Optimal IT Project Selection – Quantification of Critical Scoring Criteria

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Abstract: The management of IT project portfolios is challenging because of IT projects' complexity, dynamics, unknowns, and uncertainties. IT projects account for a large IT budget proportion and significantly influence value contribution, strategic development, goal achievements, and competitive advantages. Many IT projects still fail, exceed time and resources, and do not reach their planned goals because of wrong decisions, unsatisfactory evaluation, and missing selection criteria. Thus, a continuous IT project scoring and selection is crucial to enable an optimal portfolio composition. We conduct a systematic literature review and 14 semi-structured qualitative expert interviews to develop a uniform and holistic scoring approach. Our findings show that IT projects' urgency, strategy, efficiency, risk, and complexity are critical IT project scoring criteria. Our scoring approach increases objectivity and quality in evaluating planned and running IT projects and allows more convincing and transparent decisions.

Keywords: Information Technology (IT) Projects, IT Project Portfolio Management (ITPPM), IT Project Evaluation, Scoring Model, Scoring Criteria

1 Introduction

Expenditures in Information Technology (IT) projects rapidly increased worldwide, and the amount is expected to rise further [Ga20]. The IT of a company or an organization is of high importance and a critical success factor and thus influences long-term performances [CS13, Ma19]. It is crucial to permanently select and manage the "right" IT projects to build an optimal IT project portfolio, achieve goals, create value, be innovative, and stay competitive because IT projects account for a large proportion of IT budgets. So the decision nowadays is not whether or not to invest in IT projects but to identify those that together contribute most to the operational and strategic goals [CS13]. Thereby, all IT project proposals share and compete for the same scarce resources and are carried out under the same management [AG99, LRS20, PMI13]. In this context, we define IT project portfolio management (ITPPM) as a continuous and dynamic process in which IT project proposals are collected and together with ongoing IT projects (re-)scored, (re-)prioritized, (re-)selected, and (re-)scheduled considering different constraints, interdependencies, resource limitations, and stakeholder interests [CEK99, Ke11, ML07, PMT15].

IT projects are challenging to manage because of their cross-functionality, dynamics, non-routine, temporary, and complex nature with resulting unknowns and uncertainties. A selection of IT projects is further connected with many difficulties, as both qualitative and quantitative factors must be considered [ANJ10]. Various IT projects fail and do not reach

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their planned goals because of wrong evaluation and selection criteria and decisions [VT16]. Instead, decisions often are based on subjective influences, personal perceptions, and experiences as there often exist no uniform evaluation and selection criteria and methods. There is the need to accurately define IT project evaluation criteria as those decisively influence the scoring and selection, enable transparent decisions, and support decision-makers [BR00]. We therefore develop a uniform and holistic scoring approach with relevant selection criteria especially for IT projects. It differs from already existing ones as it does not only rely on IT related theoretical foundations, but also takes practical expert knowledge from various IT project managers of several industries into account. We further introduce an exemplary scoring scale besides critical scoring criteria. The holistic scoring approach increases objectivity and quality in scoring, the evaluation of both IT project proposals and running IT projects, and enables uniform scores and criteria. First, we provide the theoretical background for an ITPPM cycle and IT project selection and scheduling methods. Next, we describe our research design and how we conducted our literature review and expert interviews to identify critical IT project scoring criteria. Afterward, we present our findings, develop a scoring model with an exemplary scale, and shortly introduce an optimization model to support the ITPPM decision process. Finally, we discuss our results, their implications, and outline conclusions.

2 Theoretical Background

Each ITPPM cycle is possible to divide into different stages. In a first pre-screening stage, promising IT projects from various departments are identified as well as "must" IT projects defined. After that, each IT project proposal is evaluated individually according to pre-set criteria in the stages of individual IT project analysis and screening. Also, first IT project proposals that do not fulfill knockout criteria are rejected. Next, in the stage of optimal IT portfolio selection, the most valuable IT projects that suit the selection criteria best are selected and scheduled within the planning periods. There is the possibility to readjust the IT project portfolio in the last stage, in case of internal or external changes [AG99]. When following these stages, IT projects are more likely to gain their goals and be successful, as they prevent an IT project's overload [BU12]. However, this process is challenging because of dynamics, complexities, uncertainties, unknowns, synergies, and contradicting criteria [MMM19, Zh17].

Project portfolio selection and scheduling (PPSS) is a mainstream in the project portfolio management literature. It is about whether or not to implement project groups or single projects to build a project portfolio to obtain goals [MSS17]. PPSS aims to quantify the "right" projects taking into account various interdependencies, limitations, and constraints and schedules them within a distinct planning horizon [CN13, ZHT19]. There exist different financial and non-financial PPSS approaches and methods. In general, these include single criterion analysis, scoring models, and optimization models. For the latter, it is possible to differentiate between integer linear programming, multi-criteria selection, fuzzy programming, mixed-integer linear programming, multi-objective programming, non-linear programming, and stochastic programming. Mohagheghi et al. [MMM19] and Zhang et al. [Zh17] summarize and give an overview of such approaches. However, there is the need to properly define selection criteria as they profoundly influence the scoring and selection results, irrespective of the method applied.

3 Research Method

In a first step, we performed a systematic literature review to get an overview of relevant ITPPM, scoring, and selection literature [BR15, TP15, WW02]. We searched for combinations of IT, project portfolio management, selection criteria, and scoring in the journals included in the Association for Information Systems Senior Scholars Basket of Eight, Project Management Journal, International Journal of Project Management, and Science Direct. We looked manually through the articles' references for additional relevant literature after we identified the key literature. We then used Google Scholar for a forward and author search to find further articles that cite the key articles and for a similarity search.

In a second step, we conducted explorative expert interviews to gain insights into practical IT project portfolio evaluation and selection and to identify common criteria used in practice. It enables a comparison with criteria used in literature to identify similar ones or potential differences. We conducted 14 semi-structured and guideline-oriented interviews between May and June 2019. Tab. 1 gives an overview of the experts, the industries, and their positions.

Interview	**Industry**	**Position**
INT.1	Insurance	Strategic IT project portfolio steering
INT.2	Paper factory	Head of IT Application Department and Head of IT Business Department
INT.3	Consulting	Member of the IT project management team/ IT manager
INT.4	Automotive	IT project manager
INT.5	Automotive	Member of the IT project management team
INT.6	Banking	Member of the IT project management team
INT.7	Paper factory	Leader and member in several IT Projects
INT.8	Consulting	Member in several IT projects
INT.9	Energy supplier	Member of the IT project management team
INT.10	Software manufacturer	Global HR IT project portfolio planning
INT.11	Insurance	Senior IT project manager
INT.12	Insurance	IT project portfolio manager
INT.13	Energy supplier	IT project portfolio manager
INT.14	Consulting	Consultant in several IT projects

Tab. 1: Overview of the Experts Interviewed

To ensure generalizability, the interviewed experts work in various sectors and positions with different tasks, but all have in common their strong involvement in the ITPPM decision process. One expert works in software development, four experts in the banking and insurance sector, and two experts each work in the paper industry, in the automotive industry, in consulting companies, and in energy supplier companies. We carried out a pretest before we conducted the interviews to validate our interview guideline [JW10]. Next, we sent the interview guide and an explanation about the interview's setting and purpose

to each expert. Dependent on the expert's location, four interviews took place in person and the remaining ten by telephone. The interview lasted on average 60 minutes, and we documented them by transcripts. We analyzed the transcripts using an inductive qualitative content analysis according to Mayring [Ma14] supported by the software MAXQDA 18. By paraphrasing the experts' answers, we analyzed the interviews. During this process, we summarized the encoding units into a concise, language-unified form and deleted non-relevant phrases. Based on similar paraphrases, we defined generalized categories and assigned anchor rules. We then assigned relevant paraphrases of each interview to them. This resulted in a detailed overview of all expert statements regarding different categories, which then in a next step allowed a structured analysis of the interviews' insights.

4 Results

4.1 Literature Review

Based on our literature review, we were able to identify often considered IT project evaluation and selection criteria. We categorized them on the basis of the most important literature concerning this topic into seven categories: complexity, efficiency, interdependencies, resource limitations, risk, strategy, and urgency, see Tab. 2. Where possible, we divided the categories again. However, some literature only named or referred to evaluation criteria without neither a proper definition of the criteria nor their characteristics or examples. We included these in the category "General" in the table. All listed (sub-)criteria have been mentioned multiple times in literature; single mentioned ones were omitted. Criteria are ordered alphabetically and do not reflect the importance.

An IT project's complexity is one extracted criteria from literature. It involves evaluations of how many changes occur with an IT project proposal's implementation and describes the resulting degree of changes. Another evaluation criterion is an IT project's efficiency. It mainly encompasses cost and/or benefit analyses, growth rates, and economic returns, like for example Net Present Value and Return on Investment. Underlying interdependencies between single IT projects are also important to consider. Time interdependencies occur if one or more IT projects have to be finished before another one can start, as they are required as an input. Mutual exclusiveness exits if an inclusion of one or several IT projects directly leads to the exclusion of other IT projects. Synergies reflect an IT project's either positive or negative influence on other IT projects. Also important to consider are existing resource constraints. These include a restricted availability of monetary and human resources. An IT project's risk evaluation is a further widely used criterion in literature, however, often without a specification what exactly needs to be regarded. Still, there is a general agreement that it is crucial to balance the risk within the whole portfolio to avoid the inclusion of too many risky IT projects that could weaken results. Often used evaluation criteria are the existing experience of project team members and a risk's probability of occurrence with its resulting consequences. The listed strategy criterion includes analyses of whether an IT project's implementation influences a company's or an organization's competitive advantages and whether it suits the strategic alignment and supports goals. The often named urgency criterion involves on the one hand an IT project's implementation need to replace existing systems to keep the daily business running and on the

other to conform with regulatory requirements.

Despite our identified critical criteria, an identification and categorization of all crucial evaluation and selection criteria is almost impossible because criteria are different between companies and organizations and rely on their environment [MMM19].

Criteria	Sub-Criteria	Source
Complexity	Degree of complexity	[JK99, SC19]
	General	[CZL09, CN13, CS13]
	Number of changes	[CN13, Se16, SS02]
Efficiency	Cost and/or benefit analysis	[AG99, ANJ10, Ba92, BS04, Ch02, CN13, CS13, JK99, LL08, SK95, SS02, Wi92]
	Economic returns	[AG99, CN13, IL02, JK99, LL08, Re05, RO08, Wi92, Zh17]
	Growth rate	[JK99, SS02]
Interdependencies	General	[CN13, SC19, SK95]
	Mutual exclusiveness	[AG99, CN13, Re05]
	Synergies	[CN13, CS13]
	Time-dependencies	[AG99, BS04, Re05]
Resource Limitations	General	[ANJ10, SK95]
	Human Resources	[AG99, Ch02, Ch20, CN13, JK99, Re05]
	Monetary	[AG99, CN13, Re05, RO08, SC19, Wi92]
Risk	Available experience	[Ch20, CZL09, CN13, Re05]
	General	[AG09, ANJ10, CS13, IL02, LL08, Re05, SK95, Zh17]
	Probability of occurrence and consequences	[AG99, Ba92, CZL09, CN13]
Strategy	Competitive advantages	[AG99, Ch02, IL02, JK99, SS02, Wi92]
	Increase in market share	[LL08, IL02]
	Strategic alignment/goals	[AG99, ANJ10, Ba92, Ch02, CN13, JK99, Re05, SC19, SS02,Wi92, Zh17]
Urgency	Need for daily business	[JK99, Wi92]
	Need for renewal	[Ba92, JK99]
	Regulatory requirements	[JK99, RO08]

Tab. 2: Overview of Commonly Used IT Project Evaluation Criteria in Literature

4.2 Expert Interviews

According to the experts, an IT project's contribution to a company's or an organization's strategy is often considered when evaluating IT project proposals [e.g. INT.2, INT.9, INT.11]. For example, according to INT.12 "single IT projects need to be oriented on the organization's strategy and the derived IT strategy." One expert even says that strategic orientation is one of the most important factor to consider when evaluating IT project proposals [INT.14]. Also important in this context is, for example, the "increase in the internal or external customer benefit or loyalty" [INT.10]. However, the experts also admit that a

strategic quantification often is connected with lots of difficulties, and values are not always quantifiable [INT.3].

Further, the experts agree that "regulatory requirements and need for renewal need to be considered" [INT.1], so an IT project's operational urgency [e.g., INT.11, INT.13]. Here it is essential to analyze the effects and consequences that are to be expected through a non-compliance with regulatory requirements. It also includes an IT project's contribution to modernize, replace, or supplement existing systems and their influence on the daily business [INT.1, INT.2, INT.4, INT.7]. "IT projects that are necessary for the persistence of the organization are highly prioritized" [INT.14]. According to INT.2, "many IT projects result from liabilities, like expiring maintenance contracts, new safety, or network requirements". In some companies, such IT projects even represent a significant part of the implemented IT projects [INT.2, INT. 6]. They are often considered as mandatory that definitely need to be part of the portfolio because of their importance [INT.3, INT.5].

Another identified important evaluation criterion is human resources [e.g., INT.2, INT.8]. It encompasses an IT project's evaluation regarding the requirement of internal or external human resources for an execution. As the availability is restricted, it is a limiting factor for prioritization [e.g., INT.11, INT.13, INT.14]. Resulting, the availability of human resources has a significant influence on a prioritization process. An evaluation is based on the "effort in terms of human resources and time" [INT.8]. However, in most IT projects, there is a need for specialized competencies and experts, which are widely required but only scarce in their availabilities. These often represent a bottleneck and hugely influence decisions [INT.2, INT.8, INT.12].

An IT project's risk is a further important evaluation criterion mentioned by the experts [e.g., INT.2, INT.4, INT.6]. Here, an IT project is evaluated regarding the risk that corresponds with carrying out an IT project. "An evaluation about what can go wrong in terms of risk needs to be made" [INT.4]. This includes the analysis of potential occurring risks and the remaining consequences and also impacts of a non-performance of single IT projects [INT.3, INT.6]. However, not only an IT project's risk itself is evaluated, but also its influence on other IT projects. "Evaluations about other IT projects being positively or negatively influenced by a certain IT project are made" [INT.8].

Mostly all experts agree that an IT project's evaluation should also consider interdependencies between different IT projects [e.g., INT.3, INT.8, INT.12]. Dependent on the company's or organization's size, "they cannot be considered for the whole organization but only for specific parts" [INT.5]. However, the execution differs a lot. Some experts say they have structured methods like, for example, strategy roadmaps to analyze existing interdependencies [INT.3, INT.7, INT.9]. Others include interdependencies in their business cases to mainly prevent redundancies and the execution of similar IT projects [INT.10, INT.12]. In contrast, others consider interdependencies, but not in a structure way [INT.6]; they, for example, rely on portfolio managers who "know them and take them into account when prioritizing IT projects" [INT.11]. Independent of the method applied, the identification of interdependencies reduces an IT project portfolio's overall complexity and makes it easier to handle [INT.5, INT.8]. They also partly determine the order of the IT projects to be executed in case of chained IT projects by identifying the need for one IT project being finished before another one can start [INT.7, INT.9].

Efficiency evaluation is another frequently quoted criteria by the experts [e.g., INT.2, INT.5, INT.10]. An IT project is evaluated regarding its costs in relation to its benefits [INT.1, INT.13]. Experts agree that costs are necessary to consider and are a limiting factor because of restricted budgets [e.g., INT.6, INT.8, INT.9]. "It is important to consider if the required budget is available" [INT.4]. They also agree on the importance of benefits evaluation which are direct results of an IT project's execution [INT.1, INT.7, INT.8, INT.14]. However, the experts are divided on issues to be evaluated. For some experts, only a potential cost reduction as a direct impact of an IT project's execution is considered [INT.6, INT.7]. One expert expands this by "maintenance requirements because at some point maintenance is not possible anymore" [INT.1]. Others consider the "value for internal and external customers" [INT.10] or the "growth through a better market position or diversification of business" [INT.3] as critical.

Some experts explained that specific IT projects are not evaluated regarding objective criteria, but rather are chosen due to decisions of the organization's executives. Meaning, the organization's politics influence the evaluation process, too, even though these decisions are not always based on a rational level [INT.14]. "Sometimes, the power of having a high position in the organization is used to gain resources for an IT project" [INT.6]. The same happens in relatively small family-run organizations. Here "the family has a huge impact on which IT projects are performed" [INT.2].

5 Model Development and Applicability Check

Our literature review and expert interviews show many similar evaluation criteria. To reconcile both points of view, we define such (sub-)criteria as critical mentioned in literature and/or in the expert interview and include them into our scoring model, expect interdependencies, organizational politics, and resource limitations. It summarizes the most common and relevant criteria into one score and enables a categorization of the following criteria: urgency, strategy, efficiency, risk, and complexity. These five criteria with its subcriteria set the basis for our generic scoring approach. Their application enables a more objective, transparent, and manageable evaluation of underlying IT project proposals, resulting in more reliable evaluation decisions. Eq. (1) shows the general mechanism of our scoring model.

$$a_i = \sum_{c=1}^{C} \left(\frac{\left(\sum_{n=1}^{N_c} v_{c_{n,i}}\right)}{\#N_c} w_c \right) \qquad \text{(Eq. 1)}$$

Thereby, $v_{c_{n,i}}$ denotes the values for each sub-criteria with $c \in \{1, \dots, C\}$ being the criteria, e.g., urgency or complexity, and $n \in \{1, \dots, N_c\}$ their sub-criteria, e.g., need for modernization or degree of deviation from daily business. $\#N_c$ represents the number of occurring sub-criteria for an underlying criterion. Parameter w_c denotes a criterion's weight, i.e., the importance of criterion c with $\sum_{c=1}^{C} w_c = 1$. All weights w_c and values $v_{c_{n,i}}$ have to be defined for all (sub-)criteria. An individual IT project's score a_i for an IT project i is then calculated by the sum of products of the sub-criteria's mean score with the weight of the corresponding criterion. We limited the application of an outer weighted sum to prevent more manual effort. Depending on an organization, one can set the inner sum as a weighted

sum, too. In this case, for each sub-criterion n of criterion c a weight must be defined. Again, the sum of all weights for all sub-criteria n of one criteria c being equal to one.

In a next step, we further used the findings of our literature review and expert interviews to develop an exemplary scoring table and scale, see Tab. 3. It defines which specification a (sub-)criteria must have to get a particular score. For this, we used a mix of verbal and numerical scales. Each IT project proposal and running IT project must be evaluated according to each sub-criterion and gets a score suitable to the description. The higher the total score is, the higher is the IT project's importance and value.

(Sub-)Criteria		Score 1	Score 2	Score 3	Score 4	Score 5
Complexity	# of involved business departments	> 13	10-13	7-9	4-6	< 4
	Degree of deviation from daily business	significant changes	considerable changes	isolated changes	minor changes	no changes
Efficiency	Investment recovery (periods)	> 20	16-20	11-15	5-10	< 4
	Long-term cost savings	no effects	barely noticeable	noticeable	considerable	highly significant
	Impact on the growth rate	no effects	barely noticeable	noticeable	considerable	highly significant
Risk	Probability of occurrence	> 15%	11-15%	6-10%	2-5%	< 2%
	Potential damage (share of revenue)	> 12%	10-12%	7-9%	3-6%	< 3%
	# of similar past IT projects of IT project leader	none	1-2	3-4	5-6	> 6
	Positive impact on other IT projects	none	1-3%	4-6%	7-10%	> 10%
	Negative impact on other IT projects	> 10%	7-10%	4-6%	1-3%	none
Strategy	Competitive advantage	none	barely noticeable	noticeable	considerable	highly significant
	Business goals support	none	barely noticeable	noticeable	considerable	highly significant
	Increase in market share	no effects	barely noticeable	noticeable	considerable	highly significant
Urgency	Non-compliance with regulatory requirements	non existing	short-term disruptions	considerable disruptions	legal consequences	sanctions
	Need to keep daily business running	no need	only few processes	several processes	many processes	core processes
	Need for modernization	within next 6+ years	within next 5 years	within next 4 years	within next 3 years	within next 2 years

Tab. 3: Illustrative ITPPM Scoring Table

Because each IT project proposal is scored according to the same (sub-)criteria and scale, it allows a comparison between different proposals. However, a "one fits all" scale is impossible because of a company's or an organization's heterogeneity. Instead, an adjustment with specific verbal or numerical criteria and sub-criteria is necessary. However, scoring results rather should serve as an input for further prioritization, selection, and scheduling decisions than used as the only method for these processes to overcome its disadvantages [LK01]. The scale further takes no resource limitations, interdependencies, and organization's politics into account. These are important to consider separately in additional restrictions and do not directly influence the importance of an IT project. Regarding the resource constraints, it is especially important to prevent resource overload, a situation in which selected IT projects require more resources than there are available. Different kinds of interdependencies must be identified and considered when selecting and scheduling IT projects. However, they do not indicate the importance of an IT project, but rather prevent redundancies and influence the temporal order of IT project implementations. As some selection decisions rely on organizational politics irrespective of an IT project's importance, we further excluded this criterion from our scoring approach.

Based on our findings, we developed a mathematical optimization model as a basis for a decision support tool for ITPPM decisions and used the scoring results as an input. An application of our tool allows to optimally select and schedule different IT project proposals for an optimal portfolio composition. It considers different constraints, interdependencies, and resource limitations extracted from the expert interviews and literature. It aims to maximize a company's or an organization's total value contribution by adding up the individual IT project scores. We here further integrated several restrictions for resource limitations, interdependencies, and organizational politics, which we excluded from our scoring approach. Thereby, the tool does not only ensure that IT projects can only start once during the time horizon. It also prevents resource exceedances of limited resources, for example, budget [e.g., SC19, INT.4, INT.5, INT.8] and human resources [e.g., Ch20, INT.2, INT.11, INT.12] throughout any given planning period. Mandatory IT projects cannot be excluded from the IT project portfolio independent of their score, resulting because of e.g., law regulations, strategic considerations, or other reasons [cf. criterion of organization's politics, e.g., INT.2, INT.6, INT.14]. Once an IT project is defined as such, the tool ensures its inclusion into the portfolio. The tool also considers the mutual exclusiveness between IT projects [e.g., CN13, INT.10, INT.12 - criterion of interdependencies]. Temporal interdependencies between IT projects imply that certain IT projects have to be finished (predecessor IT projects) before others can start (successor IT project) [e.g., RE05, INT.7, INT.9]. Once a successor IT project is selected into the portfolio, the tool ensures that all related predecessor IT projects are selected, too. Here it is important that the starting period of the successor IT project is sometime after the predecessor IT project's. It allows a chronology determination of chained IT projects. Thereby, it is possible to include one or several predecessor IT projects without its successor IT project(s), but not vice versa.

We provide an applicability check with a generic IT project portfolio selection problem, including 25 IT project proposals and eight planning periods, for example, two years to evaluate and demonstrate our tool's feasibility. We use our scoring model, see Eq. (1), and the criteria and scales in Tab. 3 to evaluate each IT project proposal. Based on the im-

portance of the criteria to support the organization's goal achievements, the criteria strategy and urgency both get a weight of 0.3, risk a weight of 0.2, and the remaining efficiency and complexity a weight of 0.1 each. We consider a restricted availability and requirement of three resources: general external resources (consultant, soft- & hardware costs), general internal resources (project team), and internal domain-specific resources (key employees). Periodical resource availabilities are given as input and requirements are set by decision-makers. We assume two mandatory IT projects and two pairs of mutually exclusive ones. One large IT project is divided into four smaller one-periodical IT projects that need to be finished chronologically (temporal interdependency). Fig. 1 illustrates the optimization results with selected IT projects and their schedules in a Gantt chart. In the underlying case, 17 IT projects are selected into the portfolio and scheduled within the entire planning horizon with a portfolio value of 53.61. For comparison, without interdependencies, limitations, and constraints, the maximal portfolio value contribution is 75.71.

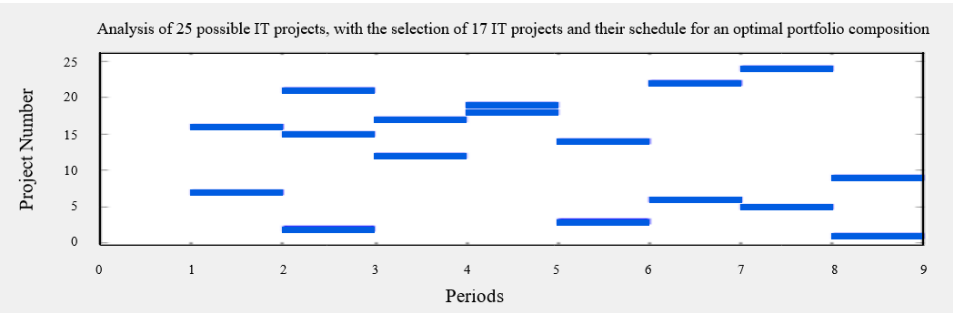

Fig. 1: Optimization Results for the Generic Portfolio

6 Discussion and Implications

The increasing importance of IT projects for a company's or organization's long-term performances also increases the importance of selecting the "right" IT projects into a portfolio. This results in a need to properly define IT project evaluation and selection criteria to support and enable transparent decisions. In a first step, we therefore conducted a literature review to identify often used selection criteria in ITPPM literature before we conducted 14 expert interviews to get more practical insights into this topic. With our findings, we were able to identify eight critical selection criteria. Most of them serve as an input for our scoring model and exemplary scale (complexity, efficiency, risk, strategy, and urgency) and the remaining for our optimization tool (interdependencies, resource constraints, and organization's politics). An application of our scoring model allows a uniform scoring of each IT project proposal. It serves as an input for the optimization tool and thus supports decision-makers in the optimal IT project portfolio selection and scheduling while considering temporal interdependencies and the existence of mutual exclusive IT project proposals. It also allows to define "must" IT projects and the determination of periodical resource requirements and availabilities.

During the expert interview analysis, we noticed that irrespective of the sector the experts work in, many named critical scoring criteria were the same. Only sub-criteria and characteristics were different for some criteria. We therefore concluded that general scoring criteria are very similar to each other irrespective of the sector. Only attributes of the individual sub-criteria differ. The identified criteria in literature and named by the experts were also very similar. There seems to be a common general understanding and agreement in both literature and practice on critical scoring criteria. The different sub-criteria result from the heterogeneity in size, the company's or organization's sector, and underlying regulations. So a "one fits all" model is not possible to develop. Instead, companies and organizations must define specific sub-criteria, scales, and weights. Our scoring model serves as an example that can be individually adapted by companies and organizations.

An application of our scoring model allows to evaluate all IT project proposals uniformly. It reduces decision-makers' subjective influences on final portfolio compositions and results are more transparent and reliable. However, it is crucial to precisely define scales and weights for each criterion, as they have a significant influence on the final portfolio composition. Because each IT project proposal must be scored according to each (sub-)criteria, their number is critical to prevent a high manual effort. It is necessary to consider between having too many criteria which lead to a high manual effort as well as having enough criteria to be able to evaluate each IT project proposal adequately. Our scoring model then serves as an input for our optimization tool. An application simplifies and automates the overall strategic evaluation, selection, and scheduling of IT projects for an IT portfolio composition and thus improves the quality and efficiency of optimization results.

7 Conclusions

Knowledge about IT project evaluation and selection is of high importance and inevitable for a company's or an organization's goal achievement, value contribution, and competitiveness. With our literature review and expert interviews we were able to quantify an IT project's complexity, efficiency, risk, strategy, and urgency as critical scoring criteria. They serve as a basis for our holistic scoring approach. It allows to evaluate IT project proposals uniformly and increases objectivity and quality. Our scoring model further serves as a basis for our optimization tool which considers various interdependencies, limitations, and constraints. It recommends which IT projects to select and schedules them within the planning horizon while simplifying and automating the overall strategic IT project evaluation, selection, and scheduling decisions.

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