Requirements for a Decision Support System for Managing Complexity of Multidimensional IT Project Assessments in the Context of IT Portfolio Management

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Abstract: Many companies evaluate their IT projects primarily according to financial decision criteria. The subsequent IT project selection for the IT portfolio is additionally influenced by political factors, various (partially unclear) standards, and questionable evaluation methods. There is a risk of misinvestment in IT projects that do not fit the company's strategy and accordingly lead to misallocation of resources. To solve this problem, this study will develop requirements for a decision support system that will enable a systematic, comprehensive, and transparent decision-making process for selecting suitable IT projects.

Keywords: Project portfolio management, IT project evaluation, project assessments, IT project selection, decision support system, requirements, requirements templates, PARIS, Patterns for Requirements Specification

1 Introduction

According to Markowitz's (1955) modern portfolio theory, securities portfolios should be selected so that the risks are spread as widely as possible through diversification. An efficiency curve can be used to identify a securities portfolio that, compared to other portfolios, has a lower risk with the same expected return or a higher return with the same risk [Ma52]. The risk dimension is also a significant consideration when selecting IT projects for IT project portfolios (ITPP) due to the imbalance between often high investment costs on the one hand and elusive, intangible benefits on the other [Ay18]. In contrast to securities portfolios, IT project portfolios require further considerations in addition to financially oriented key figures [CZ08]. Strategic, benefit-oriented, or time-related vital figures are also considered so a purely financial perspective does not fully account for such decisions.

1.1 Problem statement

According to Bernroider et al. [Be14], the systematic, comprehensive, and transparent evaluation of IT projects is still one of the most important unsolved problems for (IT) management. However, the fundamental problem is not new. In addition to optimal IT project selection, timely decision-making, targeted IT project implementation, accurate evaluation, and timely termination of projects are critical challenges of IT portfolio management [Th07]. Inefficient decision-making processes when selecting IT projects can

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have two negative consequences. On the one hand, resources are consumed by inappropriate IT projects, and on the other hand, the company cannot reap the benefits it would have achieved if those resources had been used on better projects [Es16]. Due to the scarcity of resources caused by the shortage of skilled workers and the cost pressure caused by the ever-increasing IT expenditures of recent years, the pressure to make decisions and improve efficiency is also increasing [Ay18]. At the core of the described problems is the complexity management in the form of various influencing factors. To cope with this complexity, methods, and techniques are required to achieve a systematic assessment for decision support and portfolio management. Decision support systems (DSS) offer possibilities to increase the efficiency and success of an IT portfolio and manage complexity factors simultaneously [Ko20]. The essential goal is an optimal investment decision with the highest possible value from the project result [TW14].

1.2 Aim of the study

The aim of this research is to design a DSS for IT project portfolio management. For this purpose, a model to represent the decision-making process and the corresponding requirements should be documented. The process model and the requirements are derived from the scientific literature with the help of a systematic literature review (SLR). In addition, the requirements are subject to external reviews to obtain an assessment from the perspective of practitioners to improve the requirements then. Since the requirements were formulated with Patterns for Requirements Specification (PARIS) [Li22], the advantages and disadvantages of PARIS were also examined via the external reviews in order to evaluate them as part of the PARIS research project.

1.3 Structure of the study

In Chapter 2, the problem of this study is specified. Reference is made to the complexity drivers and the need to address them. In addition, we examine which dimensional approaches are required, how these dimensions are methodically evaluated, and which processes can be used as a basis for an DSS. Upon this basis, the formulation of requirements for an DSS is described in Chapter 3 and the findings of the external reviews for validating the requirements are presented. Chapter 4 compares complementary findings from the SLR and the external reviews in terms of opportunities and risks in the introduction, as well as the use of an DSS. In the context of the PARIS research project, the advantages and disadvantages of PARIS as a formulation language for further development are reflected upon. Finally, the main results are summarized in Chapter 6.

2 Complexity drivers in IT project evaluation

In science, IT projects are considered high-risk projects because they not only involve high costs, but also the determination of benefits is time-consuming and often remains unclear [Ay18], [Sc10]. This means that, in addition to a classic cost, time, and scope analysis, a multidimensional view is also appropriate for the investment decision. Using the example of the benefit of IT projects, not only economic key figures but also non-economic key figures should be taken into account in the evaluation. In contrast to the modern portfolio theory, according to Markowitz, quantitative *and* qualitative key figures must be evaluated accordingly [Pe14]. In the case of the qualitative key figures, the consideration of personal judgments in the decision-making process is of great relevance. This is due to the fact that some researchers consider purely rational approaches to be insufficient and that, in addition to political behavior and intentions, social structure must also be taken into account [Ho21]. Another complexity driver is volatility in the IT project environment due to constantly changing project scopes, general uncertainties, unknown influences, or the challenge of implementation [Al16]. The critical importance of unpredictability and uncertainties in IT projects has a corresponding influence on the decision-making process and the IT project evaluation [Al16]. The IT project assessment is embedded in the decision-making process for the IT portfolio selection so corporate organizational frameworks for IT control must be in place to enable reliable monitoring of the implementation and management of the IT projects [RL18]. The decision-making process when selecting an IT project is another complexity driver that must be carried out not just once but rather iteratively. The project life cycle plays an important role here since the content of the project management decision is different for each phase in the cycle, so that development costs, return on investment, scheduling and project risks arise accordingly [HG09]. In [Al20], [Ke95] and [Ar14], it is argued that deciding whether to cancel or continue a project that has got into difficulties is one of the most challenging decision-making situations for management. The participation of a large number of actors in the decision-making process also makes the relevance of systematic decision-making management and decision-making support clear since the different decision-making processes should be integrated and harmonized [PK15]. In addition to the targeted selection of criteria for the evaluation, correct, precise, and reliable input data are absolutely necessary for the procedures. In other words, it would be of little use to (IT) management if the best dimensions and criteria were found, but the data used was incorrect, manipulated, or incomplete [PK15]. Therefore data quality is an important prerequisite and another complexity driver in order to meet the various requirements for timeliness, consistency, accuracy, and completeness [PK15]. Above all, collecting and reproducing data in a suitable form is difficult, time-consuming, and expensive for companies [Ar15]. In summary, it can be seen that the sum of all the influencing factors listed leads to a high level of complexity in the IT project evaluation.

2.1 Systematic Literature Review for requirements elicitation

A Systematic Literature Review (SLR) was employed to assess the current state of research in order to identify essential dimensions for evaluating IT projects. The SLR followed the methodology outlined in Kitchenham's "A systematic review of systematic review process research in software engineering" [KB13]. First, a search strategy with predefined keywords was developed, followed by searches across various scientific databases to compile a selection of relevant articles. Subsequently, a quality assessment was conducted, and a final evaluation was summarized. To identify critical dimensions, the articles were examined for criteria that could serve as suitable dimensions. Additionally, various perspectives on project evaluation were explored to uncover potential dimensions. Consequently, critical dimensions were synthesized through a combination of criteria and diverse perspectives on projects. This synthesis was necessitated by the fact that only a few articles presented a higher-level, dimensional view as a result of their research. Many articles focused primarily on analyzing and developing multi-criteria evaluation methods, evaluating processes and process models within the context of project portfolio management, or investigating industry and company-specific issues. For the SLR, the following databases were selected for the search: BASE, IEEE Xplore, ScienceDirect, Google Scholar, The ACM Guide to Computing Literature, and Wiley Online Library. The primary keywords for the in-depth keyword analysis were "IT Project Evaluation" and "IT Project Portfolio Selection." To refine the search and encompass related topics, combination keywords were incorporated into the final search terms. Prior to initiating the search, inclusion and exclusion criteria were defined, including the exclusion of books and theses. The identified candidates underwent a thorough quality assessment. Articles with a quality assessment score below 50% were excluded from further consideration in the SLR results report. Ten articles were affected by this criterion. The outcomes are outlined below in tabular form.

Table 1: Summary of Results from Database Searches

Database	**Number of hits**	**Candidates**	**Final selection**
Base	35	2	2
IEE Xplore	11	9	4
ScienceDirect	204	2	1
ACM Digital Library	3	0	0
Wiley Online Library	4	0	0
Google Scholar	312	32	28
Total	**569**	**45**	**35**

From a compilation of 35 journal and conference contributions, eight critical dimensions were synthesized. These dimensions provide a comprehensive framework for the meticulous evaluation of IT projects [Ab23].

2.2 Need for a multidimensional view

Due to the prevailing dominance of the classic dimensions of IT project evaluation time, costs, and scope (also known as the iron or magic triangle [Wa16], [PK15], [VÁ18], [Bi17], [Sa22]) there is a risk that companies will select the wrong IT project. In [Kh13] it was already recognized in 2001 that IT portfolios are selected that do not fit the company's strategy because they are based on a limited view. Due to the strategic importance of IT in companies, maximizing business value has become increasingly relevant and, thus, an essential goal of agile software development [Ho21]. The strategic dimension should be considered accordingly in the IT project evaluation.

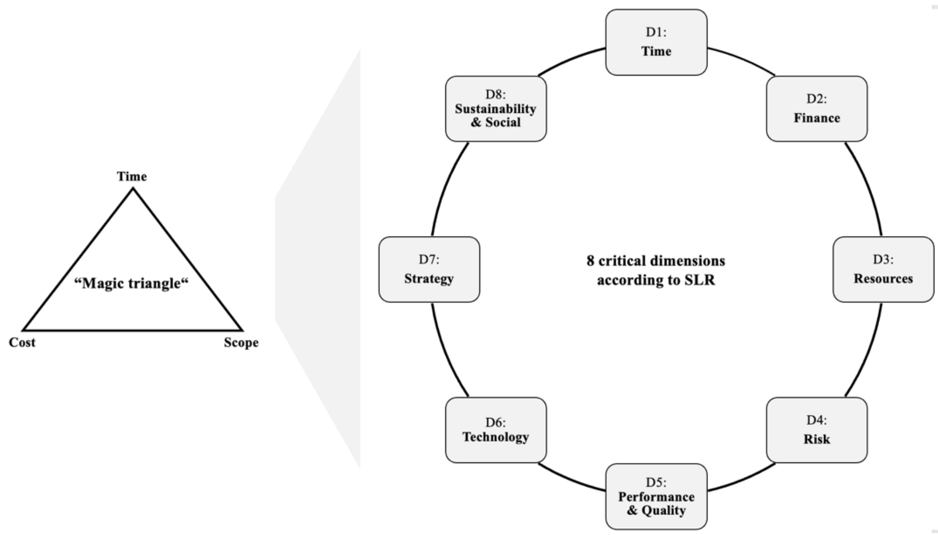

Figure 1: Extension of the "magic triangle" into further critical dimensions. Diagram by the authors.

Figure 1 shows the classic "magic triangle" compared to the results of the SLR with eight critical dimensions. Exemplary criteria for each of the eight dimensions are listed below:

- D1 Time: Project duration, milestones, or start and end times
- D2 Finance: Cost type, cost causer or project costs
- D3 Resources: Resource type or software/hardware
- D4 Risk: Project dependencies, number of risks, or risk class
- D5 Performance & Quality: Increase in company performance, improvement in customer satisfaction, or degree of requirement fulfillment
- D6 Technology: scalability, improvement of IT security or technology complexity
- D7 Strategy: Achievement of business goals, urgency, or obligation
- D8 Sustainability & Social: CO2 footprint, storage reduction, or employee satisfaction

The eight dimensions that emerged out of the SLR make it clear that a three-dimensional view no longer seems appropriate to fully evaluate IT projects. In order to be able to evaluate IT projects according to these dimensions, suitable methods must be selected. Standardized methods such as the Balanced ScoreCard already propose concrete dimensions [Ar12]. However, these must be adjusted or adapted accordingly; hence an evaluation method from the environment of multi-criteria decision analysis (MCDA) is proposed for this study.

2.3 Selection of a multi-criteria evaluation method

More than 100 methods and techniques for MCDA are established in the literature to solve different types of decision problems [Yu22]. MCDA methods help decision-makers identify the best alternative from several potential candidates, depending on several criteria or attributes, which can be concrete or vague, tangible or immaterial [Al13]. The various MCDA methods can be sorted into groups, e.g., benefits measurement, mathematical programming, cognitive emulation, simulation and heuristics, real options, ad hoc models, and financial methods (e.g., net present value, return on investment, or payback period) [Al19], [Ka20], [LH04], [PS19]. In order to propose a suitable method, the decision problem should first be specified in order to derive specific requirements. From a theoretical point of view, the optimization problem for the evaluation method can be defined in such a way that the project portfolio selection involves selecting a subset of projects with the objective of maximizing the value of the portfolio in terms of several qualitative and quantitative criteria, given the (resource) constraints [Ch18]. This results in real decision-making problems, which recognize conflicting goals, make decisions, and find compromise solutions according to several criteria [Bą21]. As part of the search for methods, it quickly became apparent that researchers [Ka20], [Bą21] take the view that the use of many different criteria leads to the increased complexity of the decision problem. This makes it almost impossible to find a single, universal method for solving various sub-problems. Researchers [Es16], [ZT10], [Kh13], [EB17], [Bą21] propose so-called hybrid approaches in which different algorithms for solving the decision problem are combined in order to meet the respective requirements for goal optimization. For this study, the Analytical Hierarchy Process method was selected from the MCDA environment [Sa08]. The method is used, examined and repeatedly mentioned in the literature and offers a concrete solution for the ranking and scoring problem of IT projects in the IT portfolio selection. In addition, it can be flexibly combined with other methods (e.g., for hybrid approaches) and takes into account personal judgments in the form of preferences weighted by criteria.

2.4 Modeling of the decision-making process and the DSS

This study proposes a holistic decision-making process that represents the interaction between the business process level and the application system level. The relevance of such process modeling for the decision-making problem is also recognized in the literature: “There is a need for an elastic, agile and flexible interaction of people and technology in the form of a DSS that can respond in totality to subtle changes to meet the complex requirements of project assessment for portfolio design” [Th19]. The aim is to show the decision-making process for the selection of an IT project portfolio with influence by relevant key players. Not only the process up to the decision-making should be mapped, but also the recurring management activities after the decision. The iterative core process can be subdivided into sub-processes. The sub-processes contain activities that can also be found in other standard or reference processes, especially the continuous improvement process. In terms of content, the core process is based on the literature regarding project portfolio management and the portfolio life cycle in order to include essential activities and critical processes [Ma11], [FT00], [Ar12]. The decision-making process was subdivided into sub-processes (P1, P2, P3, and P4) as part of the study. The core process begins with the business event of completing the strategic corporate planning, which is handed over to the IT portfolio management with strategic targets (e.g., compliance with a cost limit or prioritization of sustainability projects). The DSS, called "EMP", provides various services and functions so that the process can be run more efficiently and effectively. In summary, it offers the following advantages: improvement of the process throughput time; a reduction in workload; an increased quality of results in the context of the decision problem; and a consolidation, preparation, and processing of information with corresponding calculations for analysis. The individual sub-processes are briefly explained below. For the modeling, the modeling language ArchiMate 3.1 [Th19] was used in order to be able to represent different views. The interaction between the process and the application level should be able to be modeled, while the meaning of individual elements such as roles, services, components and goals should be able to be represented.

Figure 2 (on the next page) contains the overall representation of the process. Only sub-processes P2 to P5 are described for reasons of space and scope.

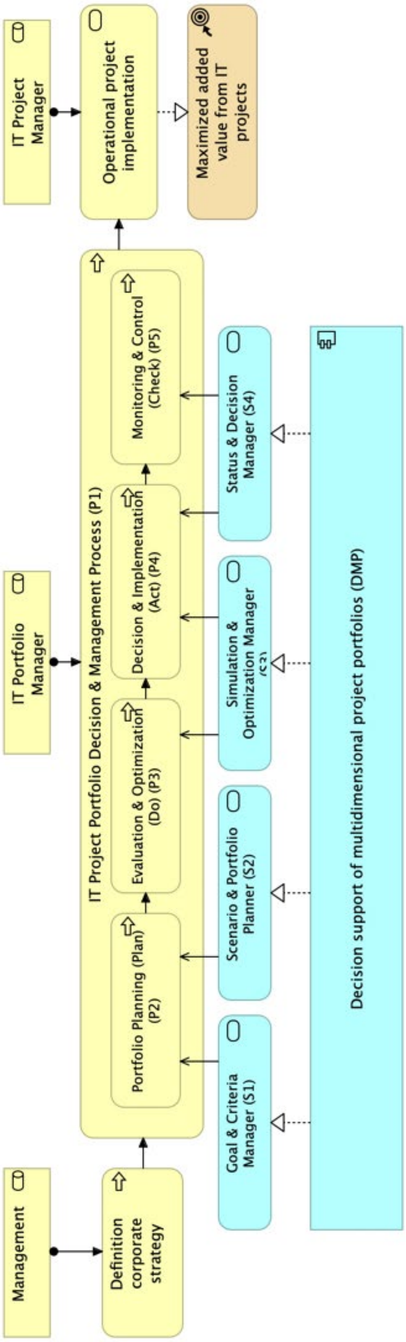

Figure 2: ITPP decision and management process as core process. Notation Archimate Ver. 3.1. Diagram by the authors. The colors correspond to the specifications in Archimate.

Sub-process P2: The portfolio planning process involves essential planning and preparatory activities necessary to be able to carry out the project evaluation and to ensure coordination with the business strategy and its business goals for the later project portfolio. The DSS services can be used to set goals and scenarios, select criteria, make an initial project selection, and then define a suitable evaluation method.

Sub-process P3: The evaluation and optimization process includes the project, portfolio and scenario evaluation to create an optimized decision template for approval by management. With the support of the application services, the following processes take place: the evaluation step for prioritization and evaluation of the planned criteria; the actual project evaluation according to the previously determined portfolio scenarios; the result check with corresponding optimization; and the preparation for a final decision template from the evaluation. In addition, the application service should automatically suggest recommendations for action for optimization, point out possible contradictions or errors, and make the decision recommendation more tangible through appropriate visualizations.

Sub-process P4: The decision-making and implementation process comprises the actual decision-making process based on the decision template, with the corresponding release from management for operational implementation. The final IT portfolio for implementation is determined here. The application service also supports deriving possible recommendations for action in order to derive possible optimization variables.

Sub-process P5: The sub-process of control involves the monitoring and control of the selected portfolio in order to continuously check the original selection decision for progress and target achievement, taking critical dimensions into account. This process step may lead to a need for reassessment and possible restructuring of the project portfolio. This would start the process again in the planning step of portfolio planning (P2). The application service provides status and progress reports on the defined goals and independently indicates changes. The service independently recognizes a new decision-making problem; for example, because individual IT projects have been aborted or stopped or because general critical dimensions have exceeded the target specifications.

3 Requirements for a decision support system

In a further step, the requirements for the decision support system were formulated using the PARIS templates in order to obtain precise requirements documentation [Li22]. The requirements were derived from the findings of the above-mentioned SLR and from the models of the ITPP decision and management process (see previous section) before being supplemented on the basis of expert reviews. A total of 210 requirements and definitions of terms were created in this way. The requirements have been documented in tabular form, with the following structure being used for the table:

Table 2: Table for formulating requirements for an DSS with PARIS (example)

ID	PARIS	Formulation according to PARIS templates	Review	ArchiMate object
129	functional requirement	If the EMP system has not yet stored business objective data, the system must allow the user to create one or more business goals.	Initial version	P2, S1

The table is sorted by an identification number (ID) and by the respective PARIS template. In addition, reference was always made to the respective expert review (EXP1 to EXP5) or the initial creation (initial version). The identification of the associated ArchiMate object was set for each requirement. This should make the reference to the modeling of the presented ITPP decision-making and management processes clear. The corresponding components (C), services (S), processes (P), databases (D), and the core system (EMP) were referenced here. When numbering the requirements (ID), reference was made in places to the corresponding process (P2, P3, P4, P5), which was modeled using ArchiMate. Different types of requirements were used with PARIS templates, such as stakeholder requirements, service requirements, objectives, context, functional requirements, and glossary. As the details of PARIS have already been presented elsewhere [Li22], [Li20], they will not be discussed further here. The appendix to this article contains an excerpt of 55 critical requirements that are identified as particularly relevant in terms of importance and according to comments made in expert reviews. A total of 249 requirements and glossary entries were documented. The full specification is published on Researchgate [AL23].

External reviews were conducted with selected experts from IT management and IT project portfolio management to review, expand and improve the formulated requirements. The five experts come from different industries, roles and responsibilities but work in a corporate environment and at a university, so no expert at the top management level could be interviewed. The main goal of the external reviews was the validation of the requirements formulated with the help of the PARIS templates in order to check them for various criteria such as correctness, completeness, comprehensibility, and usefulness for practice. In addition to the general review of the requirements, interviewees were asked to identify the requirements that are particularly critical to the success of the, so that they can be introduced and used in practice and to identify any significant opportunities and risks. The experts were asked according to their professional and qualification profile. Five suitable candidates with experience in IT portfolio management and IT management were found who agreed to participate in a review. Before the actual review with defined key questions, the experts received all the requirements in advance so that they could be discussed in an individual video call. The duration of the call for all five experts was around 90 minutes. After the review was completed, the experts were asked about PARIS [Ab23].

The result of the reviews is that all five experts confirm the problem for practice. There were also additions identified by the experts, which were taken into account by formulating new requirements. Some of these additions are listed below as examples:

- It should be possible to define dependencies between IT projects, sub-projects and programs.
- Enable release and authorization functions so that the final implementation decision is accompanied by the system and there is a commitment to release by decision-makers.
- A clear evaluation of results in the form of defined key figures (e.g. as an ROI value).
- Groupings should be made in the form of project classifications and project categories in order to be able to structure the portfolio content.

- There should be documentation of past decisions on approved portfolios to build transparency into decision history.
- It is necessary to consider prioritization options for important or urgent IT projects, for example, due to legal requirements.
- A decision-making process should be run through repeatedly; e.g., during the planning rhythms, status, and progress changes of IT projects or after certain time periods.
- There should be independent reassessment and restructuring recommendations, e.g., after a progress change.

4 Further findings after SLR and external reviews

After summarizing the various information from the literature and the discussions with the experts, further insights into the introduction and use of an DSS can be derived in the form of possible opportunities and risks. These are summarized in Tables 2 and 3 below and could form the basis for further research work.

Table 3: Opportunities of introducing and using an DSS

ID	Opportunities	Impact
1	Streamline and structure the decision-making process	Reduction of investment risks and wrong decisions Traceability and transparency
2	Release and control mechanisms	Reduction of political influencing factors and conflicts of interest Auditability and process compliance
3	Systematic comparison with the corporate strategy	Reduction of “gut feeling decisions” Strategic alignment of the IT portfolio Structured operationalization of the goals in the form of IT projects
4	Integration into the application landscape	(Partial) automation for resource and cost efficiency Collection, preparation, and processing of various data from different systems to improve the quality of decisions
5	Speed and flexibility in decision-making	Increased reaction speed in dynamic and volatile IT environments Involvement of different stakeholders Access to historical experience

Table 4: Risks of introducing and using an DSS

ID	Risks	Impact
1	Resistance of	Change process within the organization required with

ID	Risks	Impact
	individual actors	clarification of authorities and responsibilities
2	Illusion of an “optimal” IT portfolio	Clarification of objectives and expectations necessary (satisfaction and compromise solutions) Disappointment in terms of controllability and plannability among decision-makers
3	Presentation of added value	Formal and sophisticated IT project reviews might not necessarily provide better results for decision making Challenge in measuring success
4	Fulfillment of requirements	Backing of top management Quality of the data Organizational maturity
5	Standard solution not sufficient	Customization requirements for processes or interfaces, for example Different requirements depending on the industry, size of companies, or culture of companies

5 Reflection on the use of PARIS

As part of the study, the advantages and disadvantages of the PARIS templates were examined. One of the main advantages of PARIS is that the requirements formulated are easy to read and understand. This was also shown in the reviews because only a few clarification questions were asked. The structure of the PARIS templates avoided complicated wording in order to facilitate reader accessibility. The repetitive template structure not only made it easier to read but also the actual wording. PARIS thus not only offers advantages for the reader, but also for the creator of the requirements. A routine was already established after the formulation of a few requirements, since the elements and the structure are repeated. Critically, some experts noted that the tabular form could distract from important and critical requirements and therefore wanted a compressed version (e.g., via grouping or graphic highlighting). Although specifications and functional specifications are often extensive, the use of PARIS templates results in increased effort in structuring and managing individual requirements. The number of requirements is increasing because requirements formulated with PARIS are very finely granulated. During the reviews, some experts were surprised by the high number of requirements. The large number of requirements was perceived as “tiring” by experts during validation. Tool support can help with some points here, but large numbers of requirements are a fundamental problem in requirements engineering, a problem that can only be partially solved by software. For example, the search, structuring, and clarity of a large number of requirements, as well as the actual formulation, could be technically facilitated with interactive templates for the writers.

6 Conclusion and future work

Within the scope of the study, eight dimensions were identified from the scientific literature for the holistic evaluation of IT projects: time, finance, resources, risk, performance and quality, technology, strategy, sustainability and social. Companies are confronted by influencing factors with a high level of complexity, so the use of a decision support system (DSS) can help them to cope. For such an DSS, 249 requirements were formulated and assessed in a review by five external experts. After discussing opportunities and risks, it was concluded that a purely rational, algorithmic evaluation does not seem suitable for practical use. Instead, an DSS offers the possibility of combining subjective and algorithmically defined influencing factors. An DSS can thus influence decision-making behavior in order to avoid a purely intuitive, subjective decision and to solve the decision problem in a structured manner. In practice, this could provide a middle ground between elaborately detailed planning and absolute "laissez-faire" project assessments. However, technological and political barriers in companies still have to be solved by human intervention. For this reason, an DSS cannot completely resolve the complexity, but it can move toward a more optimal investment decision for (IT) managers. Since this study represents a conceptual basis for the development of an DSS, critical success factors for introduction and use should be examined in advance. In addition, an evaluation of existing software solutions on the market should be considered and a strategic positioning for the development of a prototype should be derived from this.

In summary, PARIS has proven to be an effective tool for formulating comprehensible and precise requirements. PARIS could thus be highly relevant for broad practical use and, above all, prevent failures in software development and IT projects. It is even conceivable that it could be used in non-IT subject areas, possibly creating further templates in PARIS.

7 Appendix: Review of requirements

Table 5: Excerpt of requirements for a decision support system

ID	PARIS	Formulation according to PARIS templates	Review	Archi-Mate object
12	Stake-holder Require-ment	Corporate compliance requires that the EMP system mandatorily prioritize projects into project portfolios to ensure the company's legal compliance, so that they are implemented as quickly as possible to avoid penalties and sheeple cases.	Initial version	Not mo-deled.
14	Stake-holder Require-ment	Occupational safety requires that the EMP system include projects to improve occupational safety requirements so that they are implemented as prioritized as possible to prevent occupational accidents.	Initial version	Not mo-deled.
20	Stake-holder Require-ment	(IT) management requires that the EMP system enables the Decision Maker user role to release decision templates for a project portfolio.	Initial version	P2.5, P4
34	Service Require-ment	The manager of occupational safety must review projects for requirements to increase occupational safety so that such projects are prioritized.	Initial version	Not mo-deled.

ID	PARIS	Formulation according to PARIS templates	Review	Archi-Mate object
35	Service Require-ment	The IT security manager must review projects for IT secu-rity relevance so that such projects are prioritized.	Initial version	Not mo-deled.
36	Service Require-ment	The Compliance Manager must mark projects on compli-ance requirements of the company as mandatory so that such projects are implemented immediately.	Initial version	Not mo-deled.
38	Service Require-ment	The decision maker must specify goals from strategic corpo-rate planning so that the IT portfolio can be aligned with the corporate strategy.	Initial version	Not mo-deled.
39	Service Require-ment	The decision maker can specify scenarios from strategic business planning so that the IT portfolio can be aligned with the business strategy.	Initial version	Not mo-deled.
41	Objec-tive	It must be an outcome objective of the EMP system that the system assists in pre-selecting IT project portfolios for eval-uation so that different portfolios can be compared.	Initial version	EMP
44	Objec-tive	It must be an outcome goal of the EMP system that the sys-tem will assist in restructuring IT project portfolios so that new projects can be added to the portfolio or existing pro-jects in the portfolio can be removed.	EXP5	EMP
45	Objec-tive	It must be an outcome goal of the EMP system to assist in rebalancing IT project portfolios so that existing projects can be given a different priority.	Initial version	EMP
46	Objec-tive	It must be an outcome objective of the EMP system that the system takes into account strategic objectives in the evalua-tion in order to achieve the most profitable IT project invest-ment decision with the highest possible added business value from the perspective of decision makers.	Initial version	EMP
48	Objec-tive	It must be an outcome goal of the system EMP that the sys-tem allows various stakeholders to participate in the deci-sion-making process so that the inputs or outputs can be in-fluenced to the point of decision-making.	Initial version	EMP
69	Objec-tive	It must not be an outcome goal of the EMP system to re-place operational project management applications because EMP is intended to be integrated into the core decision-mak-ing process in the context of project portfolio design.	EXP1	EMP
75	Context	The EMP system must consider it relevant that data is ma-nipulated by users to influence assessment results.	Initial version	EMP
76	Context	The EMP system must consider as relevant that -depending on the company- different processes for portfolio selection are defined to achieve decision making.	Initial version	EMP
82 (P2)	Functio-nal re-quire-ments	If the system EMP detects the project status "project abort" or "project end" in the project data, the system must inde-pendently recommend the user to re-evaluate the portfolio, so that the system can optimize the portfolio.	Initial version	P5.3, compo-nent K5
89 (P2)	Functio-nal re-quire-ments	The EMP system must allow the user to create one or more portfolio objectives so that there are objective or optimiza-tion sizes based on the business strategy.	Initial version	P2, P2.3, S2, D2

ID	PARIS	Formulation according to PARIS templates	Review	Archi-Mate object
94 (P2)	Functio-nal re-quire-ments	The EMP system must allow the user to assign one or more projects to a portfolio.	Initial version	P2.3, compo-nent K2
95 (P2)	Functio-nal re-quire-ments	The EMP system shall allow the IT portfolio manager to as-sign one or more objectives to a portfolio.	Initial version	P2.1, P2.2, compo-nent K2
97 (P2)	Functio-nal re-quire-ments	The EMP system shall allow the IT project manager to as-sign one or more projects to another project to define de-pendencies between projects.	Initial version	P2.1, P2.2, compo-nent K3
101 (P2)	Functio-nal re-quire-ments	The EMP system shall allow the IT portfolio manager to create one or more project categories.	EXP2	Not mo-deled.
103 (P2)	Functio-nal re-quire-ments	The EMP system must allow the user to jointly evaluate pro-jects with dependencies on other projects.	EXP2	Not mo-deled.
108 (P2)	Functio-nal re-quire-ments	The EMP system shall allow the IT portfolio manager to re-lease one or more portfolios to another user group for view-ing.	EXP2	Not mo-deled.
116 (P2)	Functio-nal re-quire-ments	The EMP system must allow the IT portfolio manager to create one or more criteria so that the system can use them to evaluate projects.	Initial version	P2.2, compo-nent K1
118 (P2)	Functio-nal re-quire-ments	The EMP system must allow users IT portfolio managers to weight one or more criteria so that the system can use per-sonal preferences to score projects.	Initial version	P2.2, compo-nent K1
122 (P2)	Functio-nal re-quire-ments	The EMP system must allow users to comment on user ob-jectives with a collaboration feature so that user input and assessment results can be commented on directly in the sys-tem.	EXP3	Not mo-deled.
131 (P2)	Functio-nal re-quire-ments	The EMP system must enable the IT portfolio manager to structure corporate, portfolio, and project objectives and cri-teria in the form of a goal hierarchy so that the objectives and the associated criteria are clearly assigned in each case.	Initial version	Com-ponent K1, P2.1, P2.2
138 (P2)	Functio-nal re-quire-ments	The EMP system must allow the IT portfolio manager to create one or more scenarios so that users can evaluate the portfolio according to different constraints and objectives.	Initial version	Com-ponent K2, P2.3
139 (P2)	Functio-nal	The system shall allow the IT portfolio manager to assign one or more objectives to a scenario so that multiple	Initial version	P2, S1

ID	PARIS	Formulation according to PARIS templates	Review	Archi-Mate object
	require-ments	optimization problems for the evaluation method can be solved by the system EMP for comparison.		
140 (P2)	Functio-nal re-quire-ments	The system shall allow the IT portfolio manager to assign one or more constraints to a scenario so that multiple optimization problems for the evaluation method can be solved by the system EMP for comparison.	EXP3	P2, S1
141 (P2)	Functio-nal re-quire-ments	The EMP system must allow the IT portfolio manager to create a portfolio baseline so that the system can optimize the assessment according to a budget limit.	EXP2	Com-ponent K2, P2.3
142 (P2)	Functio-nal re-quire-ments	The EMP system must allow the IT portfolio manager to assign a portfolio baseline to a portfolio so that the system can optimize the assessment according to a budget limit.	EXP2	Com-ponent K2, P2.3
143 (P2)	Functio-nal re-quire-ments	The EMP system shall allow the IT portfolio manager to assign one or more scenarios to each portfolio.	Initial version	Com-ponent K2, P2.3
144 (P2)	Functio-nal re-quire-ments	After component K1 (Goals & Criteria) has processed the input data to the goal and criteria data, component K1 (Goals & Criteria) must transmit a matrix to component K3 (Decision Support) so that component K3 (Decision Support) can create a hierarchy structure from it in the form of a mapping.	Initial version	Com-ponent K1, S1
145 (P2)	Functio-nal re-quire-ments	After component K1 (Goals & Criteria) has processed the criteria input data, component K1 must provide component K2 (Scoring) with a listing of these criteria so that component K2 can calculate the criteria weights.	Initial version	Com-ponent K2
157 (P3)	Functio-nal re-quire-ments	The EMP system shall allow the IT portfolio manager to select the AHP & ANP evaluation method for project evaluation to enable a two-step evaluation process of project ranking and project selection for IT portfolio managers.	Initial version	P3.2, compo-nent K3, S3
163 (P3)	Functio-nal re-quire-ments	After performing the evaluation methods, the EMP system must independently perform a mathematical consistency check so that the EMP system can point out inconsistencies in the user's project evaluation.	Initial version	Com-ponent K3
165 (P3)	Functio-nal re-quire-ments	The EMP system must allow the IT portfolio manager to define a criteria weight for each criterion so that the system can use the weight to consider appropriate prioritization or relevance of the criteria for project evaluation.	Initial version	Com-ponent K3, S3
169 (P4)	Functio-nal re-quire-ments	The EMP system must allow the user to obtain results of project evaluations in the form of scoring metrics so that results can be compared using numerical values.	EXP2	Not mo-deled.
170 (P4)	Functio-nal re-quire-ments	The EMP system must allow users to visualize outcome metrics of project evaluations in the form of charts so that users can retrieve descriptive reports on the results.	Initial version	Not mo-deled.

ID	PARIS	Formulation according to PARIS templates	Review	Archi-Mate object
179 (P5)	Functional requirements	The EMP system must allow the user to retrieve documentation of past portfolio releases so that the decision history can be tracked at any time.	EXP4	S5
180 (P5)	Functional requirements	The EMP system must allow the Administrator user group to set release stages to prevent arbitrary or political influence on the EMP decision-making process.	EXP1	S5
184 (P5)	Functional requirements	The EMP system must allow the decision maker user group to release one or more portfolios for implementation so that final releases are officially issued by decision makers.	EXP1	S5
189 (P5)	Functional requirements	If one or more statuses of projects change, the EMP system must independently change the objective achievement of the portfolio so that users can view the progress of the portfolio.	Initial version	P5.3, S4, component K5
190 (P5)	Functional requirements	If one or more objective achievements change, the EMP system must independently determine the progress of the portfolio so that users can reassess or restructure the portfolio.	EXP5	P5.3, S4, component K5
191 (P5)	Functional requirements	If records for one or more projects change, the EMP system should independently display a recommendation to re-evaluate the projects so that users can make new decisions about portfolio selection.	EXP5	P5.3, S4, component K5
212	Glossary	System component means in the system EMP a demarcation from its environment or consists of individual parts with definable relationships among themselves, because each individual part of the overall system EMP is then a system component.	EXP1	-
213	Glossary	DSS in EMP system means the abbreviation of the term decision support system.	Initial version	-
214	Glossary	In the EMP system, EMP stands for decision support multidimensional project portfolio (EMP).	Initial version	-
217	Glossary	In the EMP system, executing an evaluation method means being able to calculate one or more mathematical algorithms for users to solve optimization problems.	Initial version	-
224	Glossary	Project dependency in the EMP system means a definition of a dependency of a project to one or more, other projects, consisting of a predecessor as well as successor project, because this is used to calculate the critical path for the realization of the project portfolio.	EXP3	-
226	Glossary	AHP & ANP in the EMP system means the abbreviation for Analytic Hierarchy Process (AHP) and Analytic Network Process (ANP), which describes an evaluation method for solving multi-criteria decision problems because mathematical algorithms are necessary for IT project evaluation.	EXP2	-

ID	PARIS	Formulation according to PARIS templates	Review	Archi-Mate object
234	Glossary	In the EMP system, scoring means a result variable from the project evaluation, which makes it possible to derive the ranking of individual projects, because this is used to determine the most lucrative IT projects within the framework of the IT project evaluation.	EXP2	-
236	Glossary	Portfolio baseline in the EMP system means the defined cost limit that a scenario or a portfolio may not exceed, because this must be taken into account as an optimization variable in the context of portfolio design.	EXP2	-

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