6). Effective PPM should be seen as the continuous set of processes which are binded together. Without innovation strategy clear focus is not possible. Without focus otherwise effective resources management doesn't alone lead to successful product development. Innovation strategy should contain clear innovation goals and objectives, innovation goals should be linked to business goals and this linkage should lead to a product roadmap. (Cooper 2018, 1 and 6) Innovation strategy should be seen as vital part of project portfolio management, not as a separate task.

With Implementing and usaging PPM organization can reach benefits. First benefit is maximizing of value of the investments and minimizing the risks. Second is improved communication in organization and with stakeholders. Third benefit is increased management capability to allocate resources effectively and terminate unprofitable projects. If PPM is not implemented there is increased risk that organization is overloaded with too many active projects, or projects which are not adding value or does not support strategy. The project portfolio can also be unbalanced. Examples of unbalance subjects are size, risk or duration. PPM can also reduce multible other risks like delayed deliveries, resources availability, conflicts of objectives just to mention some. (De Reyck et al. 2005, 527)

2.3 Project portfolio management and strategy

All key project parameters, like size and NPV should be taken into account when selecting projects to a portfolio. These parameters should be reviewed constantly, also after selection of projects to the portfolio. A well developed and maintained project portfolio is key to ensure reaching the strategic objectives of the company. With effective PPM following aspects are included in decision making:

- Allocation and reallocation of resources
- Balanced portfolio (short-term and long-term projects, high-risk and low risk projects etc.)
- Finding synergies in portfolio
- Development of organization (skills and competences)
- Development of project management processes
- Constant review of portfolio (deleting of freezing ineffective projects, and finding new opportunities)

(Vacík et al. 2018, 108-109)

Albeith project portfolio management should transfer the main strategic parameters to the portfolio configuration to support strategy, is decision making still often less planned and more political (Vacík et al. 2018, 110). Strategic objectives vary between organizations. Typical objectives are connected to financial aspects, but there might be as well other non-profit objectives like improving customer relations. All active projects in portfolio should support one or multiple strategic objectives. (Kendall et al. 2003, 230-231)

2.4 PPM maturity level and implementation of PPM

Bert De Reyk and his group (De Reyk et al. 2005) presented in their study Berinato's theory of five maturity levels of the project portfolio in organizations. In original theory, levels were:

1. Put all projects in one database
2. Prioritise the projects in the database
3. Divide the projects into two or three budgets based on type of investment

4. Automate the repository
5. Apply Modern Portfolio Theory

(De Reyck et al. 2005, 527)

Based on the five maturity level theory three stage model of PPM maturity was defined. At the model adoption level, PPM was analyzed with using nine different elements: Centralization of project control, financial analysis, risk analysis, interdependencies, constraints, overall portfolio analysis, portfolio alignment (categorization, selection, accountability and governance), optimization and specialised software. Organizations PPM overall adoption was calculated with using four level scale. (De Reyck et al. 2005, 530)

In the study, which was concluded using an online survey to 34 medium to large size companies, was found the significant positive connection between level of PPM adoption and impact gained with it. Four PPM elements were raised with the greatest positive impact:

1. Maintaining portfolio database (90% respondents)
2. Alignment of portfolio to objectives (88%)
3. Consolidation of project data and standardization of project analysis (89%)
4. Project interdependencies (86%)

In the study was also studied a connection between the level of project problems and PPM adoption level. It was founded that the level of PPM adoption has significant positive effect on the reduction of project problems. (De Reyck et al. 2005, 531 and 533)

Based on PPM impact study De Reyck and his team presented three stage project portfolio management implementation plan. In the plan stage 1 portfolio inventory is implemented and following PPM processes are activated: *Centralized project administration, risk evaluation processes, explicit incorporation of resource constraints and increased business leaders' accountability for project results*. (De Reyck et al. 2005, 532)

With stage 1 actions can be reached better risk assessment and risk diversification, and utilization of resources. Unclear strategy is listed in study as biggest challenge against implementation of PPM. Other risks are lack of knowhow and training to measure project benefits. These have a negative effect to reliability of project data in project inventory. (De Reyck et al. 2005, 532)

Stage 2 in PPM implementation is concentrating to portfolio administration. In this stage PPM processes activated are: *Project categorization and evaluation of customer impact to the project portfolio results*. When with stage 1 is reached better understanding of projects objectives, risks and costs and benefits, with stage 2 organization can start to use processes to categorize projects and understand better customers effect to projects. Based on the study there has been challenges to reach stage 2 due lack of resources in project analyzation. (De Reyk et al. 2005, 532)

Third and final stage is portfolio optimization. Stage 3 includes activation of following processes: *Project portfolio committee, assessment of the financial worth of the portfolio, management of project interdependencies, and tracking project benefits*. In the study it was found that in stage 3 all aspects of PPM increased the return of investments and project related problems were reduced. Noteworthy finding was also that PPM software was not seen beneficial to be implemented before other aspects of PPM are implemented. (De Reyk et al. 2005, 533)

3 PROJECT PORTFOLIO EVALUATION

In the next section is described what is data driven decision making. Also portfolio evaluation parameters important for portfolio prioritization are elaborated.

3.1 Data driven decision making

Quality of project portfolio processes and practices are key to ensure success with it. The four recognized main challenges with PPM are:

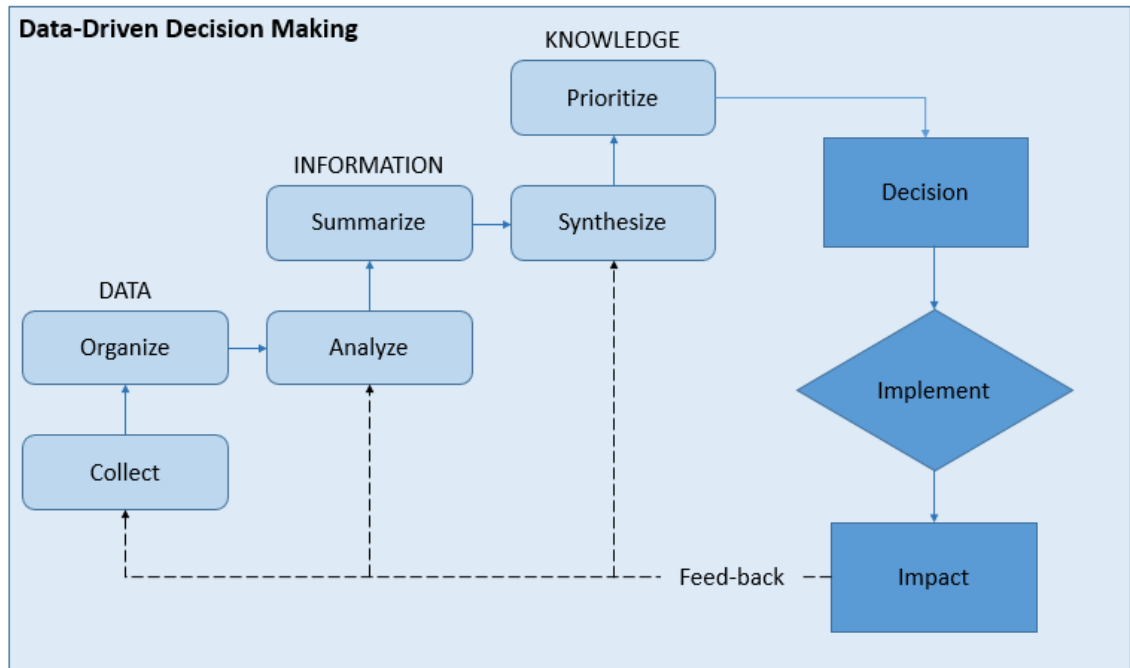
- Organization has too many active projects
- Projects are not providing value to organization
- Projects are not linked to organization's strategy
- Portfolio is not balanced
 - Development vs. research
 - Short term vs. long term
 - Utilization of strategic resources etc.

(Kendall et al. 2003, 2017)

To avoid the realization of above listed problems all decisions for portfolio should be based rather on data than gut feeling.

In a data-driven decision making the process starts from raw data that is collected and organized. From the data, information is analyzed and summarized. Information is combined and used in prioritization. Knowledge reached from data via these steps will be used to support decision making. (Mandinach et al. 7, 2006)

After implementation of decisions it is also important to notice a feedback loop to the process. (see picture 3). (Mandinach et al. 7, 2006) Feedback should be used in all decision making steps to ensure quality.



Picture 3. Data-Driven Decision Making Framework (Modified from Mandinach et al. 7, 2006).

3.2 Project size and duration

Complexity of a project often increases hand-to-hand with project size. In many sources has been seen confluences between project size and success, a good example is the below presented table from the CHAOS 2015 report. As from the below table (table 1) can be seen with software projects has been found a negative link between project success and size. (CHAOS report 2015)

Table 1. The resolution of all software projects by size from FY2011-2015 within the new CHAOS database (Modified from CHAOS report 2015).

CHAOS RESOLUTION BY PROJECT SIZE

	Successful	Failed	Challenged
Grand	2%	17%	7%
Large	6%	24%	17%
Medium	9%	31%	26%
Moderate	21%	17%	32%
Small	62%	11%	16%

Why increasing project size has negative impact to project success? There are many factors effecting for this. Links between project size and success are complex. One of the factors is related to project group size and effect on it to group performance. Although there is no consistent view of group size effect to performance (Biezenaar et al. 2016, 6-7). Typically larger projects require a bigger group of people working with it. There is consistency that one of the negative effects due increased group size is decreased coordination inside the project which effect negatively to performance (Biezenaar et al. 2016, 7).

Larger projects requirements for increased coordination. This need was highlighted in the study concluded in the University of Eastern Finland (Ahonen et al. 2015). In this study was found correlation between project size and need for higher coordination level. There was also found increased requirements for management. For larger projects should be allocated more resources to project management related activities. As a reason for this was mentioned increased need for the communication. (Ahonen et al. 2015, 209)

In the same study was also included other type of project size definition; duration. Correlation was found in requirements between the proportion of project management effort and project duration. Longer projects are requiring more project management effort. Number of changes are growing when a duration of project is increasing. This leads for increased amount of change management. Increased number of changes can be also seen as a source of uncertainties. Uncertainties has possible negative effect on project success. (Ahonen et al. 2015, 209)

3.3 Internal versus external resources

One of the main target for portfolio management is to utilize company resources as effective as possible (Enoch 2015, 84). There are always limitations with internal resources available. Utilization of external resources will be a management possibility to ensure the progress of a project. Usage of external resources in project have both positive and negative effects. It is important for management to realize these before the decision of outsourcing tasks.

Especially in some tasks requiring specialized skills with using external resources can be patched possible gaps in organization know-how. Outsourcing larger parts of projects can have positive effect on the project schedule when increased amount of experts working on it. Same time permanent employees can concentrate on the tasks in their core know-how areas. (Verzuh 2015, 2100y and 2100z)

Utilization of external resources increases risks of unknown level of competence. When the skills of own employees are typically well-known, with externals there is higher risk that hired resources are not meeting expectations. This risk can be reduced with prestudy of qualification of external experts. This action required time from management. With external resources expertise may be lost. To reduce effect of this risk, it is important from project management to ensure recording and the documentation of work. (Verzuh 2015, 2100y and 2100z)

3.4 NPV and time to profit

Based on Kendall and Rollins one of the main reasons why problems with project portfolio management are often realized is undefined or the unclear return of investments (ROI) of projects. With R&D projects, especially with a research project, it is sometimes hard to define ROI. With R&D projects management should be aware of this challenges to define ROI.(Kendall et al. 2003, 207 and 407) There should be always available for portfolio work financial evaluations of all projects.

R&D projects are investment projects, with in and out cash flows, but R&D vary typically from other type of investment projects with higher risks and rewards. The investment evaluation parameters of R&D projects should diverge from the standard investment evaluation parameters. With an operational investment project net present value (NPV)

of cash flow is the primary method for define if the project should be executed or not. In case that R&D projects are product extension or process improvement projects NPV could be used. With other type R&D projects using only NPV might lead to undesirable results. R&D projects often have a relatively long period before positive cash flow, which lead lower NPV values. (Curtis C 2001, 51-52) If evaluation parameters are used wrongly, there is risk that R&D investments are not optimized correctly to support organization strategy.

3.5 Project risks – resources, schedule, costs and quality

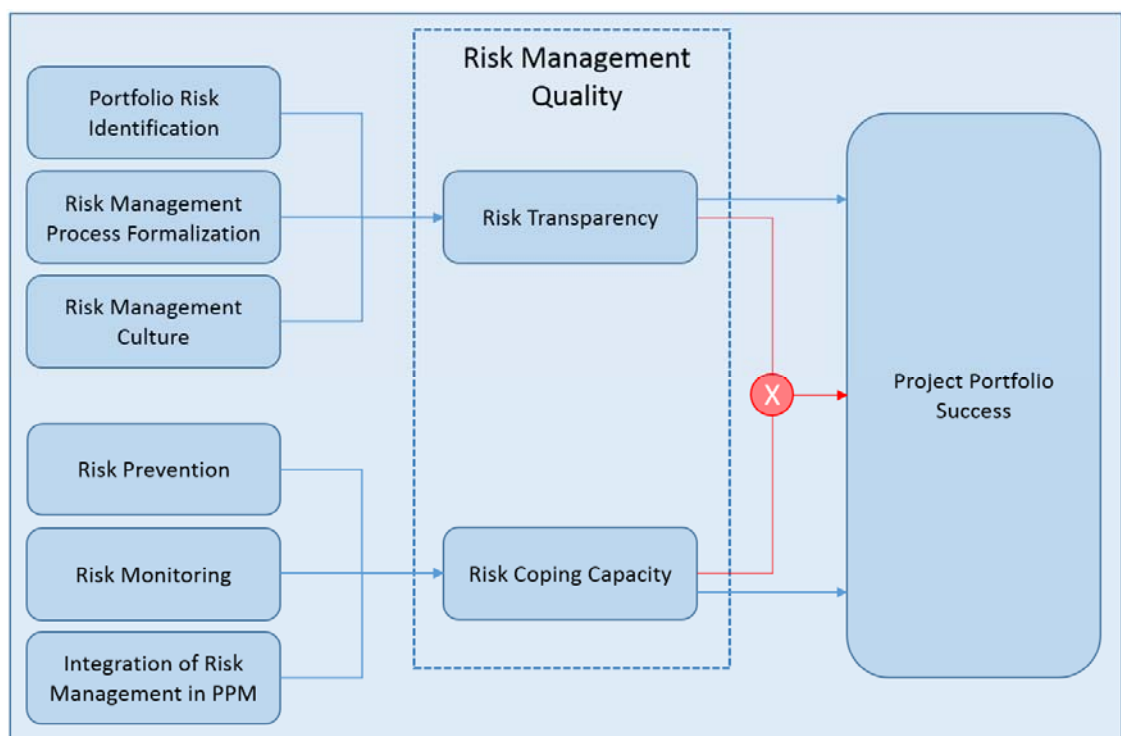
In ISO 9000: 2015 risk is defined as the effect of uncertainty, which can be either positive or negative but always deviation from the expected. *“The management of risks is a crucial element of project portfolio management”* (Teller et al. 2013, 817). With all activities in company, including R&D, risks should be taken into account. Risks, financial, schedule and technical, should be kept in an acceptable level. Still, there should not be one acceptable risk level valid for all projects in a portfolio. With having single acceptable risk level, will the strategic elements of individual projects be eliminated and in the worst case the overall risk level of organization might increase. (Cogliandro 2006, 130)

Project portfolio risk management consist of risk identification, monitoring and prevention. The implementation of these will have direct impact on risk transparency and risk management culture. Basic elements of project portfolio risk management are widely recognized, still portfolio risk management is not often implemented and organizations have the low consciousness of it. It might be that risk management is considered being time consuming and costs increasing action. There might also be lack of knowhow in portfolio management to execute effective risk management in portfolio level. (Teller et al. 2013, 817-818)

In the study of organization's risk management capabilities effects to project portfolio success Juliana Teller and Alexander Kock (Teller et al. 2013) studied following hypotheses:

- Risk transparency and risk coping capacity has positive effect to project portfolio success.
- Risk transparency increases the positive effect of risk coping capacity and vice versa.
- Portfolio risk identification, risk management process formalization and a strong risk management culture has positive impact on risk transparency.
- Risk prevention and monitoring, and integration of risk management in project portfolio management has positive relation to risk coping capacity.

After empirical investigation all other hypotheses excluding the hypothesis of risk transparency effect to risk coping capacity and vice versa were proved to be correct. From the below picture can be seen connections, the connection that was not found during study is highlighted with the red color (picture 4) (Teller et al. 2013, 819-825) With this study organization's risk management capabilities were positively linked to success in project portfolio management.



Picture 4 . Relationship between portfolio risk management, risk management quality and project portfolio success (Modified from Teller et al. 2013, 819).

3.6 Project complexity

Project complexity is seen as one of the root cause for project failure (Poveda-Bautista et al. 2018, 1). To enable increasing project success and to reduce the impact of negative effects due complexity, project complexity level should be measured. When projects complexity level is known, then correct management practices can be selected. “*Different types of projects require different managerial approaches*” (Poveda-Bautista et al. 2018, 1). Challenge is that traditional project assessment tools are not fully supporting the evaluation of complex projects. (Poveda-Bautista et al. 2018, 1 and Zhu, J et al. 2016, 1)

Measuring project complexity is not a straightforward task. First should be defined what is complexity in projects? There are available multiple theories how to execute project complexity measurement. PMI has approaches this matter with measuring structural complexity and uncertainty issues. With the simplest theory structural complexity consists of organizational complexity and technological complexity, in some theories environmental complexity is also part of structural complexity. Uncertainty contains the uncertainty of objectives and methods. This varying a bit between theories. Some theories are also including sosiopolitical elements in the evaluation. (Poveda-Bautista et al. 2018, 2)

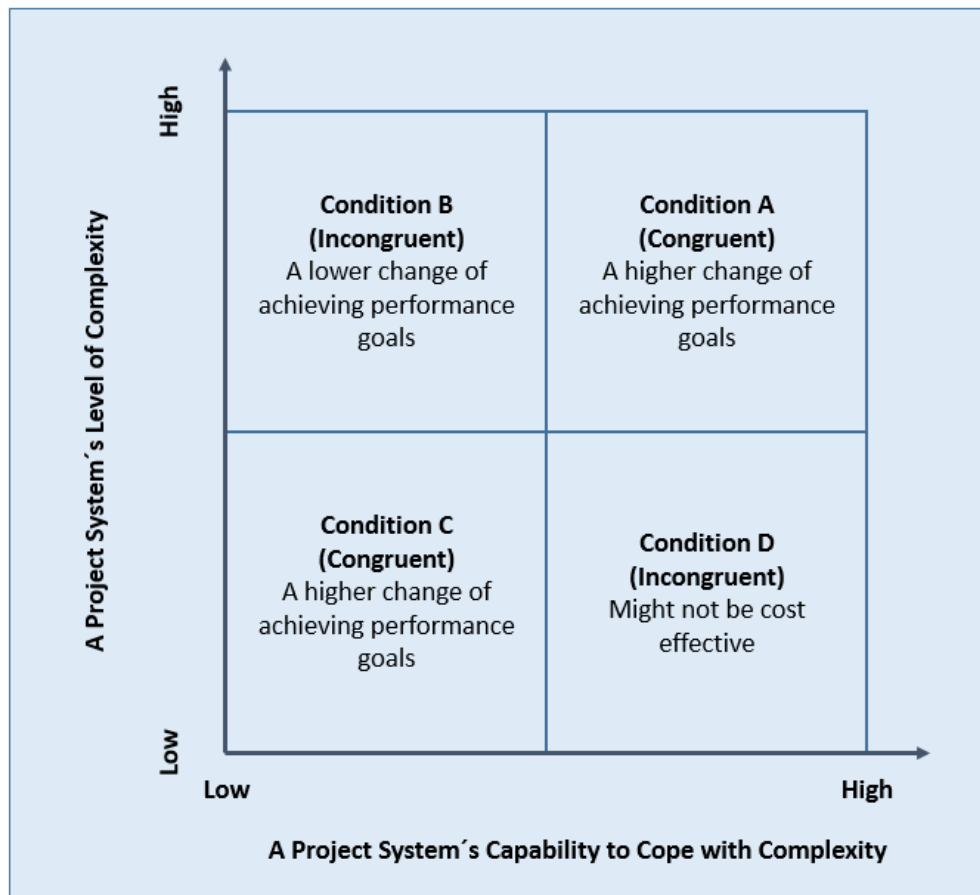
IPMA’s approach is more detailed than PMI’s. It is based on multiple factors, covering project planning and execution widely. When project complexity is evaluated utilizing IPMA tools, there are included the evaluation of objectives, stakeholders, cultural and social context, technical newness, structure and organization of projects, management, resources, risks and opportunities, and overall PM methods. (Poveda-Bautista et al. 2018, 2). Since all these criterias are included in evaluation, it is not possible to conclude without the deep knowhow of the project. IPMA complexity assessment system for IPMA B is shown below in table 2. Evaluation, no matter which method used, if completed correctly can be estimated to reduce risks with project execution. Iterative and agile methods, for example, have found to have positive impact on complex IT projects (Poveda-Bautista et al. 2018, 4).

Table 2. IPMA Complexity assessment system for IPMA B (modified from Poveda-Bautista et al. 2018, 3).

Criteria	Description of criteria	High Complexity	Low Complexity
Objectives, assessment of results	Mandate and objective Conflicting objectives Transparency of mandate and objectives Interdependence of objectives Number and assessment of results	Uncertain, vague Many conflicts Hidden Very interdependent Large, multidimensional	Defined, obvious Few conflicts Quite transparent Quite independent Low, monodimensional
Interested parties, integration	Interested parties, lobbies Categories of stakeholders Stakeholder interrelations Interests of involved parties	Numerous parties Many different Unknown relations Divergent interests	Few parties Few uniform categories Few and well known relations Comparable interest
Cultural and social context	Diversity of context Cultural variety Geographic distances Social span	Diverse Multicultural, unknown Distant, distributed Large, demanding	Homogenous Uniform, well known Close, concentrated Small, easy to handle
Degree of innovation, general conditions	Technological degree of innovation Demand of creativity Scope for development Significance on public agenda	Unknown technology Innovative approach Large Large public interest	Known and proven technology Repetitive approach Limited Public interest low
Project structure, demands of coordination	Structures to be coordinated Demand for communication Structuring of phases Demand for reporting	Numerous structures Demanding, elaborate Overlapping, simultaneous Multidimensional, comprehensive	Few structures Simple, straightforward Sequential Uni-dimensional, common
Project organisation	Number of interfaces Demand for communication Hierarchical structure Relations with permanent organisations	Many Indirect, demanding, manifold Multidimensional, matrix structure Intensive mutual relations	Few Direct, not demanding, uniform Uni-dimensional, simple Few relations
Leadership, teamwork, decisions	Number of sub-ordinates Team structure Leadership style Decision-making processes	Many, large control span Dynamic team structure Adaptive and variable Many important decisions	Few, small control span Static team structure Constant and uniform Few important decisions
Resources incl. finance	Availability of people, material, etc. Financial resources Capital investment Quantity and diversity of staff	Uncertain, changing Many investors and kinds of resources Large (relative to project of same kind) High	Available, known One investor and few kinds of resources Low (relative to project of the same kind) Low
Risk and opportunities	Predictability of risks and opportunities Risk probability, significance of impact Potential opportunities Options for action to minimise risks	Low, uncertain High risk potential, large impact Limited options for actions Large potential of opportunities	High, quite certain Low risk potential, low impact Many options for actions Low potential of opportunities
PM methods, tools and techniques	Variety of methods and tools applied Application of standards Availability of support Proportion of PM to total project work	Numerous, manifold Few common standards applicable No support available High percentage	Few, simple Common standards applicable Much support available Low percentage

Third way to plan and manage project complexity, especially if portfolio consist of varying type of projects, is to evaluate projects based on contingency theory. In contingency approach organization's capability to absorb and handle complexity is taken into account. Below, in picture 5, is shown the project evaluation table comparing a project system's complexity and projects system's capability to manage complexity. Summary is presented in the four-field table, where condition A and C are showing cases where complexity can be managed. With condition D it is also possible, but project system's capability to handle project complexity is higher than needed therefore there is risk that the projects' execution is not cost effective. (Zhu et al. 2017, 2-3) It is important to ensure

that simple projects are not executed with utilizing too complex project management processes to enable organization financial success.

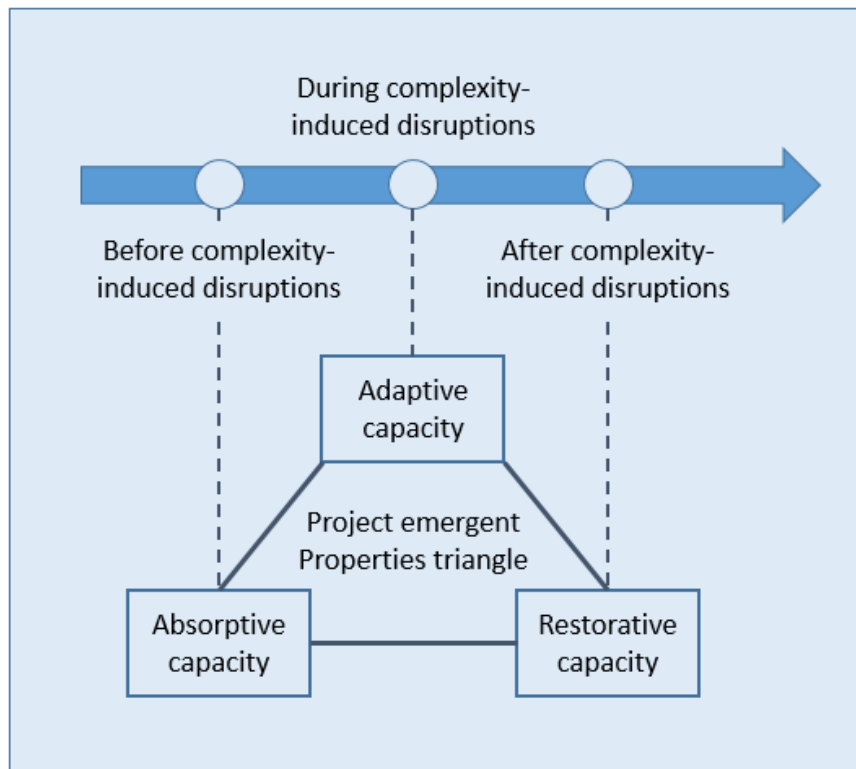


Picture 5. Four conditions in project systems regarding complexity (Modified from Zhu et al. 2017, 3).

Since complexity is causing negative impact to projects, project organization handling complex projects has to have capability to manage possible impacts. These capabilities can be divided to three: Absorptive, adaptive and restorative capacities. The common name for capabilities is emergent properties. (Zhu et al. 2017, 5)

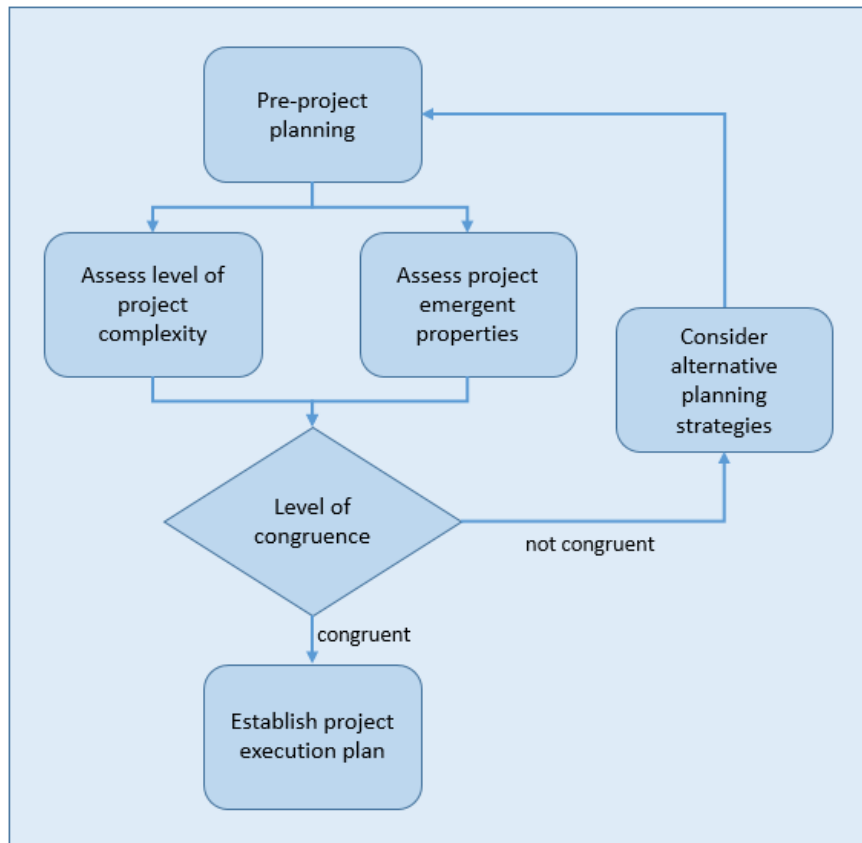
Absorptive capabilities are organizations abilities to absorb the impacts of complexity and to minimize possible impacts. *“A project with a high level of absorptive capacity can operate successfully in complex contexts without changing it initial governance structure and execution process.”* Adaptive capacity is organization's capacity to change project execution structure or processes to answer complexity related challenges. Organizations with high level adaptive capacity can react faster and more effective than organizations with lower adaptive capacity. If complexity induced disruptions has not been able to

eliminated before those realization organization's restorative capacity is defining how effective organization can recover from disruptions. *"Restorative capacity enables a project to recover and return to the desirable performance level"*. A project organization emergent properties triangle is presented below in picture 6. (Zhu et al. 2017, 5)



Picture 6. Project emergent properties triangle (Modified from Zhu et al. 2017, 5).

Project organizations emergent properties together with project complexity level should be taken into account in the preplanning phase. In proactive planning project complexity and organizations emergent properties are analyzed and the level of congruence can be evaluated. If complexity of project and organization's capability to absorb issues are not met, should alternative planning strategies considered and project should be returned to pre-planning. If organization's capability to manage complexity related risks is in high enough level compared to complexity level of project, can the project execution plan released as shown below in picture 7. (Zhu et al. 2017, 10)



Picture 7. Proactive planning of complexity related issues (Modified from Zhu et al. 2017, 10).

3.7 Market Newness and Technology Newness

Common question with R&D activities is; How much should resources be pointed to research and how much to development? Before there can be given answer to this question it is needed to be defined what is research and what is development? One of the definitions is dividing research in two classes basic and applied, *“Basic research is experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying foundations of phenomena and observable facts, without any particular application or use in view. Applied research is also original investigation undertaken in order to acquire new knowledge. It is, however, directed primarily towards a specific practical aim or objective. Experimental development is systematic work, drawing on existing knowledge gained from research and or practical experience, that is directed*

towards producing new materials, products and devices; to installing new processes, systems and services; or to improving substantially those already produced or installed". (Djellal et al. 2015, 4)

Typically in industrial organizations basic research is in minor role and R&D activities concentrate on applied research and development. In a healthy project portfolio, there should be good balance between research and development. There is no fit-for-all answer regarding this balance. It is management capability to find correct distribution that will support organization's strategy. (Kendall et al. 2003, 228-229) Distribution projects to research and development basis can be used when portfolio technological newness is evaluated.

Project can be divided other ways than based on technological newness. Other way is to evaluate project's market newness. Level of project market newness has impact on required customer involvement level. If market newness is low, in the other words if the market is familiar for the company, customer involvement is less important. When the market newness increases the customer involvement importance increase as well. Companies capable to implement customer involvement, and gather and analyze customer information can gain from these capabilities and have positive effects on new product development. (Feng et al. 2016, 1705) Therefore it is needed for management, not only to know if projects are able to renew technology (technology newness), but also get information on the market newness of projects to make possible to have needed resources in customer involvement to enable effective new product development.

In some studies market newness has reported to have stronger impact on product performance than technology newness. One of the reasons for this is that without sufficient front end study there are increased risks with market acceptance for new features. (Jin et al. 2018, 233) High market newness with high technology newness increase a project risks but also potential. In this case there is possibility for less competition (Jin et al. 2018, 233). It is widely accepted that new products, especially innovative ones, have positive impact on the performance of company (Feng et al. 2018, 218).

One of the ways for organization to reduce risks, like delays with launching new products, which are born from high market newness is to increase marketing and manufacturing integration and cooperation. This integration should be in place especially at the beginning of new product projects. It should be implemented during the business and

market analysis phase. Importance of integration increases with projects having high market newness and when a new market might require new functions and these new functions might differentiate to manufacturing capabilities. (Feng et al. 2018, 218-220)

3.8 Utilization of strategic resources

Active resource planning in broader meaning is vital for company success. *“A company that actively reallocates delivers, on average, a 10 percent return to shareholders, versus 6 percent for a sluggish reallocator. Within 20 years, the dynamic reallocator will be worth twice as much as its less agile counterpart—a divide likely to increase as accelerating digital disruptions and growing geopolitical uncertainty boost the importance of nimble reallocation.”* (Yuval 2016)

Constant evaluation of resources and their skills are needed to enable utilization of resources most effectively. In multi-project environment, good assistance for planning is WBS dictionary where tasks can be listed including needed skills (Kerzner et. al 2013, 540). Later needed resources can be matched to the available personnel with utilizing skill matrix. Skill matrix brings the overview of available skills. Example of a matrix presented in picture 8.

FUNCTIONAL AREAS OF EXPERTISE	PROJECT TEAM													
	ABLE, J.	BAKER, P.	COOK, D.	DIRK, L.	EASLEY, P.	FRANKLIN, W.	GREEN, C.	HENRY, L.	IMHOFF, R.	JULES, C.	KLEIN, W.	LEDGER, D.	MAYER, O.	NEWTON, A.
ADMINISTRATIVE MANAGEMENT		a				a		a			a	a		a
COST CONTROL		b	b		b	b	b				b	b		b
ECONOMIC ANALYSIS	c			c				c	c				c	
ENERGY SYSTEMS		d	d		d		d		d			d		d
ENVIRONMENTAL IMPACT ASSESSMENT	e	e	e					e		e		e		
INDUSTRIAL ENGINEERING	f				f				f					
INSTRUMENTATION	g			g		g					g			g
PIPING AND DESIGN LAYOUT	h		h		h	h			h			h		
PLANNING AND SCHEDULING		i		i	i			i				i		i
PROJECT MANAGEMENT	j			j		j					j			j
PROJECT REPORTING		k	k		k			k	k			k		k
QUALITY CONTROL		l	l			l	l	l	l					
SITE EVALUATION		m				m			m	m			m	
SPECIFICATION PREPARATION			n	n			n				n		n	
SYSTEM DESIGN		o	o		o		o	o		o		o		o

Picture 8. Example of personnel skill matrix (Kerzner et. al 2013, 235).

In their book regarding project management office development Kendall and Rollins are describing key stones of successful resource planning in multi-project environment:

- The organization's most precious strategic resources are giving the best value back to the organization
- There is enough protective capacity of overall resources to support the organization's project goals and to support the proper use of the strategic resources
- The organization's precious project resource pool is not wasted on projects that are not the highest priority relative to the organization's goals

(Kendall et al. 2003, 241-242)

Strategic resources are typically determining how many projects organization can execute. They are resources used in most projects or are other way the heaviest loaded. Lack of availability of these resources is causing the most likely significant delays. (Kendall et al. 2013, 242-243) If strategic resources are not used correctly, there is a risk of delays via complete project portfolio. Availability of strategic resources should even

determinate how many and which projects selected to execution. *“It is critical for the organization to stagger projects according to the capacity of this strategic resource. It is amazing how project flow can be accelerated by only activating projects according to the availability of the strategic resource. The results mean that the same resource pool will handle many more projects.”* (Kendall et. al 2003, 243)

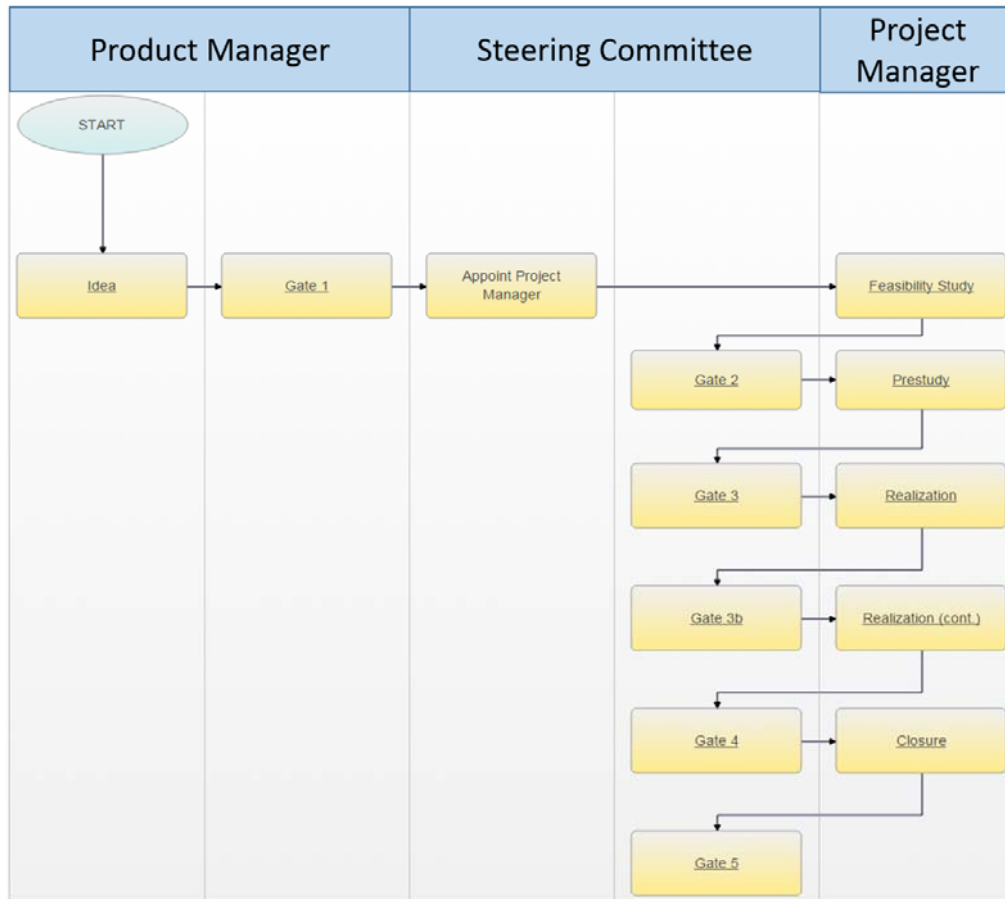
Challenge in multi-project environment is utilizing the same resources in many projects, this is called multi-tasking. Executives likes to utilize multi-tasking to increase efficiency. In studies has been proved that there is risk that projects can even take two to three times longer due bad multitasking even if resources seem to be hea vily utilized. Good results has been reached with planning project execution according to strategic resources availability and thus avoiding strategic resources multi-tasking. Letting strategic resources to concentrate on the single project, project cycle has been able to reduced even as much as half. (Kendall et. al 2003, 243 and 248)

4 CURRENT PM AND PPM PRACTICES IN ALFA LAVAL AALBORG BPDM

This chapter is concentrating on describing current project portfolio and project portfolio management processes and practices in Alfa Laval Aalborg Boiler Product Development and Management. The chapter starts with defining the project model. After project model is reviewed portfolio practices, including relevant working groups and yearly schedule for those groups.

4.1 Project Management Process

The process for development projects is based on Alfa Laval Project Model, called PROMAL. Documentation templates and the main process is following mainly the corporate process but some changes have been implemented to fit it better to R&D environment. In below flowchart (picture 9) can be seen project process from the idea to the product. (Alfa Laval Product Center Boiler – Project Process Manual)



Picture 9. Flowchart of the product screening and development process including process owners (Modified from Alfa Laval Product Center Boiler – Project Process Manual).

The project model presented above is mandatory for the project with budget exceeding 30000 EUR. It is recommended to be followed with all, even lower value, R&D projects. Although there is the highly structured project model available, with well-defined documentation requirements, it is recommended to tailor the model to fit each project as well as possible. Project manager, when taking responsibility to manage a project should review needed project management processes and list alterations between the standard model and actual project execution plan. (Alfa Laval Product Center Boiler – Project Process Manual)

The main objectives to utilize project management model are:

- Have for a project team the structured and standardized project management model available
- To ensure goal orientation, efficiency and quality in project execution

(Alfa Laval Product Center Boiler – Project Process Manual)

Since Project model is part of the quality management system and thus effecting for site ISO 9001 certification, documentation requirements for projects are described in detail. All documentation should follow the agreed identification system. To ensure the availability of documentation, all documents after review should be saved to the correct intranet folder. There are available even separate instructions for naming and filing of documents. The list of minimum and recommended documentation for the project is published. For all required documents, the descriptions and templates are available to ensure unity of documentation. Structure of project steering committee is defined, as well as instructions about how reporting of project progress to steering committee should be executed. (Alfa Laval Product Center Boiler – Project Process Manual)

4.2 Project Portfolio Management Process

Although project portfolio management is implemented as part of Boiler Product Development and Management department daily work, there is no separate PPM process available. Part of PPM processes are described in the Project Management Process documentation and part in separate documents and presentations.

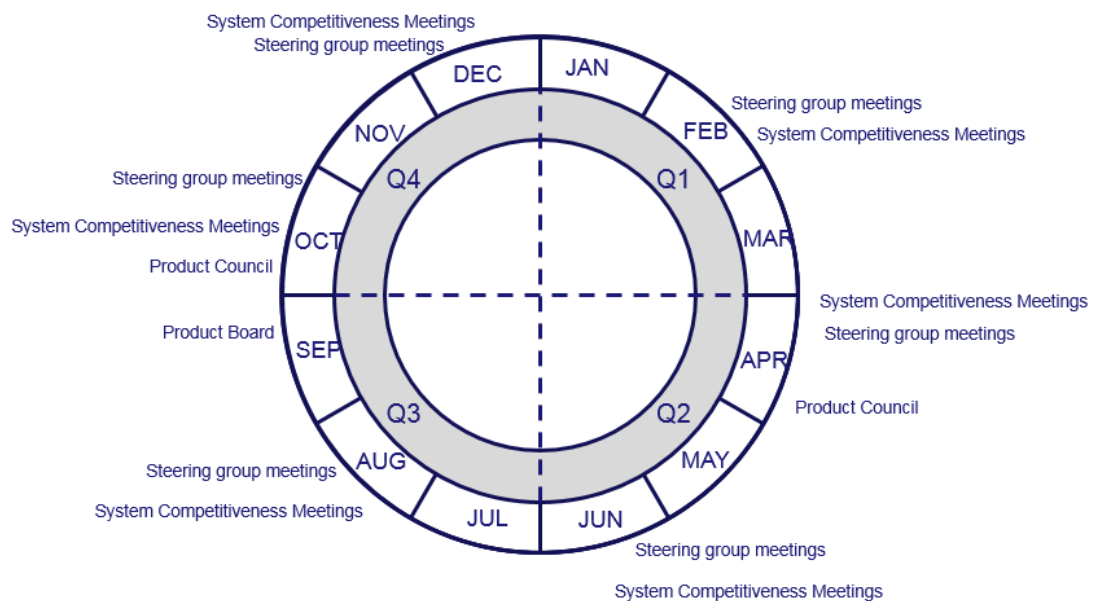
The corner stone for the project portfolio management is weekly organized portfolio review, called Performace meeting. This meeting is recently launched and still practices on it's execution are developing. On Performance meeting project managers update status of their projects, including progress, deviations and resources. Statuses are shown on the Project Portfolio Board (see picture 10). To enable overview of portfolio status, each active project is located horizontally in the correct place at the Promal process table (between correct gates or on-hold area) and vertically to relevant color area showing project status. Project status areas are green, yellow and red. Green represent status for projects that are on track, yellow for projects in risk to miss delivery either on quality, time or cost, and red for projects where risks have realized and one (or more) milestones has been missed. If a project is located to yellow or red area, a general deviation note is required to be presented in meeting. In the deviation note deviation is defined including consequences. Also plan with the corrective actions and deadline for actions is included in the deviation note. (Alfa Laval Project Portfolio Board training material)

Other meetings and groups for project portfolio management are the Steering Group, the Product Council and the Product Board. Also Competitiveness Meetings could be considered to be part of the PPM process. System Competitiveness meetings are organized by the Product Manager. Members of meetings are BUs (Business Units) Managers, EPD (Existing-Product Development) Manager, Product Manager, Operations Manager, Boiler Sales Manager, Boiler Service Manager. Topics handled in meetings are, as the meeting name already defines, concentrated on cost related issues. In these meetings are evaluated competitiveness projects, VAVE (Value Analysis Value Engineering) and BCC (Best Cost Country) activities. Cost savings reached with R&D projects are also reported in Competitiveness meetings. Meeting will take place six times per year. (Alfa Laval Portfolio Management presentation)

The Product Council meetings are managed by the Product Manager. There will be two meetings yearly. First one at the beginning of second quarter of a year and second in the beginning of last quarter of a year, but always after the Product Board. Members of the Product Council are BUs Managers, BPDM Management, Boiler Sales Manager, Boiler Service Manager, Operations Manager and Business Control Managers. Meeting

is organized for project portfolio prioritization. All projects and starts of projects prestudies are accepted by the Product Council. (Alfa Laval Portfolio Management presentation)

Once a year, at the end of third quarter, is organized the Product Board. Chairman of this meeting is the BPDM Manager. Members of the meeting are the same as in the Product Council, but also Head of Marine Division will participate. The Product Board has the highest power amongst the portfolio management meetings and groups. In that meeting is defined the R&D investment frame, as well as approved the product plans and strategy. During the meeting, information about the NPD, EPD and technology activities will be presented. Also the status of sales of the new products is reviewed in the meeting. Meeting can also allow alliances and associated products. The year cycle of PPM activities is presented below in picture 11. (Alfa Laval Portfolio Management presentation)



Picture 11. Year cycle of the BPDM PPM activities (Alfa Laval Portfolio Management presentation).

5 PROJECT PORTFOLIO TOOL DEVELOPMENT

As well as having the correct process for decision making in place it is important that available tools are supporting the execution of the process. In the project portfolio management development workshops, the lack of a simple project portfolio data collection and visualization tool was recognized. Development of this tool was decided to take place. It was agreed to be part of this thesis. Targets for tool are to increase transparency of projects statuses and enable data driven decision making with PPM.

In the next chapters are presented the PPM tool construction, how data integrity is ensured and how with data visualization is supported tool users. In the end of chapter is defined main evaluation parameters of the projects. List of the all attributes with details are located in the attachment 1.

5.1 Tool development

When the project portfolio tool was agreed to be developed as part of this thesis current tools used with PPM and commercially available PPM applications were screened. First notification was that there was no internal tool for PPM management available in Alfa Laval. Many commercial applications were found from market. Each of commercial applications have own pros, and most of those has similar cons; Licencees needs to be purchased, and most of the cases to ensure effective implementation training would be needed. Due these needs commercial PPM application were decided not to be used.

Since all Alfa Laval office employees have access to Excel it was selected to be used. This decision took place albeit using Excel brings some limitations in possibilities with visualizations of data. Excel was found to be cost effective solution since with it external IT resources were not needed. All required functionalities were developed as part of the thesis. The Excel format, as database, also enables later implementing other portfolio tools. Data from Excel can be relatively easily extracted and imported to the new tool. Selecting Excel does not effect for future application selections.

The first step for the tool development was to define requirements for it. In discussions with the future users of the tool was agreed that tool should be simple to use and should contain a basic set of information needed for portfolio evaluation.

5.2 Tool construction

Tool consist of data filling table where project data is filled by project portfolio manager. This sheet is called “Project list and evaluation”. There are two functions with this sheet, house data collection table and also give quick overview of data of all projects in the portfolio. Project data is filled to the tool via open cell or via dropdown menus. An example of the dropdown menu is presented below in picture 12. There are totally 24 evaluation parameters.

PROJECT NAME	PROJECT NO	REVIEWED LAST [WW/YY]	PROJECT STATUS	PROMAL PHASE
Example A	P001		On track	Idea
Example B	P002		On track	Idea
Example C	P003		Risk	Idea
Example D	P004		Missed	Idea
Example E	P005		On hold	Prestudy
Example F	P006		Missed	Realization
Example G	P007		On hold	Prestudy
			Risk	Idea

Picture 12. Example of dropdown menu (Excel tool for PPM).

Second page where data is filled, part of data is automatically collected from the sheet, is named Promal gates. This sheet is used to follow project progress in Promal process. Rest of the unhidden pages are Executive summary 1 and 2, and Scale description. Scale description page contain description of manually filled data.

Executive summary pages contain automatically generated visualizations of PPM data filled to the first sheet. From parameters filled to the first sheet are generated nine automatically updating executive summary charts. In the attachment 1 is presented all project evaluation parameters including details of data filling method, data sources, description and planned utilization of data.

The project data table is the heart of PPM tool. First columns in the data filling table are containing the standard information of projects. The data collected was agreed with the senior project manager who was nominated to be responsible of maintaining the PPM tool data. The starting point for the evaluation parameters was the existing product board and product council presentation templates. Other source for the parameters was the

portfolio tool used in the other Alfa Laval entity. When first version of tool was developed content was reviewed with the future user of tool and with the head of product management of BPDM. Changes to the tool were agreed on meeting and were implemented into the final version of the PPM tool.

5.3 Data integrity

Data integrity contains all aspects of data correctness, accuracy and consistency. It will ensures searchability, traceability and connectivity of the data. Data is not staying static thus keeping the integrity of it in the high level require work. (Lund H. 2017) Data integrity has a significant role in the successful implementation of any business management systems, including PPM (Perry 2011, 205). Ensuring data integrity it should be taken into account already when new tools are designed and implemented. There should be in place plans for data entry, validation, cleaning and maintenance (Lund H. 2017). Data quality should be revised constantly (Lund H. 2016).

In the PPM tool data quality has been taken into account with using as much as possible dropdown menus with data filling cells. Dropdown menus are used to ensure that filled data can be later compared and analysed. Second aspect to ensure data integrity is the description of required data. Descriptions are located directly under data titles, with possible references to original data source. Tool users does ot need to decide what data be filled. Main source for project data with the PPM tool is CBA (Cost/Benefit Analysis) of projects. The CBA document is defined in the Promal process to be generated for each project before starting of project. Third method to ensuring data integrity is the column where is defined last date of data review. With data review date column can be ensured data newness in decision making. In picture 13 is shown an example of data descriptions and example values.

COSTS [1000 EUR]	INTERNAL HOURS	START [WW/YY]	DURATION [Weeks]	TIME TO PROFIT
▼	▼	▼	▼	▼
Total project costs from CBA	Amount of internal hours, from project plan	Project starting week, gate 1	Estimated project duration from gate 1 to gate 4, from project plan	From G2, source CBA
180	1280	41/18	21	3.7

Picture 13. Example of data descriptions and example values (Excel tool for PPM).

Fourth way to ensure data integrity are predefined scales for the columns where values are decided by user. The example of this kind of column is complexity. In complexity column scale is from one to four (1 = low, 2 = low medium, 3 = high medium and 4 = high), see picture 14. Each value has predefined descriptions. In case of complexity, descriptions are modified from the document called Managing Complexity released by IPMA (2012). Also with other user definable attributes sources for descriptions are recognized sources. For defining scales are used sources like Product Development Institute and Alfa Laval internal practices or policies.

Complexity	Description
1 - Low	Problem: Simple Parameter/variable: Well known and easily manageable with the standard practices and procedures Needs: No need for special procedures or special resources
2 - Low medium	Problem: Complicated Parameter/variable: Manageable with the standard practices and procedures Needs: Analysis and internal coordination
3 - High medium	Problem: Complicated Parameter/variable: Exceed ordinary capacities of the organization Needs: Relying extraordinary resources and experts
4 - High	Problem: Complex Parameter/variable: Exceed largely ordinary capacities of the organization. High degree of uncertainty. Needs: Extraordinary resources and expertise. Innovation required.

Picture 14. Example of scale description table, in this case project complexity (Excel tool for PPM).

5.4 Data visualization

Without method to demonstrate project's contribution to deliver objectives of organization, there is risk that correct decisions in portfolio management process are jeopardized (Enoch 2015, 77). Access to facts enables right decisions instead of gut-based decisions (Carter K. 2014, 48). Visualization of portfolio data is one solution to support management with project portfolio decisions. Decisions are not made by visualization tools. Decision makers have to find relationships between projects and strategy. To support decision makers work visualizations of data should be simple and contain all relevant information (Carter K. 2014, 80 and da Silva et al. 2017, 686).

Some visualization methods working better than others. Bar and pie charts are easier for users than raw data tables. Raw data tables required more to find relationships between presented information. With well selected visualization, it is made easier for data users. (Carter K. 2014,80) Therefore in the PPM tool was decided to use colors in data collection table to highlight differences between projects. It was decided also to develop automatically generated executive summaries with preset charts.

Data table coloring was selected to present differences in project risks and highlight projects that possible are not aligned with the strategy. Risk level was highlighted with

“traffic light” colors. Projects with low risk were colored with green, medium risk with yellow and high risk with red. In strategic effect column it was selected to highlight projects that are not aligned with strategy with red color.

As described in the data integrity chapter, the values of these cells were selected from dropdown menus. This functionality enables automatic coloring. If cell content of cell would be free to define by user automatic coloring function would not be possible. From below screen shot can be seen an example of automatic coloring (picture 15). With utilizing colors it is enabled for decision makers quick overview. Projects with red color are requiring more attention than other projects.

PROJECT NAME	RISK RESOURCES	RISK SCHEDULE	RISK COSTS	RISK QUALITY	STRATEGIC EFFECT
Example A	1 - Low	1 - Low	1 - Low	1 - Low	Customer
Example B	2 - Medium	2 - Medium	2 - Medium	2 - Medium	Service
Example C	3 - High	3 - High	3 - High	3 - High	Product
Example D	1 - Low	2 - Medium	2 - Medium	2 - Medium	Product
Example E	1 - Low	1 - Low	2 - Medium	3 - High	Customer
Example F	3 - High	1 - Low	2 - Medium	1 - Low	Service
Example G	2 - Medium	3 - High	2 - Medium	2 - Medium	Customer
Example H	3 - High	2 - Medium	3 - High	2 - Medium	No strategic alignment
Example I	3 - High	2 - Medium	2 - Medium	1 - Low	No strategic alignment
Example J	2 - Medium	1 - Low	3 - High	2 - Medium	Service
Example K	1 - Low	2 - Medium	2 - Medium	3 - High	Customer
Example L	1 - Low	2 - Medium	1 - Low	3 - High	Product
Example M	2 - Medium	3 - High	3 - High	1 - Low	No strategic alignment

Picture 15. Example of automatic data table coloring based on cell value (Excel tool for PPM).

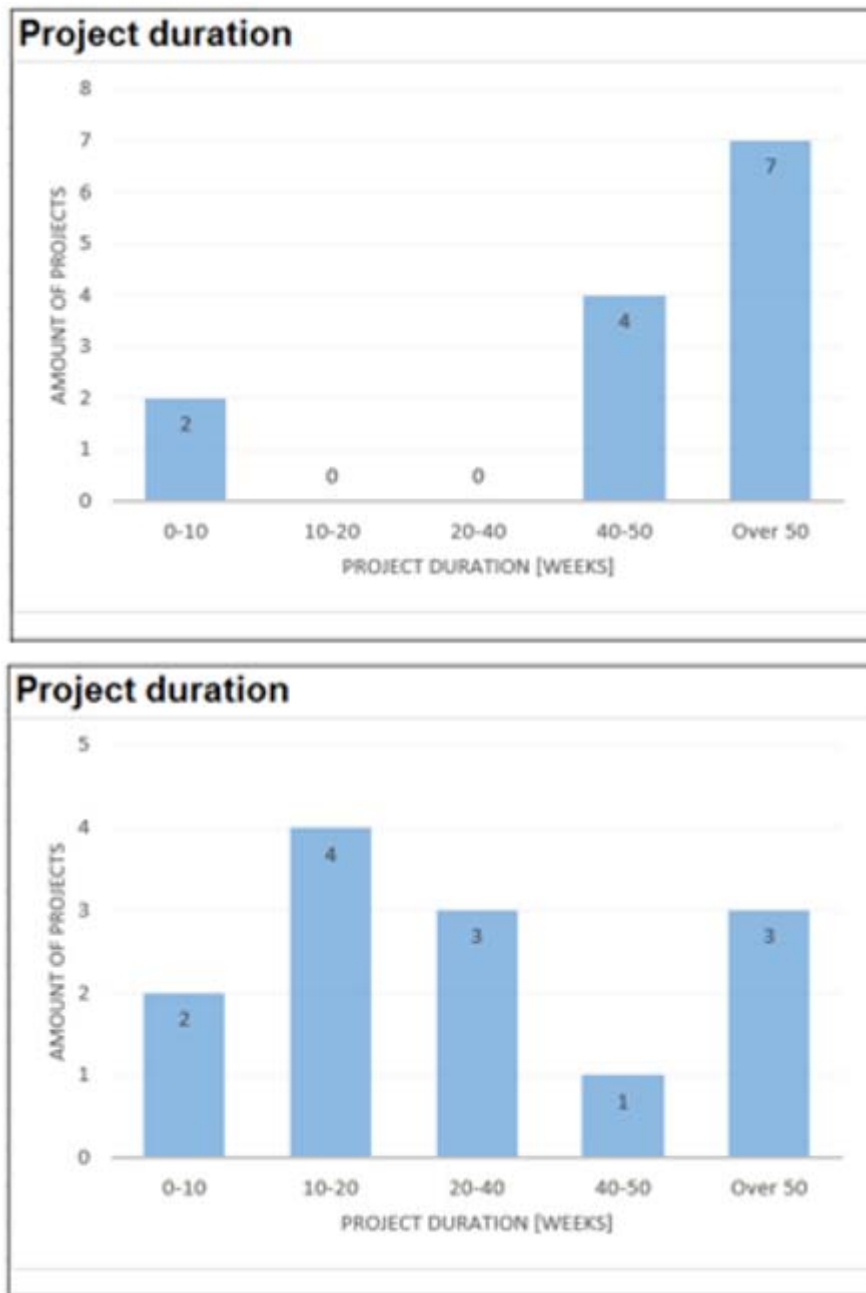
5.5 The executive summaries

Other automatic visualizations build-in to the project portfolio tool are executive summary sheets. In the development phase of the PPM tool it was selected to be present selected information in automatic generated charts. Decision was made to support project prioritization and selection work. Some of the charts based on existing charts, currently manually generated for the Product Board and the Product Council meetings, some were new and agreed during the PPM tool development work.

The executive summary charts are combination of column, pie and bubble charts. There are used highlight effects to emphasize differences between the projects. The charts are presenting different aspects of projects. The charts are planned to ensure balance of the portfolio, and to give management a quick overview of the status and healthiness of the portfolio.

Project size, duration, status and progress are presented with column chart. To ensure that data is always presented the same uniform way and to make a comparison of the portfolio development possible column charts have predefined X-axel values. The project size and the duration charts are selected to enable balancing the portfolio based on these parameters. The project status is used to increase the portfolio overall status transparency. With the project amount in different Promal phases is aimed to ensure that portfolio is healthy build and that there is right amount of the projects in each phase.

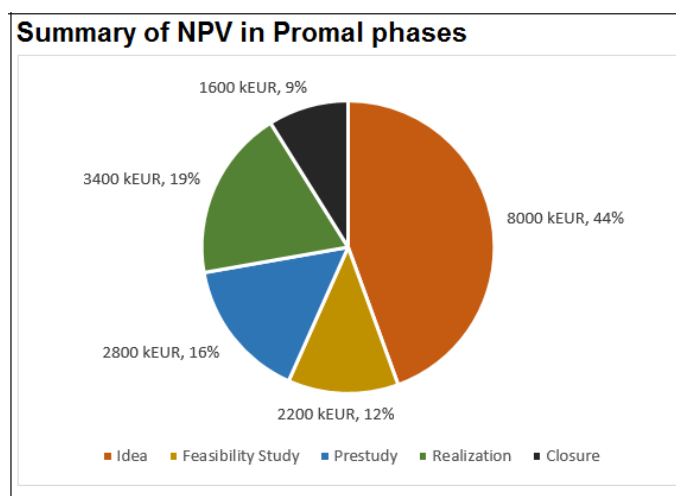
From the column charts can with one look received an overall picture if the distribution of projects is healthy or if the portfolio is unbalanced. See example of balanced and unbalanced portfolios below (picture 16). The first picture is an example of the unbalanced portfolio. There are no median duration projects, only short and long ones. The second example is presenting more balanced portfolio. When data is visualized with column charts it enables management to make needed decisions to balance the portfolio according to the strategy.



Picture 16. Example of unbalanced and balanced portfolio in regards of project duration. (Excel tool for PPM).

Other way to present data in executive summaries is pie charts. Summary of projects' NPV values in different Promal phases is presented with utilizing a pie chart method. Presenting these values in a pie chart gives management opportunity to see from the one graph if there is balance between NPV values in different Promal phases. For example in unhealthy situation there could be high sum of the NPV values in realization and closure phase, and minimum value in feasibility and prestudy. Previous presented

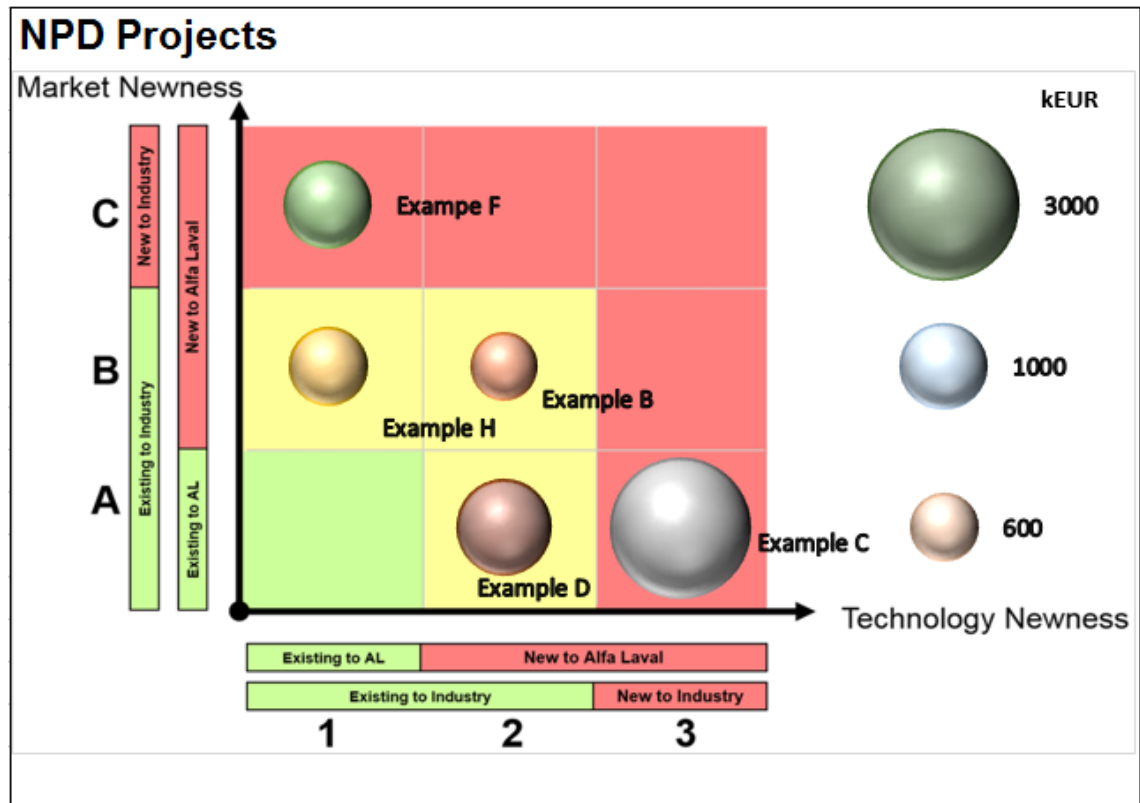
situation could lead to a situation that in the future portfolio can not support company's business growth. See below example of pie chart (picture 17).



Picture 17. Pie chart used to present summary projects NPV values in different Promal phases. (Excel tool for PPM).

From the NPD, EPD, Technology and Operations Development projects are presented the market and technology newness combined with the NPV values. A presentation method selected for this information are bubble charts, see picture 18. Each project type has the own chart. The similar way was used before development of the PPM tool. Before the tool the graphs were generated manually.

Vertical axis in the charts are presenting the projects market newness and horizontal axis the technology newness. The NPV value of the projects are presented with the bubble size. In the charts is presented automatically generated scale for the bubble sizes. In the scale the biggest bubble is presenting the highest single NPV value of the all portfolio projects. The middle bubble is the average NPV calculated from the all portfolio projects. The smallest bubble is the lowest single NPV value of all the projects. In the graphs are added predefined background graphic. Background graphic support easy usage of the graphs in visual presentations.



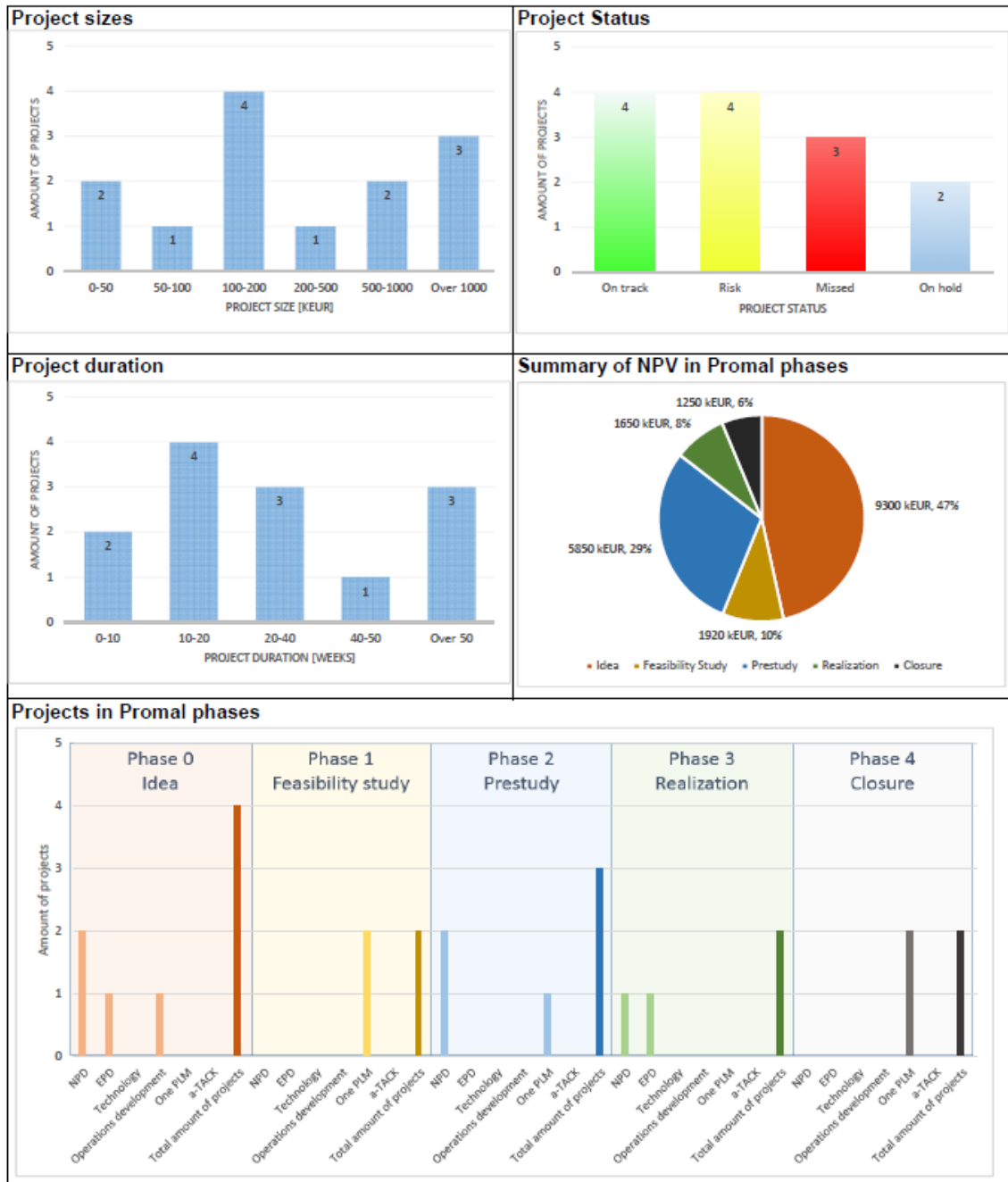
Picture 18. Example of Market-Technology Newness matrix and projects in it. (Excel tool for PPM).

Executive summary charts are listed with details in below table (table 3) and are screen shots of actual executive summary pages are shown in picture 19 and 20.

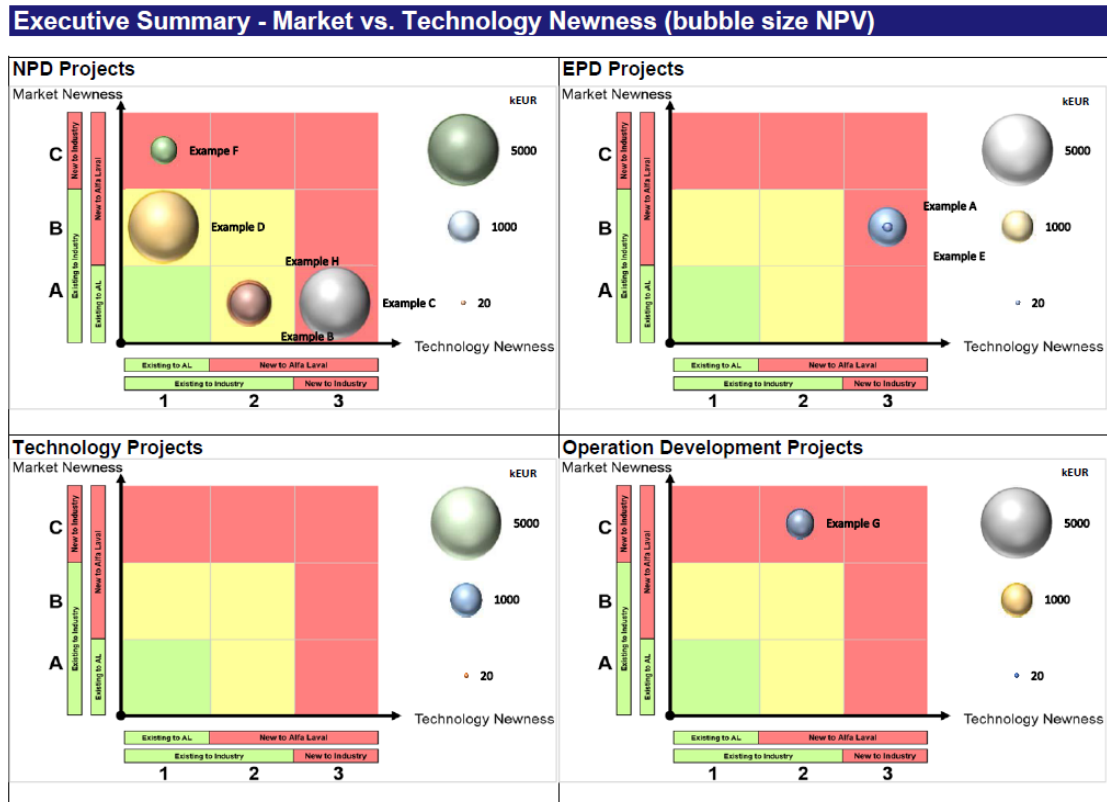
Table 3. Description of automatic charts presented in PPM Excel tool executive summary sheets (Excel tool for PPM).

Chart name		Chart type	Description	Object for chart
Project sizes		Column chart, predefined X-axel values	Chart presents amount of projects divided in size (total costs) categories	To enable project size-wise balanced portfolio
Project duration		Column chart, predefined X-axel values	Chart presents amount of projects divided in duration categories	To enable project duration-wise balanced portfolio
Project status		Column chart, predefined color coded X-axel values	Chart presents amount of projects divided in status categories Color coding: On track – green Risk – Yellow Missed – Red On hold - Blue	To enable transparency in project status and quick access to portfolio condition
Summary of NPV in Promal phases		Pie chart	Chart presents sum of NPV value of projects divided in project phases	To enable that projects in different phases are in balanced NPV-wise
Projects in Promal phases		Column chart, predefined color coded X-axel values, background graphics to separate X-axel parts	Chart presents amount of projects divided in type of projects and project phases	To ensure that projects in different phases are in balance and that portfolio is healthy
Market vs. Technology Newness –	NPD Projects	Bubble chart, background graphics with predefined Y- and X-axel values and descriptions, automatic bubble size example table	Chart presents how projects are located in market and technology newness matrix, same time projects NPV values are determining bubbles size	To ensure that projects are market and technology newness-wise balanced and give quick overview to see projects' expected effect to these factors
	EPD Projects			
	Technology Projects			
	Operations Development Projects			

Executive Summary



Picture 19. Executive summary page 1 (Excel tool for PPM).



Picture 20. Executive summary page 2 (Excel tool for PPM).

5.6 Project parameters: Project cost and project duration

Project cost and project duration were selected to be part of the portfolio tool parameters. These parameters represent project size. A health portfolio should contain a variety of different size projects. Therefore adding the project cost and duration in the PPM tool enable portfolio balancing based on these parameters. A well-balanced portfolio also decreases portfolio risk level.

With implementing project internal hours to be part of the portfolio tool it is made management possible to see in one view total number of estimated internal hours and utilize this information for better resource management.

Without having financial evaluation parameters available it is not possible to make a portfolio related decisions based on information. Otherwise decisions are made by

political reasons or gut feeling. To enable the data-driven approach in the portfolio tool was selected to present two of these attributes: Time to profit and NPV.

Time to profit in Alfa Laval is defined to be moment when project total costs are covered and earned once more (total costs x 2). Alfa Laval follows the standard calculation method for NPV, formula 1:

$$NPV = \sum_{t=0}^n \frac{Rt}{(1+i)^t}$$

R_t = net cash inflow-outflows during single period t

i = discount rate or return that could be earned in alternative investment (interest rate)

t = number of periods

Formula 1. NPV calculation (Kenton 2018).

In the other words, NPV is today's value of expected cash flow reduced with today's value of invested cash. Estimated interest rates are thus taken into account, and value of reflecting effect of estimated interest.

Presenting NPV values in the portfolio tool enable project prioritization. NPV value cannot be the only factor for it but typically it has high value in decision making. If NPV values are correctly calculated, it is a very effective tool for management.

5.7 Project parameters: Project risk and complexity

The Alfa Laval Promal model includes risk management tools and practices. From the Promal risk assessment tool was modified three level risk assessment scale for the portfolio tool. Four risk groups will be evaluated and results visualized in the tool. These groups are: Resources, schedule, costs and quality related risks. Detailed risk analysis and preventive actions will stay at project level. Visualization of risk levels in the portfolio tool will be used to balance risk levels throughout the portfolio.

As a starting point for the portfolio management tool complexity parameter was selected IPMA 2012 Managing Complexity. Complexity analysis was modified to fit for the portfolio tool purposes. Since many of the project managers in BPDM doesn't have the deep knowhow of project complexity theories, primary conditions for parameter development were to develop simple and unambiguous way to evaluate complexity of projects. It was decided that the complexity will be evaluated with using four step scale and three different aspects will be evaluated: Problem, parameter/variable and needs. These are shown below in table 4.

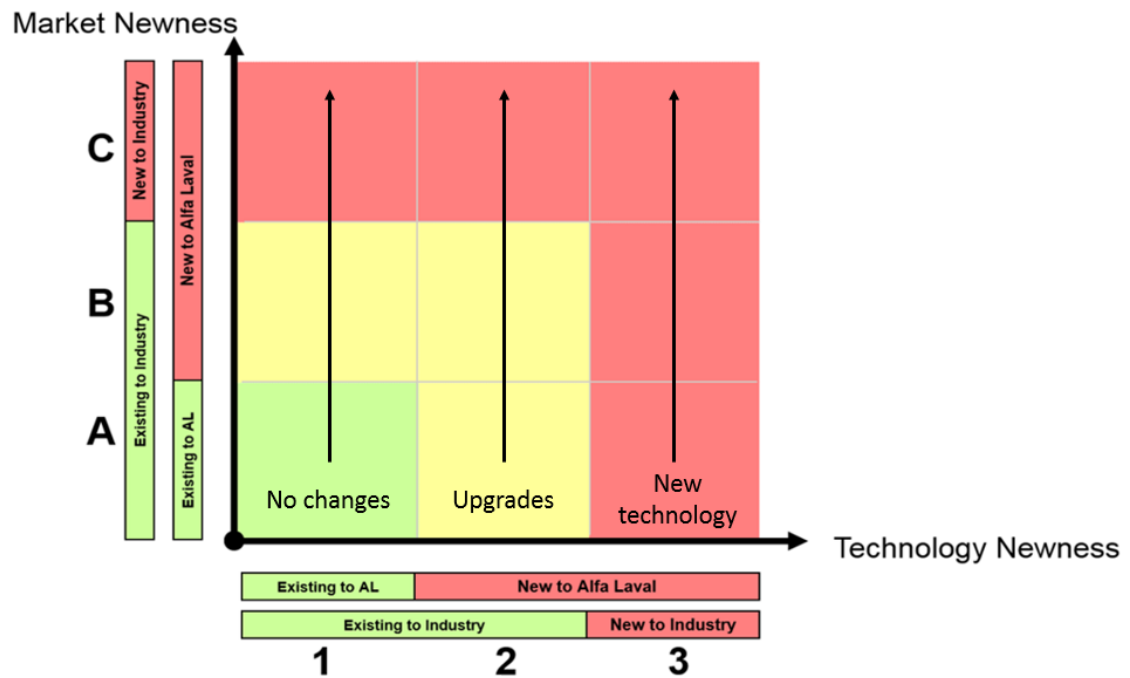
Table 4. Project complexity parameter evaluation table (the portfolio tool, modified from IPMA 2012 Managing Complexity).

Complexity	Description of criteria
1 – Low	Problem: Simple Parameter/variable: Well known and easily manageable with the standard practices and procedures Needs: No need for special procedures or special resources
2 – Low medium	Problem: Complicated Parameter/variable: Manageable with the standard practices and procedures Needs: Analysis and internal coordination
3 – High medium	Problem: Complicated Parameter/variable: Exceed ordinary capacities of the organization Needs: Relying extraordinary resources and experts
4 - High	Problem: Complex Parameter/variable: Exceed largely ordinary capacities of the organization. High degree of uncertainty. Needs: Extraordinary resources and expertise. Innovation.

5.8 Project paramaters: Technology and market newness

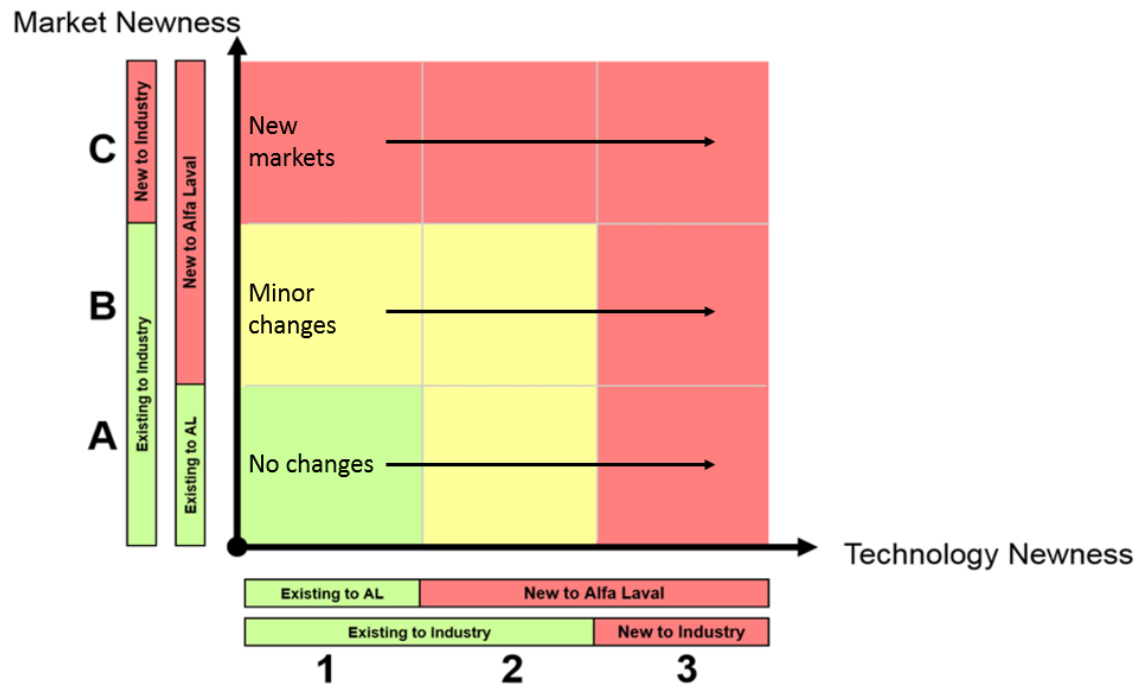
In Alfa Laval Aalborg portfolio management technology newness evaluation is used for determining how projects are allocated in the field of R&D. In the portfolio tool, evaluation is done in three level categorization: No changes, upgrades and new technology. No changes can be considered being outside of R&D. Upgrades is representing development and new technology represent research. Making differences between two last mentioned is hard and based on user's opinions.

Product Development Institute was used as source for the categories. If the project doesn't bring any changes to technology, it will be categorized "No changes". If the present product is made more useful, category will be "Upgrades". Final category "New technology" contain projects which develop product with a new technology. In the portfolio tool executive summary results are shown in a matrix, where technology newness is located in horizontal axis (picture 21).



Picture 21. Technology Newness classes in Market Newness – Technology Newness matrix (Excel tool for PPM).

Market newness evaluation in BPDM, like technology newness, is based also to three levels: No changes, minor changes and new markets. Product Development Institute was also source for the market newness categorization. Category "No changes" represent projects which have no changes to the market. If project widen the line of products offered to present customers, it belongs to category "Minor changes". Projects extending sales to types of customers not presently served are under category "New markets". Market newness is presented in the same matrix with technology newness in the vertical axis, see picture 22.



Picture 22. Market Newness classes in Market Newness – Technology Newness matrix (Excel tool for PPM).

When projects in BPDM are executed in multi-project environment, where projects are competing to the same resources, the importance of resource planning is emphasized. Same time requirements are increased for personnel. Capability to work effectively in product development and management projects is needed, also technical and product knowhow is required. There should be also time for developing skills and follow the newest technical development. Both aspects increase challenges with BPDM resource planning.

6 CONCLUSION

6.1 PPM in the future at Alfa Laval BPDM

In theory Alfa Laval Aalborg BPDM has adopted the project portfolio management in middle or in high level in the many aspects. There are the frequent PPM meetings in place, the project progress is followed and the project management processes are well defined and documented. It can be said that the processes and practices are in place, but those are not fully followed by whole organization.

For example, basic documents which are defined in the project management processes are not available in many of the active projects. Good example are the project plans. During information collection project plans were not found from the most of projects

Positive is that there are recognized by management need to development both the project management and also the project portfolio management. Recently there has been nominated more resources for these tasks. When the resources and the tools are available there are good opportunity to improve PPM processes and enable successful execution.

During the thesis work findings were collected. Based on these findings, it can be recommended that PPM implementation should be continued deeper than implementing the project portfolio tool. Based on studies there can be expected significant positive effects for both project and project portfolio management results. Below is listed recommended actions to ensure that the PPM processes can be implemented effectively.

To enable the project management quality getting better it is important that available resources for the PM work are ensured. Therefore management should ensure that there are needed resources available and that those resources has needed knowhow.

Based on most of the basic studies of the PPM, clear strategy is mentioned as one of the keys for success. Management should ensure that strategy is clear and that it is communicated clearly to the organization. Management is in important role also to implementation of the PPM processes. If there is in management level lack of information regarding PPM and benefits of it, there is risk that PPM will not be utilized correctly.

Management knowhow towards the PPM and opportunities that effective PPM can bring should be increased to ensure management commitment.

Data quality in PPM tool can be ensured only by people filling it to the tool. And they can only fill information available in project files. Everyone working with projects, especially project managers, should be trained to analyse projects correctly to enable data quality in the PPM processes. There should be defined clear roles and responsibilities in the project management, especially with financially aspects. With this action could be ensured that each project is planned and executed correctly.

Utilization of PPM tools effectively would require that everyone working with PPM has been trained to use those tools. As it was said earlier implementing commercial PPM software before other aspects of PPM development has been taken into account should be avoided to get best benefits from expensive implementation.

As general recommendation to improve the project management and the project portfolio management excellence can be said that:

- Implementation of the IPMA complexity assessment to the projects would improve understanding of complexity and connections between and in projects
- Ensuring that the project evaluations are done each gate in the Promal process would improve project's quality and thus effect better results and effective usage of resources
- Prioritization of the projects, including freezing or stopping projects, should be strengthened to avoid unhealthy portfolio and especially ensure that limited project resources are guided to work with the correct projects
- The project managers should have more focus on the project management and not to have other parallel operational tasks. This would improve project managers possibilities to run projects effectively and raise the quality of project execution.
- Strategic resources should be able to concentrate to limited number of projects at a time, in optimum case only to a single project, to ensure that selected projects can be executed most effectively and results of development work could be taken into sales.

6.2 Conclusions about thesis

Thesis was successfully executed. The PPM tool was delivered within schedule and it has been already implemented as part of daily work in BPDM. Tool was tested and after launching some updates has been already implemented. Implementation and updates were defined not to be part of this thesis and therefore those are not described in this document.

Thesis also served well of learning purposes. Since work consist of theory part and practical execution all details learn in theory were possible immediately be tested in real life. Although it is a bit too early to say how building and implementing the PPM tool will effect to PPM effectivity. Important part of that is still organization capability to see benefits and really implement all tools as part of daily work.

It seems that the company and most important key users of the PPM tool are happy for tge results. What could have been done more would be sharing information and training more people about PPM, but this was not possible due limited schedule. Greatest learning for thesis writer was to get support from theory to own thoughts. It is in the future easier to defend own views when getting support to those from theory. Altogether topic of work was well selected and execution of it supported all parties goals.

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Project evaluation attributes table

Project attribute	Data filling method	Data source	Description	Utilization of attribute
Project name	Free text	Project plan	Project name as in project plan	
Project No	Free test	Project plan	Project number as in project plan	
Reviewed last	Week/Year		Week when project last time reviewed and data updated in PPM Excel	To ensure data quality (newness) in decision making.
Project status	Dropdown menu	Project manager	Values are presenting projects progress compared to project plan. Values are: On track, Risk, Missed and On hold	To get overview of portfolio status. Values used in visualization.
Promal phase	Dropdown menu	Project manager	Values are presenting projects stage in Promal project model. Values are: Idea, Feasibility study, Prestudy, Realization and Closure	To get overview of portfolio balance based on projects' phases in process. Values used in visualization.
Type of project	Dropdown menu	Project plan	Values are presenting projects type. Values are: Strategic, Change, Development and Customer order	To enable portfolio balance based on projects' types. Values used in visualization.
Program	Dropdown menu	Project plan	Values are presenting which program projects are located. Values are: NPD, EPD, Technology and Operations Development Other values added when new programs started	To get overview of portfolio balance based on program sizes. Values used in visualization.

(continue)

Project attribute	Data filling method	Data source	Description	Utilization of attribute
Costs	Value in 1000 EUR	CBA	Total project costs from CBA	To enable portfolio balance based on projects' sizes (costs). Values used in visualization.
Internal hours	Value	Project plan	Amount of internal hours from project plan	To enable portfolio balance based on projects' internal hours (costs). Values used in visualization.
Start	Week/Year		Week when project last started	
Duration	Weeks	Project plan	Estimated project duration, including phases from beginning of feasibility study to end of realization	
Time to profit	Years	CBA	Years for project start when profit generation starts	To enable prioritization of projects based on each project time to profit.
Complexity	Dropdown menu Predefined values	Project manager	Predefined values, described in sheet Scale description. Scale is: Low, Low medium, High medium and High	To enable portfolio balance based on projects' complexity.
NPV 10Y	Value in 1000 EUR	CBA	NPV value from CBA	To enable prioritization of projects based on each project NPV. Values used in visualization.
Risks Resources, Schedul, Costs, Quality	Dropdown menu Predefined values	Project manager	Predefined values, described in sheet Scale description. Scale is: Low, Medium and High	To get overview of portfolio balance based on projects' risks.

(continue)

Project attribute	Data filling method	Data source	Description	Utilization of attribute
Market Newness	Dropdown menu Predefined values	Project manager	Predefined values, described in sheet Scale description. Scale is: No changes, Minor changes and New markets	To enable prioritization of projects based on each project market newness. Values used in visualization.
Technology Newness	Dropdown menu Predefined values	Project manager	Predefined values, described in sheet Scale description. Scale is: No changes, Upgrades and New technology	To enable prioritization of projects based on each project technology newness. Values used in visualization.
Key resources 1-3	Free text	Project plan	List of projects strategic resources	To get overview of utilization of key (strategic resources).

