Open Access

*Open Journal of Information Systems (OJIS)*
*Volume 5, Issue 1, 2018*

www.ronpub.com/ojis
**ISSN 2198-9281**

# IT Project Success from the Management Perspective - A Quantitative Evaluation

Mark Harwardt

WHU – Otto Beisheim School of Management, Burgplatz 2, 56179 Vallendar, Germany,
mark.harwardt@whu.edu

## Abstract

*This work investigates the effects that different success criteria and their dimensions may have on the success of IT projects. It focuses on a model that represents the management's view of the success of an IT project. This is of particular interest due to demand for developing and examining such a model. To show the effects of the success criteria and their dimensions a survey of 646 participants was conducted. The effects of the criteria and dimensions on IT project success were subsequently studied with structural equation modeling. Because of some inconsistencies within the original model of IT project success a deducted model had to be developed. Some of the success criteria and dimensions had to be rearranged or removed from the original model due to the results of the study. The new model shows that the perception and the results of a project have a significant impact on the success rating of an IT project.*

## Type of Paper and Keywords

Regular research paper: *Project management, IT projects, success criteria, success dimensions, project evaluation*

## 1 INTRODUCTION

Identifying the success of an IT project by the criteria of Iron Triangle (time, budget and quality) [2] is not a new approach [3, 16, 21, 38, 42, 59, 61]. The Iron Triangle can thus be regarded as a traditional approach of rating project success [8, 53, 55].

Nevertheless, experts have always criticized the Iron Triangle for the following reasons: The Iron Triangle rates a project on the level of its conduction [54]. The actual project success though may arise with a temporal delay to its completion, e.g. sales figures, turnover or won market share. A temporal interval should thus be given between the completion of a project and the rating of its success [16, 21, 44, 48, 57]. Since the Iron Triangle mainly measures the success of the project management process, it depicts only one aspect of the overall performance of a project [36, 44, 46]. Project success should thus be understood as a multidimensional construct [3, 33, 36, 44, 57, 59], meaning that projects can still be successful even if they do not match the Iron Triangle's criteria [21, 22, 33, 44, 59, 61]. A wide range of researchers argue that the targets like completion date, budget and quality cannot be reliably estimated at the beginning of a project, since they are frequently subject to changes during the life circle [40, 53] of the project. Rating a project based on imprecise estimations thus appears counterproductive, especially as those estimations are often politically biased [25, 39]. The rating of project success depends on the perspective of the respective stakeholder [36, 49, 57, 61]. A project manager may rate a project as successful, while the customer considers it a failure [56].

Even though there is consensus among researchers on the Iron Triangle's inadequacy due to the various points of criticism, there is, on the other hand, no

consensus on which criteria can be considered benchmark regarding the rating of success [1, 2, 3, 8, 16, 21, 22, 38, 4, 42, 49, 59, 61]. The great variety of models dealing with the rating of project success is thus not astonishing, e.g. Baccarini [3], Pinto and Slevin [48] and Shenhar et al. [57].

Due to the increasing significance of IT projects in daily business [54], this research will exclusively focus on models dealing with the success of IT projects. Here, too, a considerable number of widespread models exist, which present a holistic view on IT project success. Harwardt [27] developed the first model of IT project success from the management perspective. The model is a result of a qualitative study with a small sample, so questions arise, e.g. about the potential for broad acceptance and the effects of the success criteria and dimensions presented in the model. Therefore, the main goals of this study are to evaluate the effects of the model and exanimate the acceptance in practice of Harwardt's model [27].

The rest of this paper is structured as follows. Section 2 lays the foundations for this research by reviewing existing models of IT project success and the model developed by Harwardt [27] in particular. In Section 3, the research methodology is explained. Section 4 presents the main results of this study and Section 5 discusses the study results in depth and concludes this work.

## 2 THEORETICAL EMBEDDING

This section will provide the theoretical fundamentals that are necessary for a better understanding of Harwardt's model [27]. To achieve this objective, the most common models of IT project success will be presented first. In the next step, Harwardt's model of IT project success will be explained in depth. Finally, this section will outline the main goals of this study.

### 2.1 Models of IT Project Success

The need to develop success models for the IT sector derives from the frequent changes that success criteria may be subject to depending on the type of project [41, 45, 57]. Thus, it is obvious that the success of a project concerned with the restoration of a historic city center is rated by other success criteria rather than the criteria of IT project success.

Table 1 exemplarily shows the models of IT project success that are often referred to or have been developed in the recent past and that target IT in general or the development and implementation of information systems. The summary shows that the main points of criticism on the classic success rating with the Iron Triangle have meanwhile been implemented:

- Project success is considered as a multidimensional construct [3, 33, 36, 44, 57, 59].
- Success rating does not exclusively rely on the Iron Triangle [2, 40, 53, 62].
- Instead of just rating project conduction and by the efficiency of implementation, success dimensions and success criteria are considered to assure a long-term observation of project success even after project completion [16, 21, 44, 48, 55, 57].
- The perspectives of different stakeholders are integrated into the models [36, 49, 57, 61].

Table 1 shows, though, that currently no model exists which exclusively reflects the management's perspective on IT project success. Various researches, however, now demand the development of such a model [18, 33]. Therefore, in order to address this demand, Harwardt [27] developed a model and this model captures the management's perspective on the success rating of an IT project. The model will be presented in the next subsection.

### 2.2 Model of IT Project Success from a Management Perspective

To develop a model of IT project success from the perspective of management, Harwardt [27] surveyed 21 managers who are all confronted in their daily business routine with the success rating of IT projects. From these surveys, a model of IT project success was derived by extracting those success criteria from the managers' statements which they considered relevant for the success rating of an IT project. In this model, 14 success criteria were identified and summarized in four success dimensions (see Figure 1): *Planning Success*[1], *Implementation Success*, *Perception Success* and *Result Success* [27].

*Planning Success* is the short-term perspective on project success and rates the success of the project management. It is determined by the criteria A*dherence to Schedule*, *Adherence to Budget*, *Achieved Scope*, *Achieved Quality* and *Appropriate Use of Resources*. *Implementation Success* rates the success of the project implementation by the criteria *Cooperation in Project* and *Goal-oriented Proceeding*. *Implementation Success* is thus a short-term success rating of the project, too.

[1] For a better readability, the success dimensions and success criteria are italicized in the paper (with tables and figures excluded).

**Table 1: Models of IT project success**

| Model | Dimensions and Criteria of IT Project Success | Model Goals | Key Findings |
|---|---|---|---|
| **Atkinson [2]** | Dimensions and their success criteria (Dimensions: Criteria):<br>• Iron Triangle: Time, Budget, Quality<br>• Information System: Maintainability, Reliability, Validity, Quality of Information, Use<br>• Benefits for the Organization: Improved Efficiency, Improved Effectiveness, Increased Profit, Strategical Targets, Learning Effects, Less Waste<br>• Benefits for the Stakeholders: Satisfied Users, Social and Ecological Effects, Personal Development, Professional Learning, Profits of Contractors Involved, Sponsors, Satisfaction of Project Team, Economic Effects for Surrounding Community | • Development of a new model of IT project success which exceeds the Iron Triangle | • Emphasis that the Iron Triangle is not suitable for rating project success. Instead, emphasis should be put on the success dimension "Iron Triangle" only when rating the efficiency within a short-term observation during the project conduction.<br>• The more time passes after completion of project, the more significant the dimensions "Information System", "Benefits for the Organization" and "Benefits for the Stakeholders" become for the long-term success rating of an IT project. |
| **Badewi [4]** | Dimensions and their success criteria (Dimensions: Criteria):<br>• Project Management Success: Time, Budget<br>• Project Investment Success: Benefits Generated by Project, Return on Investment | • Examination of effects of project management and benefits management on project success. | • Project management can have a positive influence on project management success and project investment success, while benefits management has a minor influence.<br>• A combination of both methods significantly increases the probability of the success of a project. |
| **Basten, Josten and Mellis [8]** | Dimensions (no nomination of success criteria which form the success dimensions):<br>• Functional Requirements<br>• Operational Requirements<br>• Usability<br>• Process Efficiency<br>• Customer Satisfaction<br>• Adherence to Planning | • Development of a structural equation model for the development of a measurement concept of process success<br>• Verification of effects of process and product success on overall success | • Project Success is defined by the perspective of the project managers<br>• Major effect of functional requirements and operational requirements on customer Satisfaction<br>• Major effect of customer satisfaction and process efficiency on overall success.<br>• Minor effect of adherence to planning |
| **Blaskovics [11]** | Success criteria (no nomination of corresponding dimensions):<br>• Dates<br>• Budget<br>• Quality<br>• Customer Satisfaction<br>• Satisfaction of Stakeholders | • Examination of effects of personal qualities of a project manager on his leadership and his way of managing projects. Additionally, it is shown which methods are being applied by project managers to ensure project success. | • Within the scope of this qualitative study, project success is considered as multidimensional, meaning that projects can be successful even if they do not comply with all success criteria.<br>• It is shown that the way of managing projects influences the choice of methods that are applied to accomplish Project Success. |

**Table 1 (continued): Models of IT project success**

| Model | Dimensions and Criteria of IT Project Success | Model Goals | Key Findings |
|---|---|---|---|
| **DeLone and McLean [20]** | Dimensions and exemplarily named success criteria (Dimensions: Criteria):<br>• Information Quality: Integrity, Easy Intelligibility, Personalization, Relevance, Safety<br>• Quality of System: Adjustability, Availability, Reliability, Response Time, Usability<br>• Service Quality: Trust, Empathy, Reactivity<br>• Use of System: Type of Use, Navigation Pattern, Number of Visits, Number of Executed Transactions<br>• User Satisfaction: Rebuys, Revisits, User Surveys<br>• Essential Benefits: Cost Savings, Market Expansion, Increased Additional Buying, Reduced Search Costs, Time Savings. | • Revision of the model of project success developed in 1992 [19], and dealing with the development of information systems<br>• Consideration of increasing significance of e-commerce | • The three dimensions (Information Quality, Quality of System and Service Quality) form the basis of Success Rating and have immediate influence on Use of System and User Satisfaction.<br>• These two success dimensions can have reciprocal influence (e.g. High User Satisfaction can lead to a High Use of System) and generate benefits (e.g. market expansion).<br>• The resulting benefits can lead to further investment into the system and in turn influence the Use of System and User Satisfaction. |
| **Gable, Sedera and Chan [24]** | Dimensions and their success criteria (Dimensions: Criteria):<br>• Personal Effects: Learning, Alertness, Effectivity, Productivity<br>• Effects on Organization: Costs, Demands on Staff, Cost Reduction, Total Productivity, Improved Results, Improved Capacity, e-Government/Business, Business Processes<br>• Information Quality: Relevance, Availability, Format, Intelligibility, Usability, Conciseness<br>• System Quality: Easy Usability, Easy to Learn, Meeting User Requirements, Functionalities, Accuracy, Flexibility, Complexity, Integration, Adjustability. | • Development of a multidimensional model for rating the success of projects dealing with the implementation of information systems. | • The developed model basically consists of two parts. Part one consisting of effects with the dimensions Personal Effects and Effects on Organization, part two consisting of quality with the dimensions Information Quality and System Quality.<br>• The holistic model is supposed to capture the effects and Perceptions of the Stakeholders at a specific time. |
| **Lech [40]** | Dimensions and their success criteria (Dimensions: Criteria):<br>• Product Success: Achievement of Organizational Goals, Achievement of Economic Goals<br>• Project Management Success: Adherence to Budget, Adherence to Time, Adherence to Quality Specifications (functionalities). | • Examination of both success dimensions and their criteria in practice.<br>• Examination of the Iron Triangle's significance in success rating. | • The Iron Triangle is still frequently applied in practice and is considered as important, but the rating of a project as successful is not subject to it.<br>• Product Success is subordinate to Project Management Success. |

**Table 1 (continued): Models of IT project success**

| Model | Dimensions and Criteria of IT Project Success | Model Goals | Key Findings |
|---|---|---|---|
| **Ifinedo and Nahar [32]** | Dimensions and their success criteria (Dimensions: Criteria):<br>• System Quality: Accuracy of Data, Flexibility, Easy Usability, Easy to Learn, Reliability, Integration of Data, Efficiency, Adjustability, Functionalities, Integration of System, Meeting of User Requirements<br>• Information Quality: Currency, Access Time, Intelligibility, Significance, Briefness, Relevance, Usability, Availability<br>• Provider/Advisor Quality: Support, Credibility, Relations Within the Organization, Experience and Training, Communication<br>• Personal Effects: Creativity, Learning Effects, Productivity, Benefits of Task Execution, Decision-making, Time Saving<br>• Effects on Working Group: Participation, Organization-wide Communication, Coordination, Responsibility, Efficiency, Productivity, Effectivity<br>• Effects on Organization: Cost Reduction, Total Productivity, e-Business/Commerce, Competitive Advantage, Business Processes, Decision-making, Use of Data | • Development of a model for rating ERP systems<br>• Research to determine differences in success rating between a fully developed national economy (Finland) and a just recently developing national economy (Estonia) | • Basically, no significant differences in success rating could be determined.<br>• Participants of research consider Information Quality as the most important success dimension, while Effects on Organization, Personal Effects and Effects on Working Group are considered least important. |
| **Karlsen et al. [37]** | The most important success criteria (5 out of 16, no nomination of corresponding dimensions):<br>• System Works as Expected and solves the problem<br>• Satisfied Users<br>• High Reliability of the System<br>• System Contributes to Improved Efficiency and Competitive Ability<br>• System Contributes to Achievement of Strategical, Tactical and Operational goals | • Identification of the most important rating criteria of a project on the development of information systems<br>• Statements about time of rating and stakeholders involved | • Perspective of different stakeholders is captured, among which are 25 line executives<br>• Users are identified as most important stakeholders and should be considered both in defining the success criteria and during the evaluation of the system.<br>• Long-term success criteria are more important than success criteria that only rate the project management success. As a result, project success should be rated with a delay in time to project completion. |
| **Liu et al. [43]** | Success criteria (no nomination of corresponding dimensions):<br>• Achievement of Project Goals<br>• Execution of Incoming Work<br>• Adherence to Budget<br>• Adherence to Time<br>• Efficient Execution of Tasks<br>• Maintenance of High Working Morale. | • Examination of the effect of changing demands, interpersonal conflicts and manifold demands. | • Project success is not defined as a multidimensional construct.<br>• A negative impact on project success of both changing demands and manifold demands could be verified. |

**Table 1 (continued): Models of IT project success**

| Model | Dimensions and Criteria of IT Project Success | Model Goals | Key Findings |
|---|---|---|---|
| **Saarinen [52]** | Dimensions and their success criteria (Dimensions: Criteria):<br>• Success of Development Process: Characteristics of Information System, Characteristics of Users, Stages of Development, Predictability<br>• Success of Use: Knowledge of Users and their Participation, Staff for Information System<br>• Quality of Developed System: User Interface, Flexibility, Information Quality, Information Content, Format of Information<br>• Impact of System on Organization: Benefit and Changes Generated, Efficiency and Profitability, Support of Decisions and Regulation, Communication and Reorganization. | • Development of a model for projects that implement information systems. | • The model was designed based on theoretical considerations and was validated by help of project managers and line executives. It is only suitable for projects on the development of information systems.<br>• An examination of effects was not conducted. |
| **Thomas and Fernandez [59]** | Dimensions and their success criteria:<br>• Project Management Success: In Due Time, Within Planned Budget, Satisfaction of Project Sponsors, Satisfaction of Execution Committee, Satisfaction of Project Team, Customer/User Satisfaction, Satisfaction of Stakeholders<br>• Technical Success: Customer/User Satisfaction, Satisfaction of Stakeholders, Implementation of System, Conformance to Requirements, Quality of System, Use of System<br>• Economic Success: Business Continuity, Conformance to Economic Goals, Realization of Benefits. | • Development of a multidimensional model of IT project success and replying to the question which measurement method is the most effective. | • The developed model tries to unify different stakeholder perspectives.<br>• Additionally, the model captures the project's interference of the organization's daily business routine by the success criterion Business continuity.<br>• There is no Best-Practice in success rating. Those organizations, however, that define and consistently measure success criteria are the most likely ones to have a chance on maximum project success. |
| **Wateridge [62]** | Success criteria (no notation of success dimensions):<br>• Profitable for Project Sponsor/Owner and Contractor<br>• Achievement of Business Purposes in Three Ways (strategical, tactical and operational)<br>• Achievement of Pre-defined Goals<br>• Adherence to Quality Demands<br>• Implementation According to Specification, Within Scheduled Budget and Time<br>• Satisfaction of All Parties Involved (users, project sponsor and project team) during both Project Run-time and with Project Result. | • Development of a model of IT project success that particularly integrates the perspective of the stakeholders. | • Emphasis that the measuring of project success exceeds the Iron Triangle.<br>• Not every success criterion is suitable for any project and the weighting may change depending on the type of project. The criteria for success rating should therefore be agreed upon with the stakeholders. |

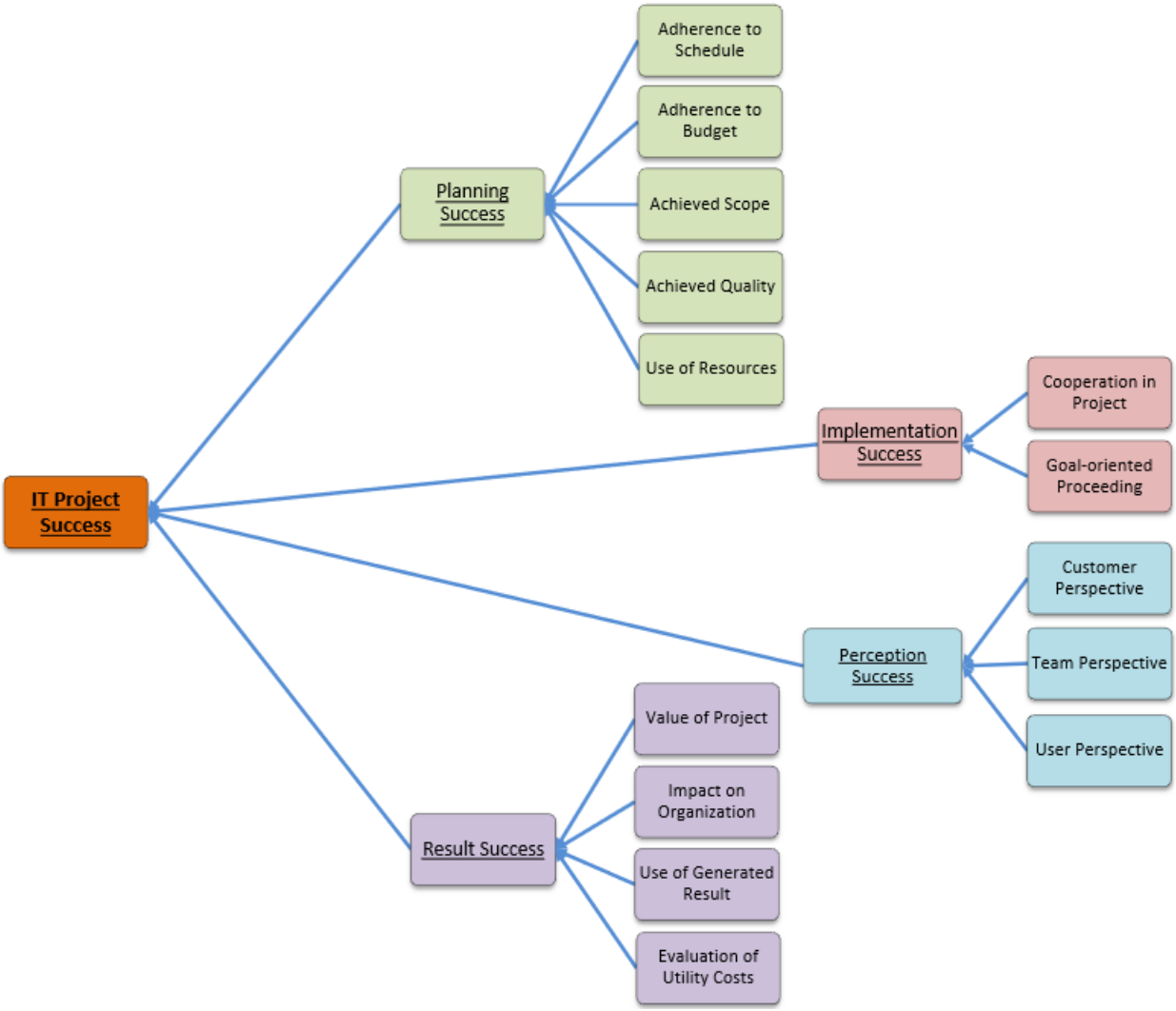


**Figure 1: The model of IT project success from a management perspective – Success dimensions and corresponding success criteria [27]**

## 2.2 Model of IT Project Success from a Management Perspective

To develop a model of IT project success from the perspective of management, Harwardt [27] surveyed 21 managers who are all confronted in their daily business routine with the success rating of IT projects. From these surveys, a model of IT project success was derived by extracting those success criteria from the managers' statements which they considered relevant for the success rating of an IT project. In this model, 14 success criteria were identified and summarized in four success dimensions (see Figure 1): *Planning Success*[2], *Implementation Success*, *Perception Success* and *Result Success* [27].

*Planning Success* is the short-term perspective on project success and rates the success of the project management. It is determined by the criteria A*dherence to Schedule*, *Adherence to Budget*, *Achieved Scope*, *Achieved Quality* and *Appropriate Use of Resources*. *Implementation Success* rates the success of the project implementation by the criteria *Cooperation in Project* and *Goal-oriented Proceeding*. *Implementation Success* is thus a short-term success rating of the project, too.

[2] For reasons of better readability, the success dimensions and success criteria are italicized in the paper (with tables and figures excluded).

The long-term perspective on IT project success is formed by the success dimensions *Perception Success* and *Result Success*. *Perception Success* combines the relevant perspectives of the stakeholders on IT project success. Here, the perspectives of the project team (*Team Perspective*), the customer (*Customer Perspective*) and the end user (*User Perspective*) are taken into consideration. An explicit management perspective is not captured here, since the comprehensive model reflects the management's perspective on IT project success. *Result Success* rates the success by the criteria *Value of Project*, *Impact on Organization*, *Use of Generated Result* and *Evaluation of Utility Costs* [27].

In his research [27], Harwardt tried to determine the relevance of the respective criteria and dimensions: "One may even take one step further by understanding the total of nominations of a success criterion as index for its relevance" [27, p. 42]. By doing so, he reached the conclusion that the success rating is mainly conducted by consideration of the Iron Triangle and thus by consideration of the project management success. The success dimensions *Result Success* and *Perception Success* turned out to be considerably less, but almost of same relevancy. While *Result Success Value of Project* and *Impact on Organization* formed the representative success criteria, with *Perception Success* it was *User Perspective* and *Customer Perspective*. *Implementation Success* is given comparably less attention by the management when rating the success of an IT project [27].

## 2.3 Research Objectives

The model developed by Harwardt [27] is the result of a merely qualitatively designed study. Therefore, the presented assumptions and correlations may be logically justifiable due to foregoing theoretical considerations and on basis of the evaluation of the interviews. The assumptions on the weighting of the respective criteria and dimensions, though, must still be empirically verified.

This paper therefore aims to answer the following questions:

- Q1: How is the model developed by Harwardt [27] seen in practice and which success criteria are missing?
- Q2: Which effects do the success criteria have on their corresponding dimensions?
- Q3: Which effects do the success dimensions have on the overall success of an IT project?
- Q4: How does the evaluated model differ from already existing models of IT project success?

The answers to these questions are both academically and practically relevant. On the one hand, the aforementioned gap in literature will be closed by presenting an extensive model of IT project success from a management perspective. Additionally, the model will attempt to capture the effects of the respective success dimensions and criteria. By this, valuable indications can be won on which aspects of the projects a project manager should devote more attention if the project shall be perceived as an overall success. On the other hand, the results of this research may be of help to managers at reflecting their own understanding of project success. They will be enabled to take on a more differentiated perspective on IT project success, if necessary, and to revise their own practice of rating, meaning that they might, for example, apply additional criteria in the process of the success rating of an IT project.

# 3 METHODOLOGY

This section is aiming to present the methodology underlying this study. Therefore, the development of the measurement model must be explained as well as the way the survey was conducted. Also, it is very important to show how the data collected was evaluated.

## 3.1 Development of Measurement Model

The focus of the research was put on a quantitative examination of the model developed by Harwardt [27] regarding the assumed correlations of effects. To verify them empirically, a suitable measurement model had to be developed first, which allows to ascertain abstract constructs, e.g. *Cooperation in Project* or *Customer Perspective*.

Harwardt developed the model of IT project success by applying the Gioia method [26, 27]. For this, the first step was to assign the relevant statements of the participants to so-called 1st order categories which represent the emphasis with regards to content of the respective statement. In a second step, the 1st order categories were aggregated to 2nd order themes, thus merging statements that were similar in content in a collective generic term. The fourteen 2nd order themes elaborated in this research form the success criteria of IT project success [27].

In order to define items for the measuring of the partly quite abstract success criteria, the twenty-nine 1st order categories identified by Harwardt [27] were referred to and incorporated into the questionnaire (see Figure 2 and Appendix A). This procedure reverses the process of the Gioia method and seems self-evident, since it refers to the original observations and

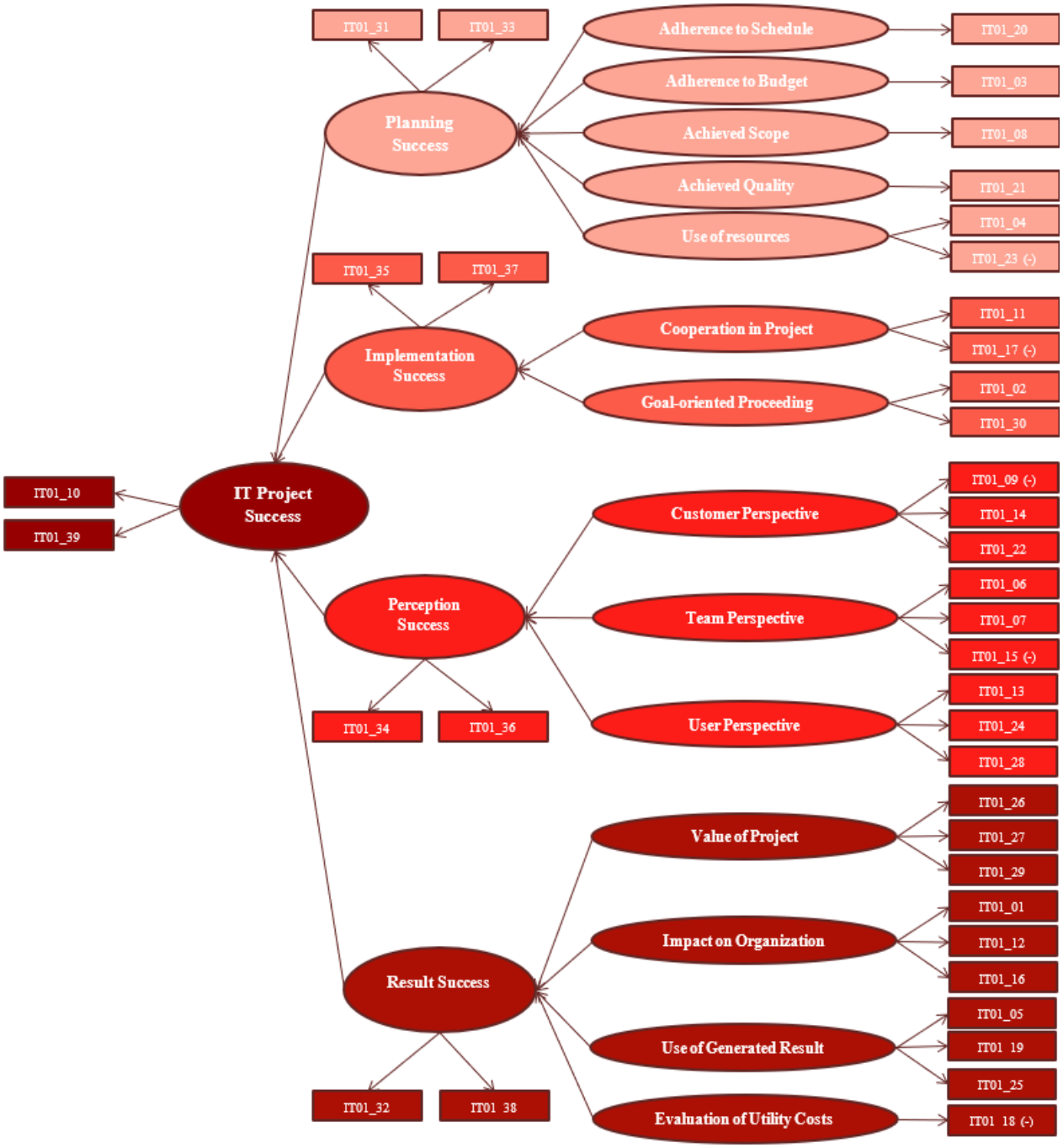


**Figure 2: Measurement model for the success model of project by Harwardt [27]: Measuring categories and corresponding measuring items**

("-" marks negatively formulated items. For a better readability, each dimension and the related success criteria and items have their own color. See Appendix A for the content of each (Item IT01_01, IT01_02...))

experiences of the survey's participants (1st order categories) when operationalizing the success criteria (2nd order themes). The measurement models of the different success criteria are thus all based on the data extracted within the frame of the qualitative examination.

The dimensions and the overall success of an IT project were operationalized, too, and rendered measurable with two items each to preserve a high quality for the following structural equation modeling [12]. All items are reflective indicators, meaning that a correlation is implied between hypothetical construct as independent variable on the one hand and measurement model as dependent variable on the other hand [34]. This seems justified as the items are manifestations of the respective dimension or success criterion. The success criterion of the abstract construct *Value of Project*, for example, manifests in items that capture the relation of receipts and expenditures, the contribution of the project to the operational result and the cost-benefit-ratio of the project.

### 3.2 Conduction of Research

The determined items, together with questions related to the respondents (e.g. their project experience, their organization and their general approval of the model by Harwardt [27]), were merged into a questionnaire on the survey platform SoSci Survey[3]. They were part of research dealing with the effect of servant leadership on IT project success. An online survey was chosen deliberately due to the assumption that the target individuals of the research are very internet savvy because of their job and do not have much time at their disposal for answering questions.

The target individuals of the survey were employees from the IT project management sector who were, due to their job, able to give an expert judgment on how projects are seen and rated in their organization. It was respectively tried to mainly recruit IT project leaders, IT project managers, ScrumMasters and executives from the IT sector for participation in the survey.

The research started on 01/09/2015 with a pretest under the participation of twenty IT project leaders recruited from the author's personal network. Their feedback concerning clarity and handling of the questionnaire was registered and integrated. The final questionnaire went online at SoSci Survey on 10/9/2015. The participants of the survey were recruited via internet platforms, user groups and personal network. Active recruiting of participants was stopped on 30/03/2016. The survey was not finally closed until 20/07/2016, though, due to the expectation of delayed returns.

### 3.3 Evaluation of the Survey

In total, 646 usable returns were won. These were evaluated with R and the additional package Lavaan[4] with the help of the statistical advisory center of the Technical University of Dortmund[5]. In cooperation with the statistical advisory center, the model quality was determined with confirmatory factor analysis and the effects in the model were estimated by covariance-based structural equation modeling.

To examine the general approval of the model by Harwardt [27], this was inquired in a corresponding question in the questionnaire. This inquiry via a single item appears justified as, on the one hand, an overall assessment of a construct should be captured, while, on the other hand, the complexity should be reduced, and the response rate should be significantly raised [10, 51]. Additionally, the participants had the opportunity to express criticism on the model in free text and to point out missing criteria of IT project success.

## 4 Main Results

After the conduction of the survey and the evaluation of data collected the main results will be presented. First, the approval of Harwardt's model [27] in practice will be checked. Subsequently, the effects of this model will be examined.

### 4.1 Sample

Table 2 provides an overview of the individual characteristics of the 646 participants of the survey. It demonstrates that most of the participants had a background in higher education, long-term professional experience and project experience. Here, the long-term project experience is of special significance as it indicates that the intended target group of the survey was actually addressed and reached.

Table 3 provides an overview of the respondents' organizations. Almost all sectors are represented, with a clear accumulation of 45.2% in the sectors IT and e-commerce. This is not surprising, though, as it was intended to recruit specialized personnel from the field of IT projects. Additionally, it is apparent that an almost

[3] www.soscisurvey.de

[4] www.cran.r-project.org

[5] Many thanks to Dipl.-Stat. Swetlana Herbrandt, who supported the examination of data quality and the development of scripts and Structural Equation Modeling in R.

**Table 2: Individual characteristics of participants**

| | Individual Characteristic | Count | Share |
|---|---|---|---|
| **Gender** | Male | 453 | 70.1% |
| | Female | 193 | 29.9% |
| | **Total** | **646** | **100.0%** |
| **Educational qualification** | No graduation | 1 | .2% |
| | General qualification for university entrance | 49 | 7.6% |
| | Professional education | 78 | 12.1% |
| | Bachelor (UAS) | 93 | 14.4% |
| | Bachelor (University) | 58 | 9.0% |
| | Diploma/Master (UAS) | 154 | 23.8% |
| | Diploma/Master/Magister (University) | 172 | 26.6% |
| | Doctor's degree | 32 | 5.0% |
| | None of the above | 9 | 1.4% |
| | **Total** | **646** | **100.0%** |
| **Professional experience** | <= 5 years | 102 | 15.8% |
| | 6 to 15 years | 274 | 42.4% |
| | 6 to 25 years | 165 | 25.5% |
| | 26 to 35 years | 80 | 12.4% |
| | > 35 years | 25 | 3.9% |
| | **Total** | **646** | **100.0%** |
| **Project experience** | <= 5 projects | 96 | 14.9% |
| | 6 to 10 projects | 150 | 23.2% |
| | 11 to 20 projects | 179 | 27.7% |
| | 21 to 30 projects | 100 | 15.5% |
| | > 30 projects | 121 | 18.7% |
| | **Total** | **646** | **100.0%** |

balanced relation of participants could be recruited whose organizations conduct IT projects either as sponsor or contractor.

Table 4 gives insight into the basic type of IT projects with which the participants of the survey are confronted. Here, too, a wide range of project types can be noticed, while the development of individual software and the adjustment of standard software display key aspects. Most of the projects are agile.

## 4.2 Approval of Harwardt's Model

The approval rate of 90.56% of the model by Harwardt [27] is very significant. Only 8.36% of the participants reject the model, while 1.08% abstained from voting (see Table 5). Apart from an overall quite homogeneous spread of approval and rejection, this does not apply for those sectors that could not be assigned to the named categories and were listed in "other". Here, the rejection rate of 15.9% is significantly higher than the average of all sectors with 8.79%. This is not astonishing, though, since even a small number of rejections generates a rejection rate above average due to the small share of participants in this category.

**Table 3: Organizations of the participants**

| | Characteristic of organization | Count | Share |
|---|---|---|---|
| **Sector** | Bank and Insurance | 52 | 8.0% |
| | Service | 57 | 8.8% |
| | Media | 36 | 5.6% |
| | IT and E-Commerce | 285 | 44.1% |
| | Health and Social Affairs | 21 | 3.3% |
| | Trade and Distribution | 71 | 11.0% |
| | Administration and Public Service | 31 | 4.8% |
| | Industry | 49 | 7.6% |
| | Other | 44 | 6.8% |
| | **Total** | **646** | **100.0%** |
| **Con-tractor** | Yes | 270 | 41.8% |
| | No | 376 | 58.2% |
| | **Total** | **646** | **100.0%** |
| **Number of employees** | < 10 employees | 43 | 6.7% |
| | 10 to 50 employees | 82 | 12.7% |
| | 51 to 250 employees | 153 | 23.7% |
| | 251 to 1000 employees | 169 | 26.2% |
| | 1001 to 10.000 employees | 116 | 18.0% |
| | > 10.000 employees | 83 | 12.8% |
| | **Total** | **646** | **100.0%** |
| **Manage-ment level** | First-line management | 194 | 30.0% |
| | Middle management | 302 | 46.7% |
| | Senior management | 150 | 23.2% |
| | **Total** | **646** | **100.0%** |

**Table 4: Projects of the respondents**

| | Characteristic of projects | Count | Share |
|---|---|---|---|
| **Staff on project** | 1 to 5 employees | 121 | 18.7% |
| | 6 to 10 employees | 238 | 36.8% |
| | 11 to 20 employees | 138 | 21.4% |
| | 21 to 50 employees | 98 | 15.2% |
| | > 50 employees | 51 | 7.9% |
| | **Total** | **646** | **100.0%** |
| **Run-time of project** | < 1 month | 41 | 6.3% |
| | 1 month to 3 months | 106 | 16.4% |
| | 4 months to 6 months | 162 | 25.1% |
| | 7 months to 12 months | 187 | 28.9% |
| | > 12 months | 150 | 23.2% |
| | **Total** | **646** | **100.0%** |
| **Execu-tion** | Yes | 347 | 53.7% |
| | No | 299 | 46.3% |
| | **Total** | **646** | **100.0%** |
| **Types of projects** | Counseling projects | 47 | 7.3% |
| | Infrastructure projects | 57 | 8.8% |
| | Databases and Migration | 43 | 6.7% |
| | Development/Integration of individual software | 184 | 28.5% |
| | Adjustment/Implementation of standard software | 140 | 21.7% |
| | Hardware projects | 25 | 3.9% |
| | E-Commerce | 113 | 17.5% |
| | Other | 37 | 5.7% |
| | **Total** | **646** | **100.0%** |

**Table 5: Approval of the model by Harwardt [27]**

| Item | Value | Total | Approval | Share approval | Rejection | Share rejection | Abstention | Share abstention |
|---|---|---|---|---|---|---|---|---|
| **Gender** | Female | 193 | 174 | 90.16% | 16 | 8.29% | 3 | 1.55% |
| | Male | 453 | 411 | 90.73% | 38 | 8.39% | 4 | .88% |
| | **Total** | **646** | **585** | **90.56%** | **54** | **8.36%** | **7** | **1.08%** |
| **Sectors** | Bank, Insurance | 52 | 47 | 90.38% | 3 | 5.77% | 2 | 3.85% |
| | Service | 57 | 51 | 89.47% | 6 | 1.53% | 0 | .0% |
| | Media | 36 | 32 | 88.89% | 3 | 8.33% | 1 | 2.78% |
| | IT and E-Commerce | 285 | 257 | 90.18% | 24 | 8.42% | 4 | 1.40% |
| | Health, Social Affairs | 21 | 19 | 90.48% | 2 | 9.52% | 0 | .0% |
| | Trade, Distribution | 71 | 69 | 97.18% | 2 | 2.82% | 0 | .0% |
| | Administration, Public Service | 31 | 28 | 90.32% | 3 | 9.68% | 0 | .0% |
| | Industry | 49 | 45 | 91.84% | 4 | 8.16% | 0 | .0% |
| | Other | 44 | 37 | 84.09% | 7 | 15.91% | 0 | .0% |
| | **Total** | **646** | **585** | **90.56%** | **54** | **8.36%** | **7** | **1.08%** |
| **Con-tractor** | Yes | 270 | 238 | 88.15% | 28 | 1.37% | 4 | 1.48% |
| | No | 376 | 347 | 92.29% | 26 | 6.91% | 3 | .8% |
| | **Total** | **646** | **585** | **90.56%** | **54** | **8.36%** | **7** | **1.08%** |
| **Agile** | Yes | 347 | 311 | 89.63% | 32 | 9.22% | 4 | 1.15% |
| | No | 299 | 274 | 91.64% | 22 | 7.36% | 3 | 1.00% |
| | **Total** | **646** | **585** | **90.56%** | **54** | **8.36%** | **7** | **1.08%** |

**Table 6: Missing success criteria**
(Frequency of nomination in brackets)

| Model in general | Missing success criteria |
|---|---|
| Dependencies of success dimensions are not considered (1) | Counseling Success (1) |
| Stakeholder perspective as individual dimension (1) | Change Management (2) |
| Vague classification of dimensions (1) | Application of Appropriate Technology (1) |
| Too simple (1) | Emotional Intelligence (1) |
| Too generic (1) | Experience from Former Projects (2) |
| | IT-Alignment (1) |
| | Communication (2) |
| | Project Marketing (1) |
| | Quality of Staff (2) |
| | Risk Management (2) |
| | Stakeholder Participation (2) |
| | Stakeholder Analysis (2) |
| | Pride of Staff (1) |
| | Appreciation of Staff (1) |

Despite the overall large approval of the model, criticism is expressed on either the model itself or on missing success criteria. A corresponding overview can be found in Table 6. The model by Harwardt [27] was considered complete for further research. On the one hand, there is large approval for the model. On the other hand, both criticism on the model and the missing success criteria represent individual opinions regarding their frequency of nomination.

## 4.3 Weakness of the Model

Despite the large approval of the model by Harwardt [27], it was subjected to a more detailed examination with help of the data gathered in the quantitative survey. In a first step, the reliability of the measurement model was examined. For this, the indicator reliability was determined to identify the share of variance of an item which is explained by its corresponding construct. Here, a threshold of .4 should not be underrun [7].

As Table 7 shows that the items IT01_06, IT01_09, IT01_23, IT01_25 and IT01_37 of the constructs *Use of Resources*, *Goal-oriented Proceeding*, *Customer Perspective*, *Team Perspective*, *Use of Generated Result* and *Implementation Success* do not reach this threshold of .4. Above this, the indicator reliability for item IT01_35 of *Implementation Success* could not be determined due to negatively estimated variances. Negative variances are an indicator for structural problems [63]. The model was therefore examined more closely.

Regarding Cronbach's Alpha for the determination of the internal consistency [47, 63] difficulties arise, too. As Table 7 shows that the success criteria *Appropriate Use of Resources* and *Goal-oriented Proceeding* have values below .7 for Cronbach's Alpha. According to Nunnally and Bernstein [47] those sets of indicators must be rejected. Additionally, the determined values of Cronbach's Alpha for *Customer Perspective*, *Team Perspective* and *Use of Generated Result* indicate that

**Table 7: Quality criteria on construct level of the original model [27]**
(Red marked items and their factors needed to be revised)

| Factor | Item | Indicator reliability | Cronbach's Alpha | Average extracted variance | Factor reliability | Fornell/Larcker-Criterion |
|---|---|---|---|---|---|---|
| Adherence to Schedule | IT01_ 20 | Rating by single item | | | | |
| Adherence to Budget | IT01_ 03 | Rating by single item | | | | |
| Achieved Scope | IT01_ 08 | Rating by single item | | | | |
| Achieved Quality | IT01_ 21 | Rating by single item | | | | |
| Appropriate Use of Resources | IT01_ 04 | .426 | .593 | .366 | .535 | Not fulfilled |
| | IT01_ 23 | .306 | | | | |
| Cooperation in Project | IT01_ 11 | .709 | .745 | .599 | .748 | Fulfilled |
| | IT01_ 17 | .490 | | | | |
| Goal-oriented Proceeding | IT01_ 02 | .401 | .514 | .329 | .492 | Not fulfilled |
| | IT01_ 30 | .256 | | | | |
| Customer Perspective | IT01_ 09 | .290 | .717 | .499 | .744 | Not fulfilled |
| | IT01_ 14 | .586 | | | | |
| | IT01_ 22 | .621 | | | | |
| Team Perspective | IT01_ 06 | .331 | .746 | .519 | .761 | Not fulfilled |
| | IT01_ 07 | .643 | | | | |
| | IT01_ 15 | .584 | | | | |
| User Perspective | IT01_ 13 | .514 | .756 | .505 | .753 | Not fulfilled |
| | IT01_ 24 | .468 | | | | |
| | IT01_ 28 | .532 | | | | |
| Value of Project | IT01_ 26 | .592 | .819 | .606 | .821 | Not fulfilled |
| | IT01_ 27 | .542 | | | | |
| | IT01_ 29 | .682 | | | | |
| Impact on Organization | IT01_ 01 | .455 | .759 | .503 | .752 | Not fulfilled |
| | IT01_ 12 | .540 | | | | |
| | IT01_ 16 | .514 | | | | |
| Use of Generated result | IT01_ 05 | .520 | .714 | .443 | .697 | Not fulfilled |
| | IT01_ 19 | .578 | | | | |
| | IT01_ 25 | .231 | | | | |
| Evaluation of Utility Costs | IT01_ 18 | Rating by single item | | | | |
| Planning Success | IT01_ 31 | .841 | .905 | .768 | .869 | Fulfilled |
| | IT01_ 33 | .695 | | | | |
| Implementation Success | IT01_ 35 | indeterminate | .767 | .711 | .823 | Fulfilled |
| | IT01_ 37 | .381 | | | | |
| Perception Success | IT01_ 34 | .630 | .849 | .740 | .850 | Fulfilled |
| | IT01_ 36 | .850 | | | | |
| Result Success | IT01_ 32 | .902 | .848 | .741 | .850 | Fulfilled |
| | IT01_ 38 | .579 | | | | |
| IT Project Success | IT01_ 10 | .939 | .893 | .817 | .899 | Fulfilled |
| | IT01_ 39 | .694 | | | | |

the internal consistency can be enhanced by omitting items.

The average extracted variance and the factor reliability too raise problems regarding the thresholds demanded in literature. They determine the degree of variance of all indicators of a construct, which is explained by the construct itself [23, 63]. As to the average extracted variance, a threshold of .5 should not be underrun [23]. In the model at hand the average extracted variance of the success criteria *Appropriate Use of Resources*, *Goal-oriented Proceeding*, *Customer Perspective* and *Use of Generated Result* does not reach the threshold of .5. The same applies for the factor reliability where the criteria *Appropriate Use of Resources* and *Goal-oriented Proceeding* do not reach the suggested threshold of .6 [6]. The weaknesses identified at the examination of the reliability are tightened by the quality testing of the comprehensive model (see Table 8). The Root Mean Square Error of Approximation examines how close a model gets to the reality found in the data [13, 63]. Here it is .075 and thus below the threshold of 0.08, which is suggested in

**Table 8: Quality of the original model by Harwardt [27]**

| Measurement | Abbreviation | Model Value | Threshold Value |
|---|---|---|---|
| Chi-Square test statistic | $\chi^2$ | 2999.623 | - |
| Degrees of freedom | df | 643 | - |
| Relation $\chi^2$/df | - | 4.665 | <= 3 [30] |
| Root Mean Square Error of Approximation | RMSEA | .075 | <= .08 [13] |
| Root Mean Square Residual | RMR | .256 | small values [35] |
| Standardized Root Mean Square Residual | SRMR | .209 | <= .08 [31] |
| Tucker-Lewis Index | TLI | .826 | >= .95 [31] |
| Comparative Fit Index | CFI | .847 | >= .9 [29] |

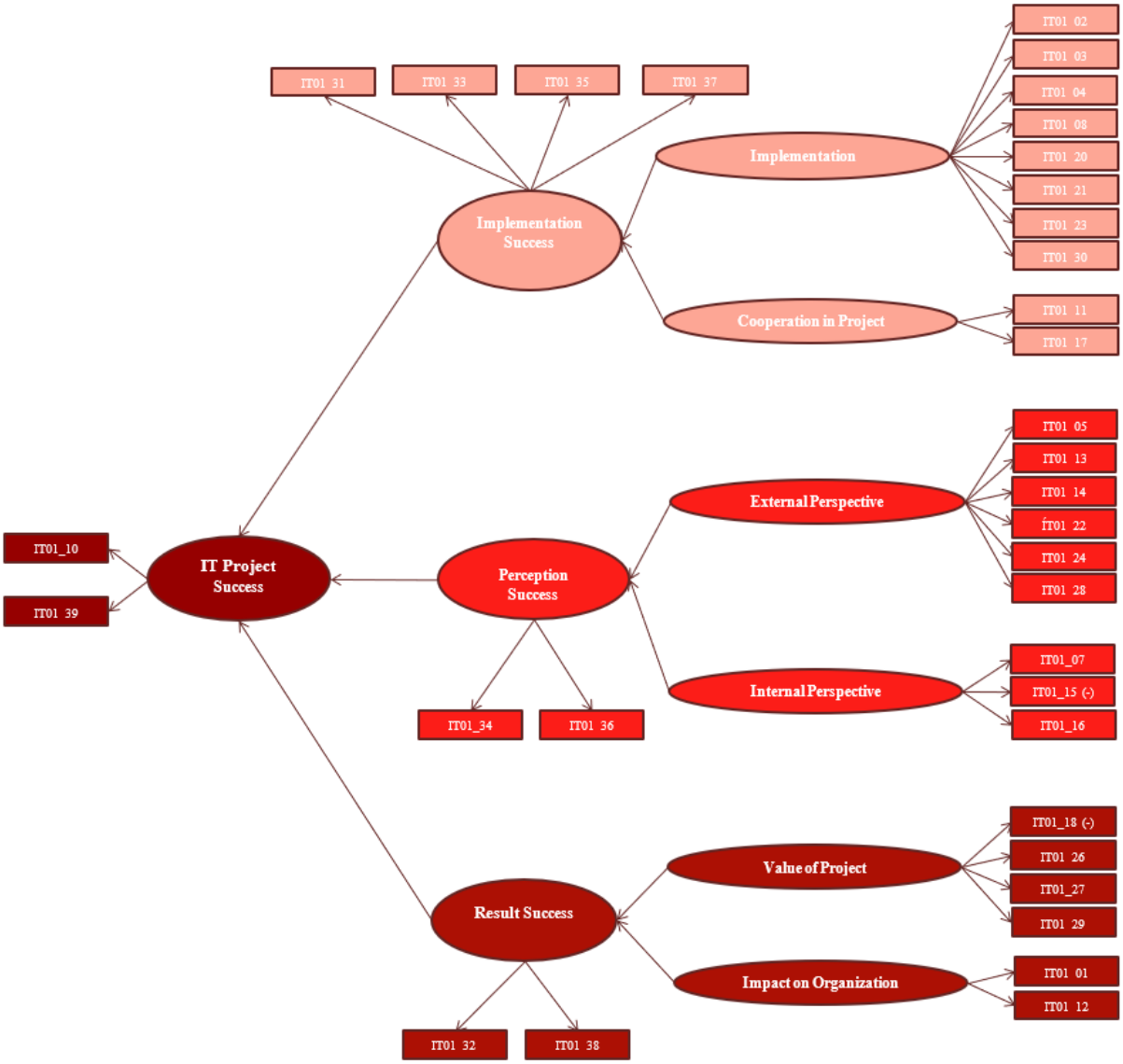


**Figure 3: Revised measurement model of IT project success**
(Each dimension and their success criteria and items are depicted with different colors for a better readability)

literature [13]. At first sight, the model seems to adequately approximate the reality found in the data. The Root Mean Square Residual determines the deviations of the empirical and model-based covariance matrix [58]. The Root Mean Square Residual has a scale which starts at zero and is open-ended. It measures the difference between the observed values and the values predicted by the model. The smaller the value, the less deviations between estimated values by the model and observed values exist. Therefore, the model approximates reality [35]. With a value of .256 for the model, though, a high adaption to reality cannot be assumed. The Standardized Root Mean Square Residual eliminates the problem of the open-ended scale and should be smaller than .08 [63]. Here, too, a value of .209 does speak in favor of a good approximation to reality.

The Tucker-Lewis-Index and the comparative fit index are incremental fit indices that compare the established model to an entirely uncorrelated independency model [9, 60]. Both indices can take on values between zero and one, with values close to 1 proving that the model differs significantly from the independency model and is thus rich in content. With respect to the Tucker-Lewis-Index, a threshold of .95 and higher is often applied [31], in terms of the comparative fit index the threshold is .9 and higher [29]. Both are not being fulfilled in this case. In total, only the Root Mean Square Error of Approximation fulfills the demanded thresholds so that the comprehensive model must be rejected.

## 4.4 Development of an Intermediate Model

As a result, a new model was deduced to countervail the weak points of the original model (see Figure 3). Due to their poor values regarding the internal consistency, the success criteria *Appropriate Use of Resources* and *Goal-oriented Proceeding* were questioned and removed from the model. The discharged items were, together with the items of the success criteria *Adherence to Budget*, *Adherence to Schedule*, *Achieved Quality* and *Achieved Scope*, combined into the new success criterion *Implementation*.

The success factors *Customer Perspective*, *Team Perspective* and *Use of Generated Result* offered possibilities to enhance the internal consistency by omitting the items IT01_05, IT01_06 and IT01_09. A high correlation was detected between *Customer Perspective* and *User Perspective*. This may be linked to the fact that users who are satisfied with the project result may in turn have a significant influence on the perspectives of both customer and sponsor. Therefore, these success criteria were merged into the success criterion *External Perspective*.

Because of the poor values for indicator reliability of item IT01_25 and the average extracted variance, the success criterion *Use of Generated Result* was again critically revised, resulting in doubts on the success criterion's and its items' suitability: Not every project result, for example, is intended for long-term use since prototypes and evaluations of new technologies may be topics of projects, too. Moreover, the designated use of a developed solution does not necessarily have to be a characteristic of a successful project as, for example, other application areas for the developed solution may be detected during or after the run-time of the project.

Additionally, the general requirements of the organization may change during the project's run-time, causing the focus of the project to digress from its original purpose. For these reasons, the success criterion *Use of Generated Result* with the items IT01_19 and IT01_25 was eliminated from the model. Item IT01_05 was assigned to the success criterion *External Perspective* because it rates the adaptability of the developed solution from the customer's perspective. Item IT01_18 rates if the calculated follow-up costs of the project meet the expectations. This rating refers to the monetary disadvantages accompanying an excess of the projected follow-up costs. Therefore, high follow-up costs may affect the value that a project can bring to the organization, so this item was assigned to the success criterion *Value of Project*.

Topical overlapping and dependencies were identified between the success dimensions *Planning Success* and *Implementation Success*. A proper use of resources may be considered as proof for good planning and efficient project implementation. Moreover, successful planning can be seen as a precondition for an efficient implementation. One may also assume reciprocal effects between project planning and project implementation as, for example, the objectives of a project may change during its run-time [40, 53]. As a result, the dimensions *Planning Success* and *Implementation Success* and their success criteria were combined into the success dimension *Project Management Success* because it rates the project management to evaluate the efficiency of project planning and implementation [2, 57]. The items of the original dimensions *Planning Success* and *Implementation Success* were transferred to the new success dimension *Project Management Success*.

Because of the high correlation between *User Perspective* and *Customer Perspective*, these success criteria were, as described, merged into the *External Perspective* on the project. *Team Perspective* was accordingly renamed as *Internal Perspective* to reflect the project staff's perspective on the project. In this context, the item IT01_16 was disassociated from the

**Table 9: Quality criteria on construct level of intermediate model**
(Red marked items and their factors needed to be revised)

| Factor | Item | Indicator reliability | Cronbach's Alpha | Average extracted variance | Factor reliability | Fornell/Larcker-Criterion |
|---|---|---|---|---|---|---|
| Implementation | IT01_02 | .474 | .873 | .476 | .878 | Not fulfilled |
| | IT01_03 | .572 | | | | |
| | IT01_04 | .556 | | | | |
| | IT01_08 | .497 | | | | |
| | IT01_20 | .540 | | | | |
| | IT01_21 | .521 | | | | |
| | IT01_23 | .364 | | | | |
| | IT01_30 | .285 | | | | |
| Cooperation in Project | IT01_11 | .727 | .745 | .605 | .752 | Fulfilled |
| | IT01_17 | .483 | | | | |
| External Perspective | IT01_05 | .556 | .878 | .552 | .881 | Not fulfilled |
| | IT01_13 | .540 | | | | |
| | IT01_14 | .562 | | | | |
| | IT01_22 | .612 | | | | |
| | IT01_24 | .505 | | | | |
| | IT01_28 | .538 | | | | |
| Internal Perspective | IT01_07 | .628 | .808 | .588 | .811 | Not fulfilled |
| | IT01_15 | .588 | | | | |
| | IT01_16 | .549 | | | | |
| Value of Project | IT01_18 | .427 | .828 | .551 | .830 | Not fulfilled |
| | IT01_26 | .616 | | | | |
| | IT01_27 | .509 | | | | |
| | IT01_29 | .653 | | | | |
| Impact on Organization | IT01_01 | .526 | .740 | .585 | .738 | Not fulfilled |
| | IT01_12 | .645 | | | | |
| Project Management Success | IT01_31 | .808 | .881 | .687 | .895 | Fulfilled |
| | IT01_33 | .865 | | | | |
| | IT01_35 | .750 | | | | |
| | IT01_37 | .327 | | | | |
| Perception Success | IT01_34 | .625 | .849 | .739 | .849 | Fulfilled |
| | IT01_36 | .852 | | | | |
| Result Success | IT01_32 | .918 | .848 | .749 | .855 | Fulfilled |
| | IT01_38 | .581 | | | | |
| IT Project Success | IT01_10 | .946 | .893 | .827 | .905 | Fulfilled |
| | IT01_39 | .710 | | | | |

**Table 10: Quality of revised model**

| Measurement | Abbreviation | Revised model | Thresholds |
|---|---|---|---|
| Chi-Square test statistic | $\chi^2$ | 1445.701 | - |
| Degrees of freedom | df | 536 | - |
| Relation $\chi^2$/df | - | 2.697 | <= 3 [30] |
| Root Mean Square Error of Approximation | RMSEA | .051 | <= .08 [13] |
| Root Mean Square Residual | RMR | .054 | small values [35] |
| Standardized Root Mean Square Residual | SRMR | .043 | <= .08 [31] |
| Tucker-Lewis Index | TLI | .933 | >= .95 [31] |
| Comparative Fit Index | CFI | .940 | >= .9 [29] |

success criterion *Impact on Organization* and instead rated by the internal perspective here. After the removal of the tem IT01_16 the success criterion *Impact on Organization* was renamed more accurately as *Impact on Organization*. Those items that could not be assigned to a success criterion or for which no new criterion could be created, were removed from the model to avoid single item ratings and to generate a model of the highest significance possible [12].

Despite the model of Harwardt [27] having been subject to major changes now, this procedure is not arbitrary for the following reasons:

- The large approval of the model in practice shows that it contains a multitude of relevant information. Therefore, the model represents a solid basis for further developments.
- The revised model is still based on the items developed from the qualitative work of Harwardt [27]. The new model thus orientates on the originally available database and corrects the structural problems in terms of negative variances that appeared during the evaluation.
- The assignment of items to success criteria and of success criteria to success dimensions was executed by detecting factually logical correlations and by evaluating and interpreting the available quality criteria.

The newly deduced model immediately shows enhanced values at the examination of reliability (see Table 9). It is only for the indicator reliability of theitems IT01_23 and IT01_30 of the success criterion *Implementation* and for the item IT01_37 of the success criterion *Project Management Success* that the determined values are below the threshold of .4 [7]. The determined values for Cronbach's Alpha for these two success criteria also show that further optimization is possible.

The quality criteria of the revised model are significantly enhanced, too (see Table 10). The relation of the Chi-Square test statistic and the degrees of freedom of the model, the Root Mean Square Error of Estimation and the Standardized Root Mean Square Residual are below the demanded thresholds [30, 13, 31].

## 4.5 Development of the Final Model

Due to the enhanced values regarding reliability and model quality, only minor revisions of the model were made in a last step. The items IT01_23, IT01_30 and IT01_37 were eliminated from the model in order to increase the internal consistency. Item IT01_02 was additionally eliminated from the model as it rated redundantly to other items (see Figure 4).

The operating figures on reliability that were determined by the model revised last do not provide further indicators for possible revisions (see Table 11). The reliability of the measurement model can thus be presumed.

The evaluation of the validity, though, is more complex. Content validity exists when the indicators of a construct represent it in a semantically comprehensive form [63]. Content validity can be presumed due to two factors: On the one hand, the success criteria and success dimensions as well as their items were extracted from statements of IT executives. On the other hand, the different measurement models were validated by experts from research and practice [17]. Moreover, the high correlations between each construct's items, which are to be found in Appendix B, Table 15, suggest content validity [28].

The construct validity states, in how far the measuring of a construct is influenced by other factors or structural errors [63]. To examine the construct validity, nomological validity is resorted first. It verifies whether the correlations presented in the model are logically justifiable and whether they are presented on a solid theoretical basis. Due to the theoretical derivation of the model [27], nomological validity can be initially assumed. Since the quality criteria of the comprehensive model (see Table 12), as well as the determined effects in the model (see Table 13), collectively support the model, the assumption of nomological validity seems plausible [5, 28].

With help of the convergent validity it is examined whether the measuring of a factor differs if two different methods are applied [23, 63]. Since this procedure proved to be very expensive in practice, an alternative procedure is often applied [63]: According to Fornell and Larcker [23] convergent validity is given when the average extracted variance of each factor is higher than the threshold of 0.5. As seen in Table 11, this applies to each factor, meaning that convergent validity can be assumed.

Additionally, it is examined by means of the Fornell/Larcker-Criterion if discriminant validity is present. The discriminant validity states if there is a significant difference in the measuring of different factors [23, 63]. The Fornell/Larcker-Criterion puts the average extracted variance of a construct in relation to the squared correlations of other factors. The average extracted variance should always be higher than the squared correlations. [23]. Table 11 shows, though, that this criterion is not fulfilled everywhere.

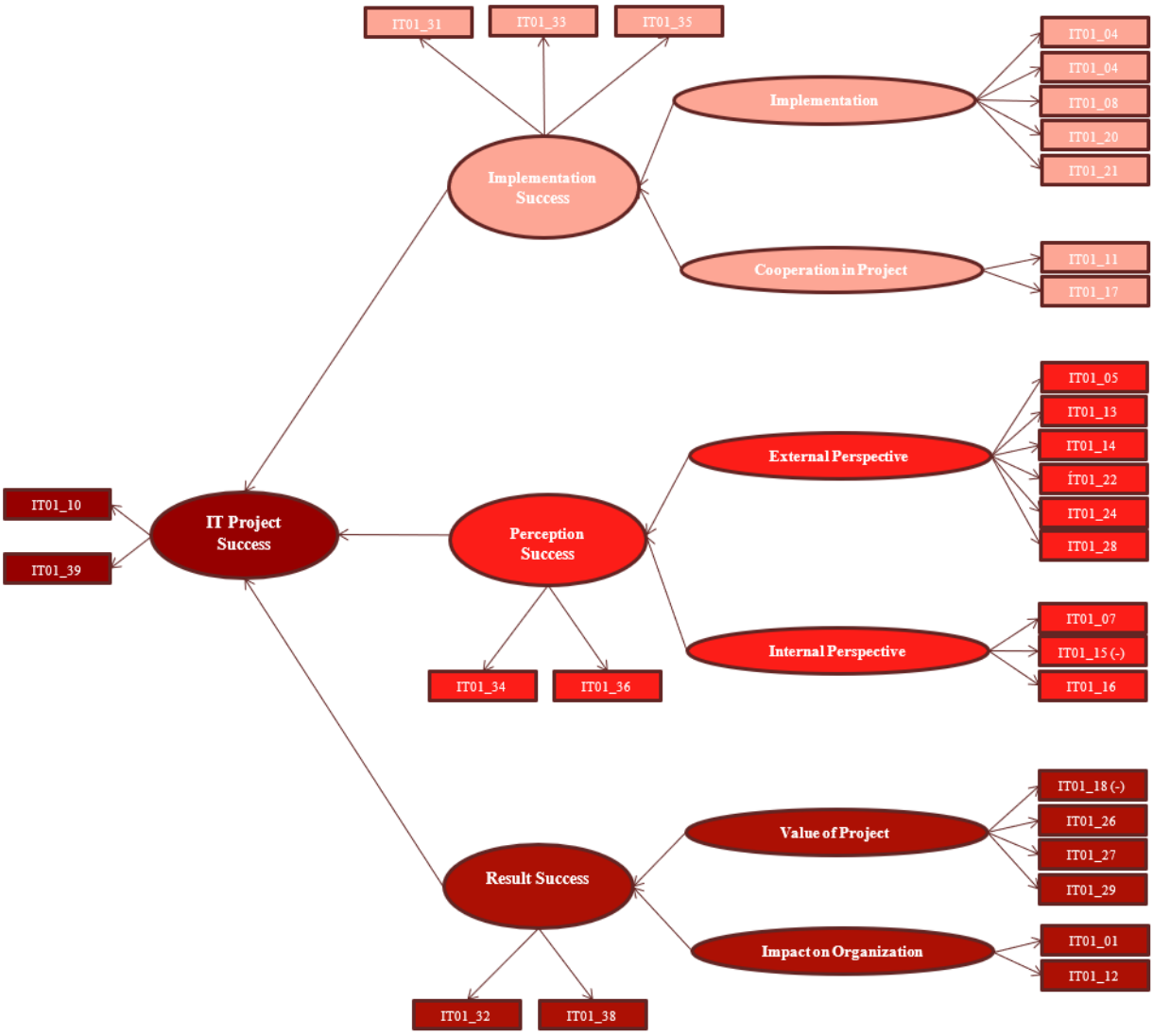


**Figure 4: Measurement model of the final model**
(Each dimension and the related success criteria and items are depicted with different color for a better readability)

To verify the discriminant validity, some researchers recommend looking at the correlations between the items of the respective factor and those of other items instead. If at least half of all possible correlations between the items of the factor and other items is smaller than the correlation between the items of the respective factor, discriminant validity can be assumed [14, 50]. Table 14 shows how large the possible correlations between the items of a factor and the remaining items are, and how many items are smaller than the correlations of the items of the respective factor. It can be stated for each factor that at least 50% of all possible correlations with the remaining items are smaller than the correlations of the items of the respective factor. Discriminant validity can thus be assumed.

Since nomological validity, convergent validity and discriminant validity were proven, construct validity can now be assumed in total. Under additional consideration of content validity, a valid measurement model is present.

In comparison to the former model, the model quality of the comprehensive model has slightly improved again, too (see Table 12). Even though the threshold of .950 for the Tucker-Lewis-Index [31] could not be met completely, a model of high quality can be assumed due to the rest of the figures. Even though the iterative proceeding reduced the number of success criteria and success dimensions in comparison to the original model, the revised model lost only a little of its original significance since it is still mainly based on the data that was determined within the scope of the qualitative research [27].

**Table 11: Quality criteria on construct level of final model**
(Red marked items and their factors needed to be revised)

| Factor | Item | Indicator Reliability | Cronbach's Alpha | Average Extracted Variance | Factor reliability | Fornell/Larcker-Criterion |
|---|---|---|---|---|---|---|
| Implementation | IT01_ 03 | .590 | .855 | .547 | .858 | Not fulfilled |
| | IT01_ 04 | .557 | | | | |
| | IT01_ 08 | .515 | | | | |
| | IT01_ 20 | .555 | | | | |
| | IT01_ 21 | .520 | | | | |
| Cooperation in Project | IT01_ 11 | .731 | .745 | .606 | .753 | Fulfilled |
| | IT01_ 17 | .481 | | | | |
| External Perspective | IT01_ 05 | .556 | .878 | .552 | .881 | Not fulfilled |
| | IT01_ 13 | .541 | | | | |
| | IT01_ 14 | .561 | | | | |
| | IT01_ 22 | .611 | | | | |
| | IT01_ 24 | .503 | | | | |
| | IT01_ 28 | .538 | | | | |
| Internal Perspective | IT01_ 07 | .629 | .808 | .588 | .811 | Not fulfilled |
| | IT01_ 15 | .586 | | | | |
| | IT01_ 16 | .550 | | | | |
| Value of Project | IT01_ 18 | .454 | .841 | .565 | .838 | Not fulfilled |
| | IT01_ 26 | .605 | | | | |
| | IT01_ 27 | .552 | | | | |
| | IT01_ 29 | .650 | | | | |
| Impact on Organization | IT01_ 01 | .524 | .740 | .584 | .737 | Not fulfilled |
| | IT01_ 12 | .644 | | | | |
| Project Management Success | IT01_ 31 | .839 | .923 | .801 | .923 | Fulfilled |
| | IT01_ 33 | .847 | | | | |
| | IT01_ 35 | .716 | | | | |
| Perception Success | IT01_ 34 | .625 | .849 | .739 | .849 | Fulfilled |
| | IT01_ 36 | .852 | | | | |
| Result Success | IT01_ 32 | .922 | .848 | .751 | .856 | Fulfilled |
| | IT01_ 38 | .581 | | | | |
| IT Project Success | IT01_ 10 | .946 | .893 | .827 | .905 | Fulfilled |
| | IT01_ 39 | .708 | | | | |

In a next step, the effects in the model were estimated with help of the Structural Equation Modeling (see Table 13). The estimated standardized path coefficients are all positive and hence correlate with the expected effects. Additionally, they are highly significant since each path coefficient holds a p-value of smaller than .01 for a chosen level of significance of 5%. The determined values for the determination coefficient of the success dimensions *Project Management Success*, *Perception Success*, *Result Success* and *IT Project Success* are all higher than .67 and hence substantial [15].

## 5 Discussion of Results

After the presentation of the main results, this section will discuss these research results and the answer the research questions formulated in the Section 2.3.

***Q1: How is the model developed by Harwardt [27] perceived in practice and which success criteria are missing?***

The model developed by Harwardt [27] was highly supported in practice. 585 out of 646 respondents (90.56%) stated that the model is complete and adequately represents IT project success. Only 54 out of 646 respondents (8.36%) did not agree with the model, with 26 participants of the survey naming reasons for their rejection of the model.

Among the reasons named by those who rejected the model, no frequency could be recognized as to which particular success criterion or success dimension is missing. Only the following success criteria were considered as missing by two participants: *Change Management, Use of Experience from Former Projects, Communication in Project, Quality of Staff, Risk Management, Stakeholder Participation and*

**Table 12: Quality of the final model of IT project success**

| Definition | Abbreviation | Final model | Thresholds |
|---|---|---|---|
| Chi-Square test statistic | $\chi^2$ | 1059.149 | - |
| Degrees of freedom | df | 410 | - |
| Relation $\chi^2$/df | - | 2.583 | <= 3 [30] |
| Root Mean Square Error of Approximation | RMSEA | .500 | <= .08 [13] |
| Root Mean Square Residual | RMR | .045 | small values [35] |
| Standardized Root Mean Square Residual | SRMR | .037 | <= .08 [31] |
| Tucker-Lewis Index | TLI | .947 | >= .95 [31] |
| Comparative Fit Index | CFI | .953 | >= .9 [29] |

**Table 13: Effects of the factors in the final model**

| Independent variable | Dependent variable | Standardized path coefficient | p-value | $R^2$ |
|---|---|---|---|---|
| Implementation | Project Management Success | .725 | < .001 | .747 |
| Cooperation in Project | | .228 | < .001 | |
| External Perspective | Perception Success | .553 | < .001 | .678 |
| Internal Perspective | | .290 | .009 | |
| Value of Project | Result Success | .519 | < .001 | .695 |
| Impact on Organization | | .353 | < .001 | |
| Project Management Success | IT Project Success | .130 | < .001 | .711 |
| Perception Success | | .246 | < .001 | |
| Result Success | | .578 | < .001 | |

**Table 14: Examination of correlations of the items of IT project success**

| Factor | Number of items | Half of possible correlations with items of other factors | Smaller than correlations within the factor | Share |
|---|---|---|---|---|
| Implementation | 5 | 65 | 68 | 52.3% |
| Cooperation in Project | 2 | 29 | 58 | 100% |
| External perspective | 6 | 75 | 92 | 61.3% |
| Internal perspective | 3 | 42 | 73 | 86.9% |
| Value of Project | 4 | 54 | 84 | 77.8% |
| Impact on Organization | 2 | 29 | 57 | 98.3% |
| Project management Success | 3 | 42 | 84 | 100% |
| Perception Success | 2 | 29 | 58 | 100 % |
| Result Success | 2 | 29 | 57 | 98.3% |
| IT Project Success | 2 | 29 | 58 | 100 % |

*Stakeholder Analysis*. Due to the lack of frequency in nomination and the overall large approval of Harwardt's model [27] these criteria were not incorporated into the model, though.

Despite the large approval of the model, it must be stated that the model by Harwardt [27] could not be empirically verified. Negative variances that occurred during evaluation of the model with R and Lavaan demonstrated structural problems of the original model. Yet, the model could be revised by help of an iterative optimization process, allowing the derivation of a reliable and valid measurement model and the identification of a Structural Equation Model of high quality. The development of the model was exclusively based on the qualitative research of Harwardt [27], thus keeping the focus on the results gathered there. In comparison to the original model, the final model of IT project success comprises only three success dimensions and six success criteria.

***Q2: Which effects do the success criteria actually have on their corresponding dimensions?***

In a first step the effects of success criteria on their corresponding dimensions were examined. In doing so, it was asserted that *Cooperation in Project* has a considerably minor effect on *Project Management Success* than *Implementation* (see Figure 5). This is of special interest since the success criterion *Implementation* contains the classical success criteria of the Iron Triangle - time, budget and quality. The long-known demand to dissociate from the Iron Triangle in

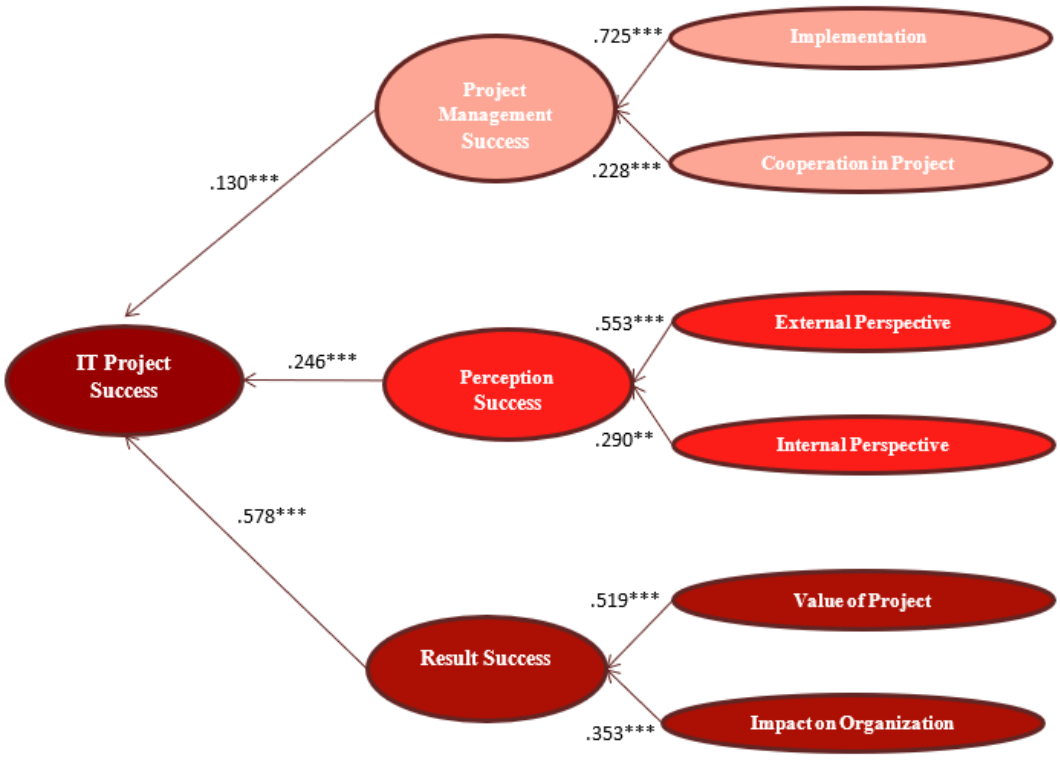


**Figure 5: Effects in the final model**
(*** = highly significant with p-value ≤ .001; ** = very significant with p-value > .001 and ≤ .01)

rating the success of a project [16, 21, 44, 48, 57] does not appear to be implemented in practice yet. A reason for the still high relevance of *Implementation Success* may be based on the Iron Triangle's simple measurability and its semblance of objectivity [36, 44, 61]. This mainly conforms to the results of the evaluation that Harwardt [27] performed subsequently to his development of the model.

Regarding *Perception Success*, it does not seem remarkable that the *External Perspective* has significantly more influence on the *Perception Success* than the *Internal Perspective*: Scarcely anybody will consider a project particularly successful if the project team is satisfied with the project result while the customer and the end users are literally upset with it. This conforms to other models, too, which emphasize the relevance of customers and users for IT project success [2, 8, 11, 20, 37, 59, 62].

It can be stated, though, that the *Internal Perspective* has a considerable influence on the determination of the *Perception Success*. This suggests that the employees, their wishes and their personal goals are being respected in daily project work, which is recommended by other researchers, too [2, 59, 62].

Concerning the effects of *Value of Project* and *Impact on Organization* on the dimension *Result Success*, it can be stated that *Value of Project* assumes the strongest part. The demand of many researchers to consider the strategical and long-term component of a project, too - especially when rating its success [3, 16, 19, 21, 36, 44, 49, 55, 57, 59, 61] - is not only captured by *Value of Project*, but also by *Impact on Organization*. The stronger weighting of *Value of Project* may be related to the difficult and partly very long-term rating of the success criterion *Impact on Organization*.

***Q3: Which effects do the success dimensions have on the overall success of an IT project?***

Regarding the effects of the success dimensions on the overall success of an IT project, the individual dimensions, too, have a clearly diverse weighting. The long-term observation of IT project success in terms of the dimension *Result Success* assumes the most important role at the determination of the overall success of an IT project. *Perception Success* is significant, too, but its effect on the overall success is considerably weaker than that of *Result Success*. *Project Management Success* is hardly considered at the determination of the overall success.

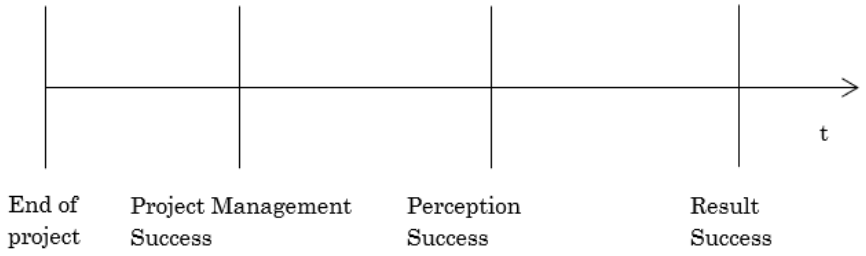


**Figure 6: Valuation chronology of the success dimensions**

These results are similar to the findings in literature since the long-term and strategical observation of project success should be of particular significance for organizations [3, 16, 19, 21, 36, 44, 49, 55, 57, 59, 61]. As *Result Success*, in comparison to *Perception Success* and *Project Management Success*, forms the long-term perspective on IT project success (also see Figure 6) and should be superordinate to the short-term perspectives [56, 57], its collectively major effect on *IT project success* is explainable.

The finding that *Perception Success* has a collectively major effect on the overall success of an IT project than *Project Management Success* is congruent to the demands to postpone the mere efficiency rating in favor of significant success criteria [16, 21, 44, 48, 57]. This is fulfilled by the *Perception Success*, whose *Internal Perspective* and *External Perspective* on IT project success are to be considered medium-term and more significant [3, 16, 48, 56, 57]

The extremely minor effect of *Project Management Success* allows the conclusion that short-term success criteria are by now attributed a minor significance only. This minor significance may additionally be due to the fact that many organizations develop projects according to particular procedure models, yet a success rating of the project management is hardly performed. This applies especially to the context of agile projects. Since projects are often subject to changes in scope during their life-cycle [40, 53], e.g. new functionalities are added, originally intended and partly realized functionalities are discarded, only a good Chance Management allows to retrace whether the guidelines regarding dates and budget were adhered to.

***Q4: How does the evaluated model differ from already existing models of IT project success?***

Due to the great variety of models of IT project success, this part will focus on those models that are often referred to in literature for a definition of IT project success. This would be the models developed by Atkinson [2], DeLone and McLean [19, 20], Thomas and Fernandez [59] and Wateridge [62].

The model by Atkinson [2] was developed to qualify the success criteria and success dimensions of the success of projects on the development of information systems. Atkinson differentiates between the short-term delivery stage and the long-term post-delivery stage. The post-delivery stage comprises the success dimensions *Benefits for Organization* and *Benefits for Stakeholders*. This model of IT project success considers the benefits for the organization and the perspective of the stakeholders on IT project success as well. The *Iron Triangle* and the success dimension *Information System* are found in the delivery stage, which exclusively aims to evaluate the developed information system [2]. This is what differentiates the model constructed in this research from the one by Atkinson, since the model developed here is supposed to be universally valid for all IT projects. Moreover, the model by Atkinson is lacking a criterion that rates the cooperation in project and integrates it into the overall success.

The original model by DeLone and McLean [19] is based on the short-term dimensions *Quality of System* and *Information Quality*, which can be measured immediately on project completion and deal with the information system developed in the project. This short-term consideration of success is missing in the model developed in this research. Harwardt [27] considered the *Use of Generated Result* in his model, yet this success criterion was eliminated from the model in the course of its revision. This seems consequent, as DeLone and McLean [19] put their focus on projects in the setting of information systems, while the model developed here is supposed to be suitable for the success rating of all IT projects from a management perspective.

In comparison to the second revised model by DeLone and McLean [20], which is based on e-commerce projects, the model presented here differentiates once more in the success dimensions *Quality of System* and *Information Quality*, which were re-included in the model. The most significant difference, though, is based on the causality that DeLone and McLean [20] established in their model. The short-term success dimensions affect the dimensions *User Satisfaction* and *Use*, which in turn influence the *Essential Benefits*, meaning the benefits that the e-commerce system generates for the organization [20]. According to DeLone and McLean [20], the *Essential*

*Benefits* are the most important success criterion: "net benefits are the most important success measures as they capture the balance of positive and negative impacts of the e-commerce on our customers, suppliers, employees, organizations, markets, industries, economies, and even our societies", (p. 25, [20]). This is consistent with the model developed in this research since here, too, the *Result Success*, and thus the monetary and strategical success rating, have the largest effect on the overall success of an IT project.

A comparison with the model by Wateridge [62] shows differences, too. Wateridge [62] differentiates between what he considers important success criteria, like *Profitable for Project Sponsor/Owner and Contractor*, *Achievement of Business Goals* in Three Ways (strategical, tactical and operational), *Achievement of Pre-defined Goals*, *Adherence to Quality Thresholds*, *Implementation according to Specifications* (within defined budget and time frame) as well as *Satisfaction of all Parties* Involved (user, project sponsor and project team) during *Run-time of Project and with Project Result*. The model developed in this paper does not strictly differentiate between the profit for project sponsor/owner and contractor since not every project is realized by a contractor and, and the contractors profit is often not assessable. Furthermore, the model by Wateridge [62] distinguishes between the business purpose and the strategical, tactical and operational purposes. A detailed definition of these purposes is not given, though. Yet the main difference is that the model by Wateridge [62] is not subdivided into dimensions and merely states that all success criteria may vary depending on project and perspective.

The model by Thomas and Fernandez [59] consists of the three dimensions *Project Management Success*, *Technical Success* and *Economic Success*. The dimension *Technical Success* hence contains success criteria that exclusively address the success rating of the developed information system: *Use of System*, *System Implementation* and *Quality of System* [59]. The model developed here does not include this exclusive assessment of information systems, as the mere rating of these systems was not the focus of this research. Moreover, the presented model does not consider the success criterion *Business Continuity*, which rates the degree by which business operations were interfered by project work [59].

In summary, some similarities as well as differences to known models of IT project success can be stated. Yet the model developed in this paper significantly differs from other models in two essential aspects:

- The presented model was developed to exclusively reflect the success rating of IT projects from a management perspective. This is achieved by a strong orientation towards the findings of the qualitative research [27].
- The effects of the success criteria on their dimensions and the dimensions' effects on the overall success of an IT project were subject to an extensive empirical examination. Thereby, a high correlation appeared between the determined effects and the theoretical assumptions in technical literature.

## 6 CONCLUSIONS AND SUMMARY

The primary goal of this paper is investigating the effect of different success criteria and their dimensions on the success of an IT project. To lay the foundation for this research, this work first conducts a comprehensive literature review on the models of IT project success which are often referred to in literature. Some researchers argue that a model of IT project success should be developed which reflects the management's perspective on IT project success [18, 33]. Harwardt [27] developed such a model in 2016 as a result of qualitative research, and this model is the basis for this research work. Harwardt's model [27] consists of fourteen success criteria that form four success dimensions: *Planning Success*, *Implementation Success*, *Perception Success* and *Result Success*.

To examine the impact of the success criteria and their dimensions on the success of an IT project, a survey of 646 participants was conducted. Afterwards, the effect of the model was estimated with structural equation modeling. The estimation of Harwardt's original model shows some inconsistencies, so a new model was deducted from the results of the survey with structural equation modeling. The new model is based on Harwardt's work, but it consists of only six success criteria that form three success dimensions: *Implementation Success*, *Perception Success*, and *Result Success*. *Implementation Success* consists of the success criteria *Implementation* and *Cooperation in Project*, while *Perception Success* is formed by *External Perspective* and *Internal Perspective*. The success dimension *Result Success* is now formed by *Value of Project* and *Impact on Organization*.

The evaluation of this model with structural equation modeling shows that *Perception Success* and *Result Success* have the greatest influence on the success of an IT project. With regard to the success criteria, *Implementation*, *External Perspective* and *Value of Project* have the greatest impact on their corresponding success dimension. These results are congruent to findings in literature because the long-term and strategical observation of project success should be of special interest for organizations [3, 16, 19, 21, 36, 44, 49, 55, 57, 59, 61].

**Limitations:** The presented research is subject to certain limitations, too. First, the local limitation must be stated. Since the questionnaire was designed in German language, only participants from Germany, Austria and Switzerland could be recruited for the survey. Furthermore, it must be noted that the approval of Harwardt's model [27] was determined in the course of a quantitative research. It must be seen critically whether the information needed for an appropriate understanding of the model was adequately transported by an online survey. It must also be noted that due to using the online survey, it cannot be determined if and to what extent the participants actually acquainted themselves with the model. Finally, it must be addressed that the newly developed model cannot claim completeness, as several indicators and success criteria as well as one success dimension are missing in comparison to the original model by Harwardt [27]. Although this model is based on the data gathered by Harwardt [27] during his research as well, it cannot be ruled out that the newly developed model lacks components which are significant for the success rating.

**Future Research:** This research proved that Harwardt's model [27] in its present form obtains large approval from practice. Yet, the effects of the model could not be estimated and verified with the help of Structural Equation Modeling. Since the determination of the measurement model was exclusively based on the original data material by Harwardt [27], further quantitative research might prove if the original model can be verified by another measurement model. Furthermore, the survey on missing success criteria demonstrated that there were no urgent indications to question of the completeness of the success criteria. Nevertheless, the significance of success criteria that are currently not strongly demanded, e.g. *Change Management* or *Risk Management*, might vary over the medium or long term, so that an extension of the model would be appropriate. In addition, it should be examined if other factors exist which influence the success of an IT project. It would be conceivable, for example, that the procedure model by which this project is executed has a decisive effect on the success of the project. It might also be possible that other influencing factors which are based on the project leaders, the management or the organization contribute decisively to the perception of a project as successful or less successful.

## REFERENCES


[1] N. Agarwal and U. Rathod, "Defining "Success" for software projects: an exploratory revelation", *International Journal of Project Management*, 24(4), pp. 358-370, 2006.

[2] R. Atkinson: "Project management: cost, time and quality, two best guesses and a phenomenon, its time to accept other success criteria", *International Journal of Project Management*, 17(6), pp. 337-342, 1999.

[3] D. Baccarini: "The logical framework method for defining project success", *Project Management Journal*, 30(4), pp. 25-32, 1999

[4] A. Badewi: "The impact of project management (PM) and benefits management (BM) practices on project success: towards developing a project benefits governance framework", *International Journal of Project Management*, 34(4), pp. 761-778, 2016

[5] R. P. Bagozzi: "The role of measurement in theory construction and hypothesis testing", in O. C. Ferrel, S. W. Brown and C. W. Lamp (eds.), *Conceptional and theoretical developments in marketing*. Chicago, IL: American Marketing Association, pp. 15-33, 1979.

[6] R. P. Bagozzi and Y. YI: "On the evaluation of structural equation models", *Journal of the Academy of Marketing Science*, 16, pp. 74–94, 1988.

[7] R. P. Bagozzi and H. Baumgartner: "The evaluation of structural equation models and hypotheses testing", in R. P. Bagozzi (eds.), *Principles of marketing research*. Cambridge, UK: Blackwell, pp. 386–422, 1994.

[8] D. Basten, D. Joosten and W. Mellis: "Managers' perceptions of information system project success", *Journal of Computer Information Systems*, 52(2), pp. 12-21, 2011.

[9] P. M. Bentler: "Comparative fit indexes in structural models", *Psychological Bulletin*, 107, pp. 238-246, 1990.

[10] L. Bergkvist and J. R. Rossiter: "The predictive validity of multiple-item versus single-item measures of the same constructs", *Journal of Marketing Research*, 44, 175–184, 2007.

[11] B. Blaskovics: "The impact of project manager on project success – the case of ICT sector", *Society and Economy*, 38(2), pp. 261–281, 2016.

[12] K. A. Bollen, *Structural equations with latent variables*. New York, NY: Wiley, 1989.

[13] K. A. Browne and J. S. Cudeck: "Alternative ways of assessing equation model fit", in K. A. Bollen and J. S. Long. (eds.), *Testing structural equation models*. Newbury Park, CA: Sage, pp. 136-162, 1993.

[14] D. T. Campbell and D. F. Fiske: "Convergent and discriminant validation by the multitrait multimethod matrix", *Psychological Bulletin*, 56, pp. 81-105, 1959.

[15] W. W. Chin: "The partial least squares approach for structural equation modeling", in G. Marcoulides (eds.), *Modern methods for business research*. London, UK: Lawrence Erlbaum Associates, pp. 295-336, 1998.

[16] A. Collins and D. Baccarini: "Project success - a survey", *Journal of Construction Research*, 5(2), pp. 211-231, 2004.

[17] L. J. Cronbach and P. e. Meehl: "P. E., Construct validity in psychological tests", *Psychological Bulletin*, 52, pp. 281–302, 1955.

[18] K. Davis: "Different stakeholder groups and their perceptions of project success", *International Journal of Project Management*, 32(2), pp. 189-201, 2014.

[19] W. H. DeLone and E. R. McLean: "Information systems success: the quest for the dependent variable", *Information Systems Research*, 3(1), pp. 60-95, 1992.

[20] W. H. DeLone and E. R. McLean: "The DeLone and McLean model of information systems success: a ten-year update", *Journal of Management Information Systems*, 19(3), pp. 9-30, 2003.

[21] A. de Wit: "Measurement of project success", *International Journal of Project Management*, 6(3), pp. 164-170, 1988.

[22] D. Dvir, S. Lipovetsky, A. J. Shenhar and A. Tishler: "In search of project classification: a non-universal approach to project success factors", *Research Policy*, 27(9), pp. 915-935, 1998.

[23] C. Fornell and D. F. Larcker: "Evaluation structural equation models with unobservable variables and measurement error", *Journal of Marketing Research*, 18, pp. 39–50, 1981.

[24] G. G. Gable, D. Sedera and T. Chan: "Re-conceptualizing information system success: the IS-impact measurement model", *Journal of the Association for Information Systems*, 9(7), pp. 377-408, 2008.

[25] R. L. Glass, J. Rost and M. S. Matook: "Lying on software projects", *IEEE Software*, 25(6), pp. 90-95, 2008.

[26] D. A. Gioia, K. G. Corley and A. L. Hamilton: "Seeking qualitative rigor in inductive research: notes on the Gioia methodology", *Organizational Research Methods*, 16(1), pp. 15-31, 2012.

[27] M. Harwardt: "Criteria of successful IT projects from management's perspective", *Open Journal of Information Systems (OJIS)*, 3(1), pp. 29-54, 2016. [Online]: http://nbn-resolving.de/urn:nbn:de:101:1-201705194797

[28] L. Hildebrandt: „Beurteilung von Kausalmodellen", *Marketing: Zeitschrift für Forschung and Praxis*, 17(3), pp. 162–176, 1995.

[29] C. Homburg and A. Giering: „Konzeptualisierung and Operationalisierung komplexer Konstrukte – Ein Leitfaden für die Marketingforschung", *Marketing: Zeitschrift für Forschung and Praxis*, 18(1), pp. 5–24, 1996.

[30] L. Hu and P. M. Bentler: "Fit indices in covariance structure modeling: Sensitivity to underparameterized model misspecification", *Psychological Methods*, 3, pp. 424-453, 1998.

[31] P. Ifinedo and N. Nahar: "Quality, impact and success of ERP-systems: a study involving some firms in the Nordic-Baltic region", *Journal of Information Technology Impact*, 6(1), pp. 1-28, 2006.

[32] L. A. Ika: "Project success as a topic in project management journals", *Project Management Journal*, 40(4), pp. 6-19, 2009.

[33] C. B. Jarvis, S. B. MacKenzie and P. M. Podsakoff: "A critical review of construct indicators and measurement model misspecification in marketing and consumer research", *Journal of Consumer Research*, 3. pp. 199–218, 2003.

[34] K. G. Jöreskog and D. Sörbom, *LISREL: Analysis of linear structural relationships by the method of maximum likelihood, user's guide, versions V and VI*. Chicago, IL: Scientific Software, 1983.

[35] K. Judgev and R. Müller: "A retrospective look at our evolving understanding of project success", *Project Management Journal*, 36(4), pp. 19-31, 2005.

[36] J. T. Karlsen, J. Andersen, L. S. Birkely and E. Odegard: "What characterizes successful IT projects", International *Journal of Information Technology & Decision Making*, 4(4), pp. 525–540, 2005.

[37] H. Kerzner, *Project management - a systems approach to planning, scheduling and controlling*. 11. Edition. Hoboken, NJ: Wiley, 2013.

[38] R. E. Kraut and L. A. Streeter: "Coordination in software development", *Communications of the ACM*, 38(3), pp. 69-81, 1995.

[39] P. Lech: "Time, budget, and functionality? IT project success criteria revised", *Information Systems Management*, 30(3), pp. 263-275, 2013.

[40] S. Kylindri, G. Blanas, L. Henriksen and T. Stoyan: "Measuring project outcomes: a review of success effectiveness variables", in *Proceedings of 7th Annual MIBIS International Conference*, pp. 212-223, 2012.

[41] D. Lock, *Project Management*. 9. Edition. Aldershot, UK: Gower, 2007.

[42] J. Y. C. Liu, H. G. Chen, C. C. Chen and T. S. Sheu: "Relationships among interpersonal conflict, requirements uncertainty, and software project performance", *International Journal of Project Management*, 29(5), pp. 547–556, 2011.

[43] L. McLeod, B. Doolin and S. G. MacDonell: "A perspective-based understanding of project success", *Project Management Journal*, 43(5), pp. 68-86, 2012.

[44] R. Müller and R. Turner: "The influence of project managers on project success criteria and project success by type of project", *European Management Journal*, 25(4), pp. 298-309, 2007.

[45] A. K. Munns and B. F. Bjeirmi: "The role of project management in achieving project success", *International Journal of Project Management*, 14(2), pp. 81-87, 1996.

[46] J. C. Nunnally and I. H. Bernstein, *Psychometric theory*. 3. Edition. New York, NY: McGraw-Hill, 1994.

[47] J. K. Pinto and D. Slevin: "Project success: definitions and measurement techniques", *Project Management Journal*, 19(1), pp. 67-72, 1988.

[48] G. P. Prabhakar: "What is project success: a literature review", *International Journal of Business and Management*, 3(9), pp. 3-10, 2008.

[49] D. Robey, L. A. Smith and K. R. Vijayasarathy: "Perceptions of conflict and success in information systems development projects", *Journal of Management Information Systems*, 10(1), pp. 123-139, 1993.

[50] J. R. Rossiter: "The C-OAR-SE procedure for scale development in marketing", *International Journal of Research in Marketing*, 19(4), pp. 305-335, 2002.

[51] T. Saarinen: "An expanded instrument for evaluating information system success", *Information & Management*, 31, pp. 103-118, 1996.

[52] P. Savolainen, J. J. Ahonen and I. Richardson: "Software development project success and failure from the supplier's perspective: A systematic literature review", *International Journal of Project Management*, 30(4), pp. 458-469, 2012.

[53] K. Schwalbe, *Information Technology Project Management*. 7. Edition. Bosten, MA: Cengage Learning, 2013.

[54] P. Serrador and J. R. Turner: "The relationship between project success and project efficiency", *Procedia - Social and Behavioral Sciences*, 119, pp. 75-84, 2014.

[55] A. J. Shenhar, D. Dvir and O. Levy: "Mapping the dimensions of project success", *Project Management Journal*, 28(2), pp. 5-13, 1997.

[56] A. J. Shenhar, D. Dvir, O. Levy and A. C. Maltz: "Project success: a multidimensional stategic concept", *Long Range Planning*, 34, pp. 699-725, 2001.

[57] J. H. Steiger: "Structural model evaluation and modification: An interval estimation approach", *Multivariate Behavioral Research*, 25, pp. 173-180, 1990.

[58] G. Thomas and W. Fernandez: "Success in IT projects: a matter of definition?", *International Journal of Project Management*, 26(7), pp. 733-742, 2008.

[59] L. R. Tucker and C. Lewis: "The reliability coefficient for maximum likelihood factor analysis", *Psychometrika*, 38, pp. 1-10, 1973.

[60] J. Wateridge: "IT projects: a basis for success", *International Journal of Project Management*, 13(3), pp. 169-172, 1995.

[61] J. Wateridge: "How can IS/IT projects be measured for success?", *International Journal of Project Management*, 16(1), pp. 59-63, 1998.

[62] R. Weiber and D. Mühlhaus, *Strukturgleichungsmodellierung. Eine anwendungsorientierte Einführung in die Kausalanalyse mit Hilfe von AMOS, SmartPLS and SPSS*. 2. Edition. Berlin, GER: Springer, 2014.

## APPENDIX A: QUESTIONNAIRE OF IT PROJECT SUCCESS

The following statements are extracted from the questionnaire on IT project success and were supposed to be rated by the participants with the help of a five-stage Likert scaling [63]. The value 1 represents the complete refusal of the statement, and the value 5 represents the full approval:

"While answering the questions, please orientate yourself on projects you were responsible for. Try to imagine a project which is typical for your projects with regard to planning, realization and result - that means a typically average project. In the further course of the questionnaire a sponsor will be mentioned. This refers to the persons who initialized the project and commissioned it to you. Some companies also refer to them as customer or specialized requester.

To what extent do you agree with the following statements on your average project?"

IT01_01: The project contributes to the advancement of the organization, e.g. learning effects, sustainability or process optimization.

IT01_02: A resource saving and efficient implementation is pursued in project.

IT01_03: The agreed budget is adhered to.

IT01_04: Both internal and external resources are sufficiently considered in planning.

IT01_05: The developed solution can be easily adapted to new requirements.

IT01_06: Personal goals, e.g. the publication of professional articles or the trial of new technologies, can be pursued.

IT01_07: The staff is able to advance during the project.

IT01_08: The project scope agreed upon with the sponsor is fully realized.

IT01_09: The sponsor is not interested in further cooperation on other projects.

IT01_10: The project is perceived as successful in total.

IT01_11: The project team has an appearance appropriate to the individual situation.

IT01_12: The project generates strategical benefits.

IT01_13: The end users are satisfied in total.

IT01_14: The sponsor is satisfied with the project handling and its result.

IT01_15: Team satisfaction is extremely low.

IT01_16: The project supports the company values, e.g. transparency and trust.

IT01_17: An acceptable cooperation in project is impossible.

IT01_18: The follow-up costs, e.g. maintenance and operational cost, are higher than planned.

IT01_19: The developed solution is used according to purpose.

IT01_20: The project is accomplished at the agreed point of time.

IT01_21: Valid quality thresholds are met.

IT01_22: The sponsor happily recommends the project team.

IT01_23: The resources used are often overloaded.

IT01_24: The developed solution is perceived as easy to use.

IT01_25: The developed solution is used long-term in daily business.

IT01_26: The relation of revenues and expenses adheres to planning.

IT01_27: The project makes a positive contribution to the operating income.

IT01_28: The end users accept the developed solution.

IT01_29: Costs and benefits of the benefits have an appropriate relation.

IT01_30: The project is granted an extensive preparation and planning phase.

IT01_31: The project planning is perceived as successful.

IT01_32: The project result is rated as successful.

IT01_33: The project management is highly efficient.

IT01_34: All stakeholders are satisfied with the project.

IT01_35: The project is conducted without serious incidents.

IT01_36: The stakeholders have a positive perspective on the project.

IT01_37: The project team is convincing during the conduction stage.

IT01_38: The project result complies with the goals related to it.

IT01_39: The project in total is considered as successful though not all goals were met.

## APPENDIX B: CORRELATIONS OF ITEMS

**Table 15: Correlation of items used for measuring the success of an IT project**

(See Appendix A for detailed information about the items. To calculate the correlations the Pearson correlation coefficient is used [63])

| | | Items of IT Project Success | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Item | 1 | 3 | 4 | 5 | 7 | 8 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 20 | 21 | 22 | 24 | 26 | 27 | 28 | 29 | 31 | 32 | 33 | 34 | 35 | 36 | 38 | 39 |
| Items of IT Project Success | 1 | 1 | .358 | .395 | .455 | .464 | .371 | .531 | .153 | .588 | .423 | .446 | .461 | .48 | .16 | .359 | .373 | .449 | .475 | .436 | .428 | .472 | .477 | .488 | .426 | .513 | .368 | .386 | .339 | .453 | .41 | .418 |
| | 3 | .358 | 1 | .599 | .454 | .416 | .559 | .547 | .374 | .393 | .437 | .479 | .429 | .457 | .283 | .442 | .593 | .498 | .474 | .429 | .616 | .444 | .419 | .491 | .656 | .513 | .593 | .348 | .53 | .415 | .384 | .474 |
| | 4 | .395 | .599 | 1 | .481 | .438 | .536 | .53 | .287 | .445 | .47 | .507 | .472 | .443 | .27 | .404 | .585 | .553 | .494 | .43 | .53 | .41 | .405 | .494 | .586 | .506 | .517 | .363 | .449 | .444 | .374 | .479 |
| | 5 | .455 | .454 | .481 | 1 | .55 | .478 | .553 | .281 | .472 | .585 | .541 | .539 | .508 | .226 | .427 | .469 | .469 | .541 | .528 | .466 | .472 | .52 | .499 | .533 | .559 | .455 | .552 | .439 | .601 | .403 | .464 |
| | 7 | .464 | .416 | .438 | .55 | 1 | .453 | .525 | .257 | .492 | .54 | .456 | .615 | .601 | .228 | .363 | .428 | .471 | .544 | .472 | .414 | .475 | .52 | .489 | .494 | .515 | .437 | .543 | .418 | .624 | .378 | .435 |
| | 8 | .371 | .559 | .536 | .478 | .453 | 1 | .548 | .314 | .396 | .478 | .501 | .424 | .428 | .27 | .411 | .539 | .468 | .477 | .443 | .509 | .39 | .428 | .479 | .558 | .488 | .578 | .355 | .528 | .435 | .368 | .462 |
| | 10 | .531 | .547 | .53 | .553 | .525 | .548 | 1 | .302 | .572 | .586 | .683 | .584 | .529 | .263 | .511 | .579 | .542 | .667 | .563 | .586 | .55 | .604 | .6 | .6 | .743 | .523 | .467 | .462 | .569 | .559 | .818 |
| | 11 | .153 | .374 | .287 | .281 | .257 | .314 | .302 | 1 | .217 | .247 | .209 | .249 | .331 | .594 | .268 | .298 | .322 | .279 | .257 | .341 | .229 | .239 | .306 | .528 | .321 | .429 | .219 | .406 | .267 | .232 | .252 |
| | 12 | .588 | .393 | .445 | .472 | .492 | .396 | .572 | .217 | 1 | .503 | .487 | .52 | .473 | .189 | .426 | .453 | .494 | .521 | .479 | .467 | .586 | .544 | .552 | .473 | .605 | .42 | .363 | .387 | .456 | .448 | .483 |
| | 13 | .423 | .437 | .47 | .585 | .54 | .478 | .586 | .247 | .503 | 1 | .555 | .506 | .453 | .219 | .441 | .474 | .445 | .579 | .488 | .453 | .462 | .498 | .487 | .477 | .497 | .401 | .482 | .373 | .624 | .379 | .5 |
| | 14 | .446 | .479 | .507 | .541 | .456 | .501 | .683 | .209 | .487 | .555 | 1 | .572 | .49 | .219 | .434 | .514 | .476 | .617 | .547 | .489 | .456 | .511 | .509 | .51 | .592 | .454 | .437 | .421 | .548 | .443 | .586 |
| | 15 | .461 | .429 | .472 | .539 | .615 | .424 | .584 | .249 | .52 | .506 | .572 | 1 | .532 | .193 | .405 | .49 | .509 | .541 | .511 | .448 | .485 | .53 | .517 | .494 | .514 | .433 | .434 | .39 | .519 | .391 | .495 |
| | 16 | .48 | .457 | .443 | .508 | .601 | .428 | .529 | .331 | .473 | .453 | .49 | .532 | 1 | .26 | .361 | .475 | .46 | .515 | .441 | .475 | .476 | .531 | .539 | .519 | .521 | .458 | .454 | .403 | .54 | .364 | .47 |
| | 17 | .16 | .283 | .27 | .226 | .228 | .27 | .263 | .594 | .189 | .219 | .219 | .193 | .26 | 1 | .225 | .221 | .309 | .247 | .164 | .303 | .195 | .198 | .272 | .411 | .275 | .365 | .187 | .32 | .207 | .216 | .242 |
| | 18 | .359 | .442 | .404 | .427 | .363 | .411 | .511 | .268 | .426 | .441 | .434 | .405 | .361 | .225 | 1 | .482 | .402 | .425 | .423 | .547 | .571 | .416 | .508 | .496 | .48 | .452 | .331 | .401 | .441 | .387 | .422 |
| | 20 | .373 | .593 | .585 | .469 | .428 | .539 | .579 | .298 | .453 | .474 | .514 | .49 | .475 | .221 | .482 | 1 | .497 | .496 | .469 | .525 | .442 | .477 | .498 | .591 | .526 | .52 | .377 | .445 | .455 | .394 | .483 |
| | 21 | .449 | .498 | .553 | .469 | .471 | .468 | .542 | .322 | .494 | .445 | .476 | .509 | .46 | .309 | .402 | .497 | 1 | .532 | .461 | .466 | .457 | .459 | .491 | .638 | .549 | .624 | .383 | .49 | .44 | .407 | .472 |
| | 22 | .475 | .474 | .494 | .541 | .544 | .477 | .667 | .279 | .521 | .579 | .617 | .541 | .515 | .247 | .425 | .496 | .532 | 1 | .562 | .498 | .495 | .581 | .56 | .538 | .602 | .428 | .468 | .365 | .578 | .462 | .586 |
| | 24 | .436 | .429 | .43 | .528 | .472 | .443 | .563 | .257 | .479 | .488 | .547 | .511 | .441 | .164 | .423 | .469 | .461 | .562 | 1 | .491 | .457 | .545 | .506 | .482 | .548 | .417 | .437 | .387 | .501 | .422 | .458 |
| | 26 | .428 | .616 | .53 | .466 | .414 | .509 | .586 | .341 | .467 | .453 | .489 | .448 | .475 | .303 | .547 | .525 | .466 | .498 | .491 | 1 | .546 | .486 | .654 | .581 | .565 | .515 | .388 | .467 | .472 | .423 | .489 |
| | 27 | .472 | .444 | .41 | .472 | .475 | .39 | .55 | .229 | .586 | .462 | .456 | .485 | .476 | .195 | .571 | .442 | .457 | .495 | .457 | .546 | 1 | .522 | .607 | .49 | .583 | .416 | .4 | .357 | .481 | .445 | .484 |
| | 28 | .477 | .419 | .405 | .52 | .52 | .428 | .604 | .239 | .544 | .498 | .511 | .53 | .531 | .198 | .416 | .477 | .459 | .581 | .545 | .486 | .522 | 1 | .527 | .479 | .57 | .407 | .492 | .35 | .557 | .423 | .474 |
| | 29 | .488 | .491 | .494 | .499 | .489 | .479 | .6 | .306 | .552 | .487 | .509 | .517 | .539 | .272 | .508 | .498 | .491 | .56 | .506 | .654 | .607 | .527 | 1 | .566 | .629 | .514 | .387 | .442 | .501 | .464 | .521 |
| | 31 | .426 | .656 | .586 | .533 | .494 | .558 | .6 | .528 | .473 | .477 | .51 | .494 | .519 | .411 | .496 | .591 | .638 | .538 | .482 | .581 | .49 | .479 | .566 | 1 | .63 | .831 | .444 | .749 | .488 | .464 | .508 |
| | 32 | .513 | .513 | .506 | .559 | .515 | .488 | .743 | .321 | .605 | .497 | .592 | .514 | .521 | .275 | .48 | .526 | .549 | .602 | .548 | .565 | .583 | .57 | .629 | .63 | 1 | .514 | .417 | .456 | .505 | .741 | .664 |
| | 33 | .368 | .593 | .517 | .455 | .437 | .578 | .523 | .429 | .42 | .401 | .454 | .433 | .458 | .365 | .452 | .52 | .624 | .428 | .417 | .515 | .416 | .407 | .514 | .831 | .514 | 1 | .378 | .827 | .414 | .391 | .446 |
| | 34 | .386 | .348 | .363 | .552 | .543 | .355 | .467 | .219 | .363 | .482 | .437 | .434 | .454 | .187 | .331 | .377 | .383 | .468 | .437 | .388 | .4 | .492 | .387 | .444 | .417 | .378 | 1 | .371 | .738 | .297 | .374 |
| | 35 | .339 | .53 | .449 | .439 | .418 | .528 | .462 | .406 | .387 | .373 | .421 | .39 | .403 | .32 | .401 | .445 | .49 | .365 | .387 | .467 | .357 | .35 | .442 | .749 | .456 | .827 | .371 | 1 | .403 | .343 | .368 |
| | 36 | .453 | .415 | .444 | .601 | .624 | .435 | .569 | .267 | .456 | .624 | .548 | .519 | .54 | .207 | .441 | .455 | .44 | .578 | .501 | .472 | .481 | .557 | .501 | .488 | .505 | .414 | .738 | .403 | 1 | .357 | .457 |
| | 38 | .41 | .384 | .374 | .403 | .378 | .368 | .559 | .232 | .448 | .379 | .443 | .391 | .364 | .216 | .387 | .394 | .407 | .462 | .422 | .423 | .445 | .423 | .464 | .464 | .741 | .391 | .297 | .343 | .357 | 1 | .496 |
| | 39 | .418 | .474 | .479 | .464 | .435 | .462 | .818 | .252 | .483 | .5 | .586 | .495 | .47 | .242 | .422 | .483 | .472 | .586 | .458 | .489 | .484 | .474 | .521 | .508 | .664 | .446 | .374 | .368 | .457 | .496 | 1 |

## AUTHOR BIOGRAPHIES

**Dr. Mark Harwardt** was born in 1979 in Iserlohn, Germany. He first studied computer science with subject area economics at the University of Applied Sciences Dortmund and obtained his diploma. Later on, he also obtained a master's degree of computer science at the FernUniversität in Hagen. In 2017 Mark Harwardt finished his doctorate on the topic "The Impact of Servant Leadership on the Success of IT Projects" at the WHU - Otto Beisheim School of Management, Germany.