Optimization of IT-Project Portfolio Management: Analysis and Software Development

Masterarbeit

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1 Introduction and Motivation

Worldwide, expenditures in Information Technology (IT) have increased in the recent years and have become a significant part of the total organizational budget spending.[2] According to Gartner, the global IT-spending in 2018 was estimated to be 3.65 billion U.S. Dollars.[3] Future projections even show that the amount still is increasing.[4]

Thus, the IT of an organization has become a critical success factor and therefore significantly influences the organizational long term performance and competitiveness.[5] Hence, the selection- and management process of single IT-projects in order to build a portfolio is of high importance.[6] So the decision nowadays is not whether or not to invest in IT-projects, it is rather about to identify those IT-projects that together contribute most to the organization's objectives.[7]

However, IT-projects often are analyzed individually instead of as a combination within a portfolio.[8] In this context, IT-project portfolio management (PPM) ensures that each selected IT-project within the portfolio contributes to the organizational objective while considering inter alia resource limitations, dependencies, risks and economic efficiency.[9] So it is the dynamic decision process where a set of IT-projects is permanently updated and evaluated.[10] Due to a limited IT-budget this selection process of various potential IT-projects is of great importance.[11] Still, the availability or usage of tools in order to standardize and ease this selection process is only low.[12]

As there exists only relatively few studies on the topic of IT-project portfolio management[13] and additionally it increases in importance and interest, there is the need to expand the research. Therefore, this thesis deals with the selection, prioritization and scheduling of IT-projects within a portfolio and provides a better insight in the PPM. Further, as tool-based decision support systems (DSS) have increased in importance, are more reliable, and automize the decision process, a MATLAB tool development is introduced. With help of this tool it is possible to calculate a score in order to evaluate the single IT-projects and to prioritize and select IT-projects into the portfolio. Thus, decisions about scarce resources can be made and the optimal

[2] Cf. Oh, Ng, and Teo (2007, p. 1266) / Cho and Shaw (2013, p. 739)
[3] Cf. Costello and Omale (2019)
[4] Cf. Gartner (2017) / Costello and Omale (2019)
[5] Cf. Wiener and Denk (2012, p. 43) / Cho and Shaw (2013, p. 739) / Maruping, Venkatesh, Thong, and Zhang (2019, p. 121)
[6] Cf. Cho and Shaw (2013, p. 739)
[7] Cf. Kesten, Müller, and Schröder (2013, p. 10)
[8] Cf. Jiang and Klein (2014, p. 14)
[9] Cf. Benaij Khadija and Kjiri (p. 134) / Cho and Shaw (2013, p. 739)
[10] Cf. Cooper, Edgett, and Kleinschmidt (1997, p. 24)
[11] Cf. Cho and Shaw (2013, p. 739)
[12] Cf. Seider (2006, p. 43)
[13] Cf. Cho and Shaw (2013, p. 739)

schedule considering different constraints is determined. Therefore, the central research issues discussed in this thesis are

- How to calculate the total score of an IT-project?
- Which IT-projects should be selected and when is the optimal starting point in order to optimize the whole value of an IT-project portfolio?
- Is a MATLAB tool development suitable for a useful decision support system for the IT-project portfolio management?

To answer these research questions this thesis is structured as follows. In Chapter 2, the terms IT-project and PPM are explained. Furthermore, resulting challenges are introduced and different optimization methods described. In addition, different aspects for the IT-project portfolio management process are introduced. In this context, a general framework as well as a concrete model for the process of IT-project portfolio selection, prioritization and scheduling are explained. Thereafter, the economic efficiency with its benefit- and cost analysis as well as the risk management are exemplary introduced as two criteria influencing the selection and prioritization process. In order to analyze the status quo of the existing literature, identify relevant papers and to answer the research questions, the Literature Review Methodology of Webster and Watson is then applied. Based heron follows the structured expert interviews in Chapter 3. Here, the applied selection based on Mayring takes place and findings are presented as well as discussed. In Chapter 4 a tool is developed. Therefore, a validation and extension of an already introduced model takes place, the main criteria for software quality are explained followed by the description of the software design and implementation as well as a user guide. Afterwards, an example for the use of the tool is given and the results of the performance analysis are shown. In the final Chapters, findings are discussed, recommendations given, and limitations shown. The thesis ends with a conclusion and an outlook for further research.

2 Literature Review and Status Quo Analysis

2.1 Definition IT-Project

The implementation of different projects seems to be inevitable for every organization[14] as an early reaction to chances and risks and tasks are possible to be managed efficiently.[15] According to the Project Management Body of Knowledge (PMBOK) a project is a "temporary endeavor undertaken to create a unique product, service, or result."[16] However, there are several different

[14] Cf. Lomnitz (2004, p. 11)
[15] Cf. Schelle and Ottmann (2014, p. 22)
[16] Cf. Project Management Institute (2008, p. 5)

was spent on the usability of the tool. What would improve the tool's software quality is the compatibility as well as the portability.
The large majority of the experts that were interviewed works in organizations that do not use a tool for IT-project prioritization. This is on the one hand rooted in the fact that it is hard to find a tool which fulfills all the criteria an organization requires. On the other hand, tools often have large initial hurdles. In order for the algorithms to work, before using the tool first many input data and criteria are required. Further, whenever a new IT-project is added to the selection and prioritization process, data about its need for resources as well as the evaluation of the criteria to calculate the score needs to be made. As long as there is no solution to facilitate this process, the initial hurdles for an organization might be too high and it consequently decides against the implementation of a tool and for an already established solution, which mostly is Excel. This fact leads to another limitation of this paper. Since MATLAB is not very common in use, there is a further initial hurdle to take when needing an expert that is able to work with this software and when buying a license.
All in all, this thesis and the developed tool are mostly limited by their generality. If the tool would be designed for a certain organization with its IT-project portfolio, some of the limitations would not exist anymore. However, some aspects can be improved by further research.
This includes inter alia the enhancement of the implemented source code. Thus, computing time could be saved and the execution of an optimization with 1,000 IT-projects or more would require much less time.

7 Final Remarks

7.1 Conclusions

In the course of this thesis, different research questions were examined. The first question aimed to the IT-project's evaluation about how to calculate the total score of an IT-project. Further, it was analyzed which IT-projects should be selected and when the optimal starting point in order to optimize the whole value of an IT-project portfolio is. Moreover, it was examined whether a MATLAB tool development is suitable for a useful decision support system for the IT-project portfolio management. To examine and answer the research questions, the fundamentals were defined at the beginning of this thesis. In this context, the most important concepts regarding IT-project portfolio management were as well explained as its challenges. Further, different optimization methods, a framework for project portfolio management, the Zero-One Integer Model, and some criteria for IT-project evaluation were introduced. The second Chapter ended with a literature review after Webster and Watson. This was followed by the description and the analysis of the expert interviews that were used as a basis for the model development, which

was then explained in Chapter four. To show how the model can be used in practice some examples were introduced and a performance analysis done.
PPM has taken a central part and its role as a DSS is valuable for the management to achieve the organizational objectives and to create a sustainable competitiveness. Organizations establish a PPM in order to identify the most valuable IT-projects that optimize the portfolio and decide which should be excluded. Especially in times of increasing number of IT-projects, PPM is a challenging and very complex task. An efficient PPM can therefore lead to significant advantages for an organization and can decrease the number of cancelled IT-projects significantly. However, there is the need to consider several different criteria and restrictions for the prioritization and selection process. In this thesis, this process was conducted based on the Zero-One Integer model by Ghasemzadeh, Archer and Iyogun (1996). To provide a more practical view on this topic, expert interviews were conducted. With the expert's help the initial model could be validated and expanded. The process of IT-project prioritization is very different in each of the experts' organizations since the organizations are different in size and in the sector they are set in. However, each expert told about criteria that are used in order to evaluate single IT-projects. Depending on the organization, some criteria are more important than others. This is why, the selected binary model was expanded by a scoring model in order to increase objectivity in this process. The score describes the IT-project's value considering factors like strategy, operational urgency, economic efficiency, risk, and complexity. Scores in each category and their relative importance are than the basis for an overall IT-project's score. However, it can be stated that even though subjectivity is decreased with this process, it could not be eliminated completely. Thus, the prioritization can still be influenced by the decision maker. Further, there are many IT-projects that do not require an evaluation regarding these criteria since they are must projects that need to be executed due to regulatory or operational reasons.
The whole model including the scoring model was then implemented in a MATLAB tool. Hence, it can be seen how the model works under different circumstances. Thereby, it was possible to optimize different underlying portfolios with different number of IT-projects, periods and constraints. The output shows which IT-projects should be selected into the portfolio and their optimal starting period. It could be seen that the performance of the tool is depending on the input made and the underlying device with its specifications. The RAM of both computers thereby hardly is affected of the optimization. However, with an increasing number of IT-projects, the time to find an optimal portfolio composition increases for both computers, however different in the value. In general, it is true that the higher the resources are limited and the more constraints existing, the higher is also the time until a solution is found. With in increase in the number of planning periods the required time decreases again. Differences could also be seen in the resource load, processor performance and the usage of the cores and threads. Even though the use of the cores and threads were very different between the devices, they were nearly equally distributed for one computer on one scenario. This implies that MATLAB is able for parallel processing. All in all, MATLAB tool is a suitable DSS for the IT-project portfolio

management. However, the tool's output rather serves as decision support than a final portfolio composition.
Summing up, PPM is a very complex process not be underestimated by organizations. Thereby, existing literature mostly provides a more theoretical approach. This thesis shows how the theoretical model can be applied and thus, provides more practical insights. Nevertheless, the tool development should be expanded by adding some constraints and by testing the tool in a real business environment as a following step.

7.2 Outlook

Even though this thesis provides a good and practical approach for IT-project portfolio management, it should be expanded by further research and inputs. Thus, some constraint can be added to improve the optimization process. If for example a certain IT-project has a low score and only a small benefit it may nevertheless make sense to execute the IT-project, if it is a predecessor project for an IT-project with a high score. Therefore, the IT-projects' relation of predecessor and successor needs to be expanded. Further, a distinction between different kind of employees that work in the IT-project can be made. In this thesis the human resource restriction that can be made in the model, only includes human resources in general but does not consider that there are usually different kind of resources with different importance, knowledge, and capacities working in an IT-project. Thus, distinguishing between these different kinds would make the model more precise and realistic.
Further, the tool implementation could be expanded by an ex ante control of the steered values. Thus, the future measurement of efficiency, compliance of the budget and the objective's achievement could be controlled after the IT-project is finished in order to evaluate whether the made assumptions can be held and whether the cost frame was exceeded. Like this, not only the IT-project itself but also the ex ante situation in comparison to the ex post situation can be evaluated and important insights for further IT-projects gained.
Further, a new restriction can be introduced to reduce the complexity of the whole portfolio. Thus, some predefined large and important IT-projects should not be conducted in the same period to prevent an excessive demand of the employees. Another extension of the model is the implementation of a capability map into the tool. Thus, not only the organization's strategy as a whole is considered but rather different parts of the strategy that need to be fulfilled in order to achieve general strategic objectives. Therefore, the certain capabilities are evaluated regarding their needs. Capabilities that are not covered by an IT-project thus do get a higher prioritization. All in all, the implemented tool already gives first insights for a tool-based DSS. However, there are still aspects that should be further considered and expanded in future research.