On the determination of the optimal methodology for ERP projects

A statistical analysis of the relation between the application of hybrid agile methodologies and project outcomes

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Abstract: The current research contains three separate studies (RQ1, RQ2, and RQ3) and is performed in the context of emerging (hybrid) agile methodologies in the field of ERP implementation projects. We observe that the research field lacks an applicable success definition based on which methodology performance could be measured. We furthermore address the concern that ERP projects are fundamentally different and therefore less receptive to the application of hybrid agile methodologies by looking into the existence of hypothetical ‘distinctive attributes’. RQ1: Grounded Theory is utilized in order to obtain a success definition from the consulting/implementation partner perspective. This definition is then used to derive the dependent variables (duration-, budget- and profit discrepancy). RQ2: The relation between the application of hybrid agile methodologies and the previously derived dependent variables is tested on a set of 187 cases. The test results are insignificant but suggest that the application agile practices adversely affects project outcomes. RQ3: The hypothesized moderating relation between the distinctive attributes of ERP and the relations studied in RQ2 are tested. Furthermore, a proxy variable is developed to simulate the behavior of the relations between de independent and the dependent variables. We find only limited evidence to suggest that the distinctive attributes of ERP projects have a moderating effect on the relation between methodology and project outcomes.
Acknowledgements

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In dedication to Monica Jacoba Hinrichs, who relentlessly supported me during twelve years of pre-academic and academic studies, knowing she would have done so if I would have gone to ‘De Loods’ just as well.

In dedication to Marcelle Christina Elisabeth Maria Castelijns without whom my routine would have been tiring and without whom my home would have been too far.
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Chapter I. Problem and its Background

1.1 Justification

The conduct of ERP projects has been extensively documented in the current body of literature. An assessment of this conduct has traditionally been represented by ‘success/failure rates’. This approach seems straightforward. But a comparison of different failure rates shows that these rates differ substantially based on the definition of ‘failure’ and selected population (Dantes & Hasibuan, 2011, p. 1), (Panorama Consulting Solutions, 2015a). There is, however, no discussion about whether there is room for improvement with regard to project execution. ERP projects have traditionally been executed with waterfall methodologies. During the past decennium, agile methodologies have established themselves as a mainstream methodology in software development and other types of IT projects. The agile methodologies have garnered many supporters in the field. And there is data to justify this support (Komus, 2014). But the prominence of the waterfall methodologies in the field of ERP projects has remained largely untouched. The past two years have seen attempts to implement agile methodologies in ERP projects. SAP did so in their new SAP Activate methodology (Musil, 2015). Consulting parties like Deloitte have followed by developing some agile supplements to their existing methodologies. These approaches leave the waterfall structure in place and attempt to implement agile practices within these constraints. The resulting methodologies are referred to as ‘hybrid agile’. The current research analyzes the potential effect of the use of hybrid agile methodologies in ERP projects. We thus look into how hybrid agile methodologies might provide a solution to some problems found in the context of ERP projects. The first part of the current research (research question 1/RQ1) aims to determine a valid success definition of an ERP project. The success definition is viewed from the perspective of the implementation partner/consulting party. This perspective is chosen because this party is often tasked with the development of and guidance through the project methodology. The second part of the current research (research question 2/RQ2) aims to measure the effect of the application of (hybrid) agile methodologies in ERP projects. The results of this study are reviewed with respect to the benefits suggested in the literature. The third part of this research (research question 3/RQ3) aims to find a distinctive attribute of ERP projects that could explain a (hypothetical) effect of hybrid agile methodologies in ERP projects (i.e. the relation analyzed in RQ2). Dependencies are pointed out as a hypothetical distinctive attribute. In specific the degree to which they are present in ERP projects. Answers to these questions provide a context to reason about the different degrees of the usefulness of agile methodologies in different projects. Please take note of the fact that we define usefulness in this context as: The observation that the application of a certain
(agile) practice has a relatively high return on investment relative to comparable/mutually exclusive practices.

The ERP vendor market accounts for 27 billion dollars in annual revenue. SAP is the undisputed leader in this relatively fragmented market. Their share comprises plus 23% in a market were plus 40% of the total volume is shared by parties with less than 2% market share (Pang, 2015, p. 4). When looking solely at the ‘Tier I’ ERP market, SAP has a share of about 41% (Panorama Solutions, 2015a). The market of SAP ERP services is dominated by the consulting departments of Accenture, IBM and Deloitte (Tan, 2015), (Zaidi & Little, 2014). The current research was conducted at the global consulting branch of Deloitte. So, the obtained data is centered on the largest vendor and one of the largest service providers of a 27 billion dollar market. These resources are spent on a yearly basis and the investments are only expected to increase (6%< growth from 2013 to 2014) (Pang, 2015). The aforementioned resources are invested by private and public enterprises alike. This research thus argues that there is a broad societal justification for analyzing potential optimizations with respect to the projects that comprise this market. This research aims to contribute to the optimization of ERP projects by providing insight into the optimal methodology choice in these projects. In addition to this societal justification, there seems to be a large discrepancy with respect to the desired knowledge and available (academic) knowledge on this subject. A limited body of literature exists on the application of agile methodologies in ERP projects. These studies are discussed in paragraph 2.2.1 and paragraph 2.3.2 respectively. However, there seems to be a lack of generalizable conclusions that can be derived from this body of literature. This is because only a small fraction of the current literature consists of empirical non-case studies, specifically quantitative research. The lack of generalizable conclusions on this topic provides this study with sufficient scientific justification. The current research has a ‘mixed method’ design structure. Qualitative methods are used in order approach the problem with a broad and holistic view. Quantitative methods are used in order to obtain statistically valid and generalizable conclusions wherever possible.
1.2 Knowledge problem

The current research is comprised of three separate parts. Each part relates to a specific knowledge problem. The sum of these knowledge problems is a subset of the knowledge problem of determining the optimal methodology in ERP projects. The first knowledge problem covers the definition of the dependent variables \((DV)\); namely ERP project outcomes. This problem originates from the need to measure the performance of hybrid agile methodologies \((IV)\). The definition of ERP project outcomes turns this performance (i.e. the effect of the independent variable) into a measurable relation. The construct of this definition comprises the first part of this research (RQ1). The second knowledge problem covers the nature of the relation between the independent variable and dependent variable itself. This knowledge problem results from the need to comparatively analyze the performance of different methodologies. These comparisons can then provide suggestions on the optimal methodology. This knowledge problem is addressed in the second part of this research (RQ2). The third knowledge problem covers the attributes of ERP projects that influence the comparative performance of (hybrid) agile methodologies. The current research analyzes the level of dependencies as a moderating variable \((MV)\) that is hypothesized to be a major determinant in the strength of the effect of methodology on the outcomes of ERP projects. This set of knowledge problems results in the three research questions set out below. Please note that the subquestions require further elaboration which one can find in chapter 2 and 3 of the current research. A relational model will be presented in section 1.3. Please note that section 1.3 covers a model of the variables and their respective relations:
Knowledge problem: How to determine the optimal methodology for ERP projects?

- RQ1: What are the success defining project outcomes in ERP projects from the consulting parties’ perspective?
  a) What project outcomes of ERP projects can be derived from interviews?
    - Answer/discussion: section 4.1
  b) What project outcomes of ERP projects can be included as dependent variables?
    - Answer/discussion: section 4.1

- RQ2: What is the relation between the applied methodology and ERP project outcomes?
  a) What suggestion can be derived from the literature?
    - Answer/discussion: section 2.2
  b) Do the values of ERP project outcomes change as a function of the applied methodology?
    - Hypothesis: section 3.2
    - Answer/discussion: section 4.2

- RQ3: Is there a moderating relation between distinctive characteristics of ERP projects and the strength of the relation between methodology and ERP project outcomes?
  a) What suggestion can be derived from the literature and/or other sources?
    - Answer/discussion: section 2.3
  b) What is the relation between dependencies and the strength of the relation between methodology and ERP project outcomes?
    - Hypothesis: section 3.3
    - Answer/discussion: section 4.3
  c) What is the relation between dependencies and the perceived usefulness of agile practices?
    - Hypothesis: section 3.3
    - Answer/discussion: section 4.3
  d) What is the relation between project category and the strength of the relation between methodology and ERP project outcomes?
    - Hypothesis: section 3.3
    - Answer/discussion: section 4.3
  e) What is the relation between project category and the perceived usefulness of agile practices?
    - Hypothesis: section 3.3
    - Answer/discussion: section 4.3
1.3 Conceptual Framework

1.3.1 Key construct

This paragraph covers the key constructs underlying the variables and relations in the current research. These fundamental definitions enable the construction of a conceptual framework. The proceeding part of the research covers concepts defined in this paragraph. Please take note of the fact that the underlying assumptions and reasoning as presented in this paragraph are assumed to be incorporated by the reader. I.e. when we mention and refer to these concepts, we assume that their definitions, as elaborated on below, are understood.

Methodologies

A wide variety of IT project methodologies exists. Waterfall methodologies are considered to be a family of ‘traditional’, phased, plan-driven, fixed scope, and sequential delivery methodologies with deliveries occurring at the end of the project. The current research acknowledges that there is a wide variety of waterfall methodologies. For simplicity, the term waterfall methodology will refer to these characteristics henceforth. The current research finds justification for this approach in the fact that the SAP ERP projects at Deloitte (the environment of the current research) are conducted along these lines. The family of agile methodologies is even more diverse. Agile methodologies are mostly characterized by a cyclical, iterative, incremental setup with frequent deliveries and a flexible scope. With regard to agile methodologies, ‘Scrum agile’ serves as the default methodology. Other varieties are explicitly referred to when implied. This conduct is justified with two arguments. First of all, Scrum is the most widely used agile methodology (Komus, 2014). Other competitors, such as Extreme Programming (XP), are fundamentally different in their approach to projects (programming oriented instead of management oriented). Therefore, they cannot easily be compared. More importantly, the available population elements (i.e. Deloitte projects) can be expected to use a Scrum based methodology if agile is used. We, therefore, imply henceforth that ‘(hybrid) agile methodology’ refers specifically to the Scrum based agile methodology, unless explicitly stated otherwise.

Non-dichotomist methodologies

In the contemporary context of the current research, waterfall, and agile methodologies are often posed as a dichotomy. Though characteristics like the flexible scope and fixed scope are clearly mutually exclusive there is some room for a non-dichotomist view of these methodologies. A central observation made in the current research is the insertion of agile practices into methodologies that maintain a waterfall structure. The SAP Activate Methodology is a prominent, ERP relevant, example in this regard (Musil, 2015). Deloitte has its own methodology for SAP ERP projects. This methodology
exemplifies a so-called ‘hybrid agile’ methodology. An illustration of such a methodology is presented in figure 1.3.1. Please note that the classic waterfall structure was kept in place, though some phases have been fused.

Figure 1.3.1, SAP Activate Methodology schematic, ("SAP Activate structure," 2015)

The classic gateways that the waterfall structure provided are still in place, though they are not explicitly pointed out in figure 1.3.1. There is still a solid scope definition and there is still a User Acceptance Test (UAT). Within these, and other constraints, SAP has attempted to make their waterfall methodology as agile as possible. The current research reasons that this ‘hybrid agile’ structure could become the norm. The data, however, shows that even the population of ‘agile’ projects contains a majority of non-pure agile projects (Komus, 2014). Consequently, one cannot divide projects between a pure waterfall and a pure agile set. For this would imply the largest subset (hybrid agile) is excluded. Instead, the current research views the space between waterfall and hybrid agile as a spectrum. Any point on this spectrum represents some degree of application of agile practices. The value of a project on this spectrum serves as a central (independent) variable. In the current research, ‘pure waterfall projects’ will be referred to as waterfall projects or waterfall methodology projects. Projects with some level of applied agile practices (e.g. somewhere on the spectrum between waterfall and agile) are referred to as agile or hybrid agile projects.
1.3.2 Variables & Relations

This paragraph focusses on the variables and their relations. The sum of this knowledge is summarized into a conceptual model of the current research.

Variable sets

The current research utilizes a set of variables that aims to allow measurements on the performance and usefulness of agile methodologies. A total of 48 variables and indicators are involved. The nature and definition of these variables and indicators are described in chapter 2 and chapter 3. To avoid confusion, the setup presented below should be used as a point of ‘structural reference’ when these variables are being discussed.

- **Independent variable and indicators:** \{IV, \{I^0_{IV}, I^1_{IV}, ... I^{19}_{IV}\}\}
  - IV: value ‘Corrected average agile practices’
  - \{I^0_{IV}, I^1_{IV}, ... I^{19}_{IV}\}: application values for a set of twenty Scrum practices

- **Dependent variables:** \{DV_0, DV_1, DV_2\}
  - DV_0: value ‘Duration discrepancy’
  - DV_1: value ‘Budget discrepancy’
  - DV_2: value ‘Duration discrepancy’

- **Moderator variable indicators:** \{I^0_{MV}, I^1_{MV}, I^2_{MV}, I^3_{MV}, I^4_{MV}\}
  - I^0_{MV}: value ‘Team dependency’
  - I^1_{MV}: value ‘Average dependency’
  - I^2_{MV}: value ‘System dependency’
  - I^3_{MV}: value ‘Business process dependency’
  - I^4_{MV}: value ‘Project category’

- **Proxy variable and indicators:** \{PV^{(IV-DV)}, \{I^0_{PV^{(IV-DV)}}, I^1_{PV^{(IV-DV)}}, ... I^{19}_{PV^{(IV-DV)}}\}\}
  - PV^{(IV-DV)}: value ‘Average agile usefulness’
  - \{I^0_{PV^{(IV-DV)}}, I^1_{PV^{(IV-DV)}}, ... I^{19}_{PV^{(IV-DV)}}\}: usefulness values for a set of twenty Scrum practices

Two things are worth mentioning here. First of all, the set \{I^0_{MV}, I^1_{MV}, I^2_{MV}, I^3_{MV}, I^4_{MV}\} (referred to as MV) represents the (hypothesized) distinctive characteristics of ERP projects. It therefore has a dual role. The MV set performs the role a moderator variable in relation to the set of \{IV, \{I^0_{IV}, I^1_{IV}, ... I^{19}_{IV}\}\}, \{DV_0, DV_1, DV_2\} relations (referred to as (IV, DV)). The MV set also relates to the \{PV^{(IV-DV)}, I^0_{PV^{(IV-DV)}}, I^1_{PV^{(IV-DV)}}, ... I^{19}_{PV^{(IV-DV)}}\} set (referred to as PV) as an independent
variable. The details and reasoning behind this dual role are explained in section 3.3. In addition it must be noted that $PV^{(IV-DV)}$ and indicators thereof are designed in order to mimic the behaviour of the $(IV - DV)$ relations.

**Relational model**

The set of relations can be constructed from the set of variables. The independent variable $(IV)$ is tested on relations with the first set of dependent variables: $\{DV_0, DV_1, DV_2\}$. Relations from $x$ to $y$ are represented as $(x, y)$. Consequently, the first set of relations can be represented as $\{(IV, DV_0), (IV, DV_1), (IV, DV_2)\}$. With respect to the formerly mentioned knowledge problems, these relations measure the effect of a certain methodology on certain project outcome. The aggregate of these relations allow one to perform a comparative analysis of the methodology. The moderating variable $(MV)$ has a hypothesized relation with the formerly stated relations which is indicated in the following manner: $\{(IV, DV_0), (IV, DV_0), ... (IV, DV_2)\}$ With respect to the formerly mentioned knowledge problem, these relations measure the effect of dependencies on the strength of the $(IV, DV)$ set of relations. The complete relational model is presented in figure 1.3.2.

![Relational model](image)

*Figure 1.3.2., Relational model RQ1, RQ2, RQ3, Author’s observation*
It has been mentioned that the $MV$ variable had a dual role in the current research. The variable set $PV$ attempts to ‘simulate’ the set of $(IV, DV)$ relations by assessing the perceived usefulness of the selected practices. The total set of $\left\{ (I_0^{MV}, PV^{(IV-DV)}), (I_1^{MV}, PV^{(IV-DV)}) \ldots (I_4^{MV}, I_{19}^{PV^{(IV-DV)}}) \right\}$ should thus measure the effect of dependencies on the perceived usefulness of agile practices. A relational model is presented in figure 1.3.3.

**Figure 1.3.3.**, Relational model second line of RQ3, Author’s observation
1.4 Scope and Delimitation

The scope of the current research is designed to cover three partly overlapping and sequentially dependent knowledge problems. The overarching knowledge problem is the determination of the optimal methodology in ERP projects. This overarching problem is too large to serve as a basis for determining the scope. Therefore, the three separate knowledge problems have separate scopes, cumulatively defining the scope of the current research.

The scope of the first part of this study (RQ1) is comprised by the definition of the ERP project success criteria from the consulting perspective. The basic scope is defined by the variables expressed by employees of the consulting firm. I.e. the population is limited to Deloitte Consulting global. An important limitation in this regard is the requirement that the expressed variables need to be operationalizable without starting a separate study. Variables outside this basic scope need clear justification for inclusion. The scope of the second part of this research (RQ2) is defined by the relation between the methodology variables (elaborated on in section 3.2) and the project outcomes (presented in section 4.1). The population of projects is limited to ERP centered projects (for project category definition, see section 3.3). The scope aims to cover an equally sized, as large as possible, waterfall and a hybrid agile population of projects. This part of the research is delimitated to a quantifiable assessment of the performance of (hybrid) agile methodologies in the ERP context. The scope of the third part of the current research (RQ3) is defined by the relation between distinct characteristics and the relation studied by RQ2. In the first line of research, the relation serves as a moderation variable (overlapping with the scope of RQ2). Usefulness is used as a simulation of the independent-dependent-relations and comprises the second line of research (further elaboration provided in section 3.3). The respondent population is defined as all members of Deloitte Consulting whose professional activities have overlap with enterprise technology projects.
1.5 Thesis structure

The current research covers three knowledge problems. These knowledge problems comprise a non-partition subset of the knowledge problem on the determination of the optimal methodology for ERP projects. Structuring a single research along the lines of three separate parts requires additional structure. Each core chapter (theory, methods, and results) consists of at least three sections with every section covering one part/RQ of the research. Note that this core structure can be simplified in the following table:

<table>
<thead>
<tr>
<th>RQ1 (Success Definition)</th>
<th>Ch. II Theory</th>
<th>Ch. III Method</th>
<th>Ch. IV Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>RQ2 (Methodology Outcomes)</td>
<td>2.1</td>
<td>3.1</td>
<td>4.1</td>
</tr>
<tr>
<td>RQ3 (Distinctive Attributes)</td>
<td>2.2</td>
<td>3.2</td>
<td>4.2</td>
</tr>
</tbody>
</table>

Table 1.5.1, Core structure, Author’s observation

An applicable copy of table 1.5.1 is displayed at every core section of the current research. This should prevent confusion and expedite the understanding of the current research. The ideas and studies in the aforementioned core chapters are synthesized in the conclusion (chapter 5). Since the separate studies (RQ1, RQ2, RQ3) are sequentially dependent there is merit in reading them study by study instead of chapter by chapter. I.e. reading in the sequence (2.1, 3.1, 4.1, ... 4.3) instead of (2.1, 2.2, 2.3, ... 4.3).
Chapter II. Review of Related Literature and Studies

This chapter covers a set of theories and studies that serve as a point of departure for the current study. All three research questions have a separate theory section dedicated to them. Sections 2.1, 2.2, 2.3 cover the first, second and third research question respectively.

2.1 Theory on the success defining project outcomes in ERP projects from the consulting parties’ perspective

This section covers the theory on the first research question. Comparable research (i.e. literature) is discussed. Since this parallel research does not provide a sufficiently solid basis, a conceptual framework is presented to fulfill this function. The position of this section in the current research is indicated in table 2.1.1.

<table>
<thead>
<tr>
<th>RQ1 (Success Definition)</th>
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<th>Ch. III Method</th>
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<td>4.2</td>
</tr>
<tr>
<td>RQ3 (Distinctive Attributes)</td>
<td>2.3</td>
<td>3.3</td>
<td>4.3</td>
</tr>
</tbody>
</table>

*Table 2.1.1, Core structure, Author’s observation*

2.1.1 Literature

The literature on this subject is especially sparse. Many papers consider success factors (i.e. factors contributing to success) but not the definition of success itself. The current research takes an exceptional perspective by adopting the perspective of an implementation partner (being either a vendor like SAP or a consulting party like Deloitte) instead of the usual implementer/client perspective. The interests of the implementation partner are linked with those of the implementer/client. Damage the implementers’ interests could damage the relation with- and the reputation of implementation partner. However, this intersection of interests cannot be expected to cover the entire spectrum of interest of the implementation partner. This is the main reason that most of the research on this topic could not be used derive the dependent variables used in the second research question (‘the outcomes of ERP projects’/’project outcomes’).

Some applicable results can be found in a study by Teo, Singh, and Cooper. Functionality, costs, and duration are implied as the characteristics of a success definition (Teo, Singh, & Cooper, 2009). Functionality is described specifically as those functions that are expressed within the contractual agreement between the two parties. The costs are viewed from the perspective of the planned costs (i.e. on-budget). Accordingly, the duration is viewed from the perspective of the planned
duration (i.e. on-time). Their conclusions seem reasonable for a rough outline of a success definition. However, there is no in-depth analysis or presentation that indicates a thorough treatment of the obtained data. One must take note of the fact that this research takes a vendor perspective. This implies some subtle differences with respect to the perspective of Deloitte, who fulfills solely the role of implementation partner.

2.1.2 Conceptual Frameworks
There are several conceptual frameworks that could provide a categorization tool for all the possible ‘ERP project outcomes’ that could come up during this part of the research. The method includes interviews in which experts on the subject are solicited for their views on the set of relevant outcomes (the set of dependent variables in the second research question of the current research). The discussion of the actual method and process is presented in section 3.1. To categorize these project outcome variables, we need a conceptual framework. A range of candidates currently exists. This family of conceptual frameworks is often referred to as the triangle of project management (see also ‘triple constraint’ and ‘iron triangle’). These conceptual models have the purpose of supporting decisions before and during projects. So their direct purpose is not to classify dependent variables. They are however relevant because they provide a solid basis on pointing out the things that need managing, hence, things that are important. The iron triangle, presented in figure 2.1.1 is one example.

![Figure 2.1.1, Iron triangle of project management, (Lowe, 2014)](image)

The model has been modified and adapted to the current date (Bronte-Stewart, 2015). It generally emphasizes the management of scope, costs, and schedule to maintain quality. The Project Management Institute (PMI) used to include this framework, though it has extended the description over the years (Project Management Institute, 2004, p. 8), (Project Management Institute, 2008, p. 289), (Project Management Institute, 2013, p. 6) . In the last edition of the Project Management Body of Knowledge (PMBOK), one can find a useful description of a successful project which aligns with the suggestion that this framework can be used for the selection of the dependent variables: ‘Since projects are temporary in nature, the success of the project should be measured in terms of completing the project within the constraints of scope, time, cost, quality, resources, and risk as
approved between the project managers and senior management.’ (Project Management Institute, 2013, p. 34) Risk and resources are relatively new concepts in this matter. Time and cost are consistently reoccurring in these and other conceptual frameworks. And there seems to be a focus on discrepancies to these variables. Please note that ‘discrepancy’ in the current research is defined as an undesirable deviation from an expected/planned value. Quality and scope tend to have different roles in different models since they are intertwined into the fabric of the projects product. Furthermore, the multitude of possibilities to assess the product of a project has the potential to facilitate endless discussion and elaboration.

These considerations, and the iterative process of interviewing, coding, conceptualizing and categorizing (of which the process is described in section 3.1) lead to the establishment of the following approach: Budget/costs discrepancy and duration/schedule are selected as the points of departure. The category structure is set out below:

- **Duration**: Schedule is referred to as ‘duration’ with no difference in meaning.
- **Financial**: Cost is referred to as ‘budget’ with no difference in meaning.
- ‘Financial’ became a super element to budget in order to the element of ‘profit’ since this element came up frequently during interviews. Please note that this abstraction originates from the unusual research perspective. For the implementer, the costs of the project are weighed against the business returns of the project. The implementation partner, on the other hand, can easily quantify the returns in terms of profit.
- **Product**: The product (super) category functions as a ‘catch all’ of the characteristics of the projects product. It is the objective of this approach to include the scope, the quality and other aspects of the projects product into this super category.

Please note that the treatment of first research question (RQ1) is continued in the methodology chapter, section 3.1.
2.2 Theory on the relation between the applied methodology and ERP project outcomes

This section covers the theories and studies related to the second research question. The two comprising paragraphs discuss literature and data that somehow overlaps with or serves as a predictor for the current research question. The first paragraph discusses the sparse body of academic literature that covers the agile implementation of ERP systems. This results from the fact that agile methodologies are/or have only recently left the ‘pre-paradigm state’ (Alleman, 2002, p. 76). The aforementioned literature consists mainly of case studies and this justifies the further discussion of data sources that cannot guarantee academic standards. Paragraph 2.2.2 covers some studies on the project outcomes related to the agile methodologies. This paragraph includes studies on IT projects in general (instead of ERP specifically). In this regard, data on general IT projects should provide us with some intuition on what to expect and what to look for in the current study. The observations in this section are used as input for the research method presented in section 3.2. The position of this section in the current research is indicated in table 2.2.1.

<table>
<thead>
<tr>
<th>RQ1 (Success Definition)</th>
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<th>Ch. III Method</th>
<th>Ch. IV Results</th>
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<td>RQ2 (Methodology Outcomes)</td>
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<td>3.2</td>
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<tr>
<td>RQ3 (Distinctive Attributes)</td>
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Table 2.2.1, Core structure, Author’s observation

2.2.1 Agile ERP Literature

Trabka and Soja hypothesize that the adoptability of agile methodologies is higher with companies that are familiar with IT projects. They reason, based on a cross-case study, that awareness of the system development life cycle is required for the evaluation of prototypes/Minimal Viable Products (MVP’s) (Trabka & Soja, 2014, p. 321). When extrapolating this hypothesis to the current study, one could reason that the application of agile methodologies can thus be expected to be most beneficial in ERP projects that involve clients with considerable IT project experience (e.g. banks). Mezaros and Aston performed another case study. They concluded that, apart from the technical discrepancies, there seems to be a host of cultural issues that could prevent agile adoption within a waterfall environment. They also suggest that the best practices oriented mentality of SAP specifically is at odds with the agile business value paradigm. This originates from the fact that these best practices dictate a fixed solution space with only limited room for change (whereas agile is all about change). They do
however conclude that the adoption of agile practices (while developing customization in SAP’s language ABAP) was successful in their specific case (Meszaros & Aston, 2007, p. 6). Carvalho, Johansson, and Manheas provide the first structured approach by mapping agile methodologies to traditional ERP project methodologies (Carvalho, Johansson, & Manheas, 2009). Carvalho et al. observe that significant customization is the norm rather than the exception, a claim which is confirmed by survey data (Panorama Consulting Solutions, 2015a, p. 8). In this regard, the adaptive nature of agile methodologies should prevail over the predictive nature of waterfall methodologies. They conclude, in line with the justification of the current research, that these projects could benefit from agile methodologies due to reduced misalignment (Carvalho et al., 2009, p. 8). This line of reasoning shows parallels with that of Alleman. For Alleman states that waterfall contains erroneous assumptions regarding planning capabilities, stability, and change, which negatively affect ERP project outcomes (Alleman, 2002, p. 73). Agile methodologies embrace change, lack necessity of stability and do therefore not require extensive up-front planning. The logical conclusion would thus be that these methodologies could solve some of the problems. In conclusion: these last two papers seem to indicate potential benefits to applying agile methodologies in ERP projects. The conclusions and reasoning presented in this paragraph are reviewed in relation to the results of the current research in section 4.2.

2.2.2 IT Agile Outcomes

Back in 2011, McKinsey already pointed out the potential benefits of using agile methodologies in IT. A visual summarization is presented in figure 2.2.1. This figure depicts how, by the prediction of McKinsey, project metrics should develop as a result of implementing a Lean methodology (a non-Scrum form of agile). Please take note of the fact that this representation shows overlap with the set of project outcomes presented in section 4.1.
Komus published some interesting survey results in 2012 and in 2014 regarding the use and the perception of agile methodologies in IT projects in general (Komus, 2012), (Komus, 2014). This set of results is one of the best datasets currently available on this topic. And it is, therefore, worthwhile to take a closer look at the results. Figure 2.2.2 and figure 2.2.3 displays the results of the perceived project success rate of two non-overlapping populations. The first population consists of respondents who expressed that they used mostly agile methodologies. The second population consisted of respondents who expressed that they used mostly waterfall methodologies. The results show a (significant) discrepancy between the average success rates of the populations (Komus, 2014, p. 27).

Figure 2.2.1, Improvements IT projects with lean, (McKinsey, 2011, p. 2)
Two remarks need to be made with respect to the data presented in figure 2.2.2 and figure 2.2.3. First, it must be noted that these are still based on mere perceptions of project success rates. One must also take note of the fact that the success definition of respondents may have differed from the set of criteria presented in section 4.1. The results in figure 2.2.4 originate from the same study.

Research Question 2
were asked to rate the project performance methodologies on several dimensions on a four-point scale of ‘poor’ to ‘very good’. In addition, ‘no experience’ was provided as a fifth option. The percentage value of the ‘no experience’ group was consistent among dimension within a (10%, 15%) range. The value on the y-axis indicates the percentage sum of ‘Good’ and ‘Very good’ ratings for every methodology. The results show that this population of respondents perceived the performance of agile methodologies to be better on every dimension. Scrum, in particular, seems to dominate with respect to performance perception. Please note that Deloitte also based its hybrid agile methodologies on the Scrum variant.

![Figure 2.2.4](image.png)

*Figure 2.2.4, Approval scores methodologies on project dimensions, (Komus, 2014)*

Again, several remarks need to be made with regard to the ability to draw conclusions based on these results. In this instance, agile and waterfall practitioners did not seem to have been separated. The large percentage of Scrum users is very likely to have biased these results. The same can be said for the results presented in figure 2.2.5. This graph presents the perceived success rate of respondents given a certain form of agile methodology.
Figure 2.2.5, Success rates per agile application type, (Komus, 2014)

The ‘consistently agile’ form of methodology application is perceived as more successful than either the ‘hybrid’ or the ‘selective’ application form. Komus uses these results to conclude that ‘pure play agile users are even more successful’. However, the same statements of caution that applied for the results in figure 2.2.4 apply here.

In the context of this study, there are several notions that we can take away from these results. If we assume that SAP ERP projects and the general population of IT projects are alike and that respondents’ perceptions are unbiased, then we should expect a discrepancy between the success rates of an agile (or hybrid agile) population and a waterfall population. We can however not expect perceptions to be unbiased. Then there is the assumption that SAP ERP and general IT projects are similar in this regard. There are good arguments to found the claim that this is not the case. More elaboration on this argument is presented in section 2.3. Data on this issue would provide a method of falsifying these assumptions. This research aims to contribute to the current body of knowledge by measuring variables that are less susceptible to the issues mentioned above. Furthermore, there seems to be overlap between the ‘adherence to schedule’ dimension (figure 2.2.4) and two of the dependent variables presented in section 4.1. Namely: ‘Budget discrepancy’ and ‘Duration discrepancy’, specifically the latter. Based on these results, and the assumptions posed above, one should expect discrepancies between an agile (or hybrid agile) population and a waterfall population on the variable ‘Duration discrepancy’. Furthermore, the results in figure 2.2.5 suggest that there should be a positive relation between the degree of agile application (independent variable) and the project success rate. This study, however, finds that the opposite seems to be the case for ERP projects.
2.3 Theory on the moderating relation between distinctive characteristics of ERP projects and the strength of the relation between methodology and ERP project outcomes

This section covers the theories and studies related to the third research question. The research question is posed in the context that there might be ‘something’ different about ERP projects that makes the application of agile practices less useful. Note again that we define usefulness as: The observation that the application of certain (agile) practices has a relatively high return on investment relative to comparable/mutually exclusive practices. The first paragraph (2.3.1) covers theories and literature on the determination of the optimal methodology in IT projects in general. Paragraph 2.3.2 covers the author’s hypotheses on the distinctive attributes of ERP projects and their relation to the second research question. In particular, the level of dependencies (being a subset of the aforementioned distinctive attributes) are posed as a central problem in the application of agile methodologies in ERP projects. In conclusion, a hypothesis on the relation between distinctive attributes and the usefulness of agile methodologies is posed. Please note that the ‘usefulness of agile methodologies’ is posed as a proxy for the \((IV, DV)\) relations researched in RQ2. ‘Not useful’ would imply unfavourable outcomes \((DV)\) resulting from applying agile methodologies \((IV)\). ‘Useful’ on the other hand, would imply favourable outcomes resulting from the applications of agile methodologies. The sum of this section aims to justify the inclusion of this moderating variable (i.e. the distinctive attributes of ERP projects) in the current research. The position of this section in the current research is indicated in table 2.3.1.

<table>
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*Table 2.3.1, Core structure, Author’s observation*

2.3.1 Methodology factors

Pure agile methodologies are unlikely to be the optimal methodology for every project. An interesting framework for determining the suitability of a project and its respective organization for the application of agile practices is the five pointed star of agile methodologies (Boehm & Turner, 2008). This framework (presented in figure 2.3.1) is in no way conclusive but serves as a convenient point of
departure for much of the literature on the subject (MITRE, 2010, p. 28), (Cockburn, 2006, p. 43), (Sheffield, Ahimbisibwe, Lemétayer, & Victoria Management School, 2011, p. 20).

The dimensions in this model seem straightforward and make intuitive sense when relating them to the stated methodologies. Dynamism, as it is defined here, could be described as one of the main reasons agile exists. The culture definition seems to overlap in this regard. Size corresponds to the use of small to medium sized teams in agile. The larger the number of people involved, the less applicable agile becomes. Agile scaling might provide a solution to this problem, but this topic is addressed later in this section. Criticality seems obvious since a high-stakes project would allow less iterative ‘fault and error’ improvement. Only the personnel dimension seems to require some background information. Boehm and Turner base this on a definition set out by Cockburn, on which they elaborate in their book (Boehm & Turner, 2008, p. 24). Project members are scaled along the skill set and competence they bring in. In summarization: 1B are low-end project members while level 2 and level 3 are high-end project members. One can derive from figure 2.3.1 that an agile approach requires a higher percentage of high-end project members. Furthermore, an agile approach seems to tolerate a lower percentage of low-end project members. This seems to make intuitive sense since agile project members have no clear plan to guide their steps. Instead, they have to utilize their own intelligence and creativity in order to guarantee the completion of their tasks. Deloitte has created its own guidelines to assess the usefulness of agile methodologies in a project. The guidelines are presented in figure 2.3.2 and can be partly mapped onto the Boehm and Turner model.

Figure 2.3.1, Model on the application of methodologies, (Boehm & Turner, 2008, p. 56)
‘Culture’ and ‘Planning Culture’ show significant overlap. ‘Dynamism’ and ‘Scope’ (both covering changing requirements) map out pretty much exactly. The other three dimensions show less overlap. ‘Personnel’ and ‘Team Composition’ both focus on the skill set of the project members. But the Deloitte model is updated and focuses more on the diversity of skills (making the team more agile from an inter-disciplinary perspective). Waterfall projects, on the other hand, have more use of specialists within the defined scope. Please note that the scope is assumed to be stable. This seems to beat the reasoning by Boehm and Turner; since one would in general want as much high skill project members as possible. I.e. this reasoning does not help a lot when determining methodology. Both the dimension of project ‘size’ (number of personnel) and ‘criticality’ are not included. The need for flexibility and the level up to which technology is understood are added in this regard. There will be no final conclusion to the absolute ‘rightness’ of these models. Most of them seem valid up to this day. The current research focused on the problems related to applying agile methodologies in ERP projects. These problems show overlap with some of the considerations that are mentioned in the current research section, though there is a case to argue these problems are ERP specific (as a project category). I.e. the theories presented above provide a good starting point on when to apply agile methodologies. But more considerations need to be taken into account when talking about its application in the context of ERP projects. The following section presents a hypothesis about the level of distinctive attributes of ERP projects in a project and its role in determining the optimal methodology. This moderating value overlaps surprisingly little with the theory described above. If confirmed, this hypothesis would add significantly to the determination criteria for optimal methodologies.

![Spectrum of Agility](image)

*Figure 2.3.2, Deloitte guidelines on agile application, Deloitte internal sources*
2.3.2 Agile Usefulness and the Distinctive Attributes of ERP Projects

First, the qualitative data that generated and supports the posed hypothesis is discussed. This paragraph furthermore elaborates on the role of dependencies as hypothesized attributes that are distinctive to ERP projects in general. I.e. a high level of dependencies in ERP projects are pointed out as a distinctive attribute that could explain why the application of agile practice would be less useful in ERP projects. It is pointed out that these problems gave rise to the development of agile scaling solutions. Subsequently, reasoning on why this problem is specifically relevant for the ERP project context is provided. This reasoning provides the basis for the hypothesis on the relation between distinctive ERP project attributes and the usefulness of hybrid agile methodologies (i.e. the strength of the relation in the second research question). In conclusion, a model on such a perceived relation is presented and elaborated upon.

Data and Literature

The origins of this idea lie in the interviews that were performed during the data gathering phase of the first part of this research (described in section 3.1). The presentation of qualitative data should provide some empirical underpinning to the formulation of this hypothesis. These loosely structured interviews provided considerable room for interviewees to elaborate on issues they deemed important. When transcribing all the available interviews, a common theme started to emerge. Though it was the different way in which these different professionals from different disciplines were able to address these issues that proved central to the presented idea. The following quote (translated from Dutch) originates from an interview conducted on the 22nd of February 2016 with a manager at the Deloitte Digital service line. The interviewee is involved in a large amount of customer oriented projects and is experienced in the application of agile methodologies.

Interviewee: ‘And if you want to do your thing in an agile way, then you have to be able to work independently. If there is a dependency there... Yes ok, we have delivered a web service and we are going to consume it. And then it turns out that there is something wrong with it. Then we can’t say like ‘the story is completed’. So you want to have that ticked off. Or, you want to have those people that are going to build that web service... You want to have those in your team, to make sure they are going to see the entire picture.’ Quotation 2.3.1, Interview 22-02-2016

One can observe two important issues in this regard: First, dependencies are put forward as the main problem. This is confirmed later in the interview when the research again addresses this issue.

Researcher: ‘So that is the issue that you encounter the most?’ Interviewee: ‘Yes, other parties, dependencies to third parties.’ Quotation 2.3.2, Interview 22-02-2016
The second issue one can observe in quotation 2.3.2 is the fact that the interviewee states the ‘inclusion of the dependency’ as a potential solution to the problem. This last notion proved to be central to the formulation of the third research question. To follow up on this quotation, a quotation from a conversation report is presented. The nature of these conversation reports is elaborated on in section 3.1. For now, it suffices to say that these were audio reports recorded directly after an interview and/or conversation. This fragment was recorded directly after (semi-spontaneously) talking to a manager from the SAP service line on his experience with an agile implementation of an ERP module.

Researcher: ‘A solid basis as he called it. And you need that skeleton to build on. You need to disconnect components. What he mentioned was, you can focus on a certain goal with your agile team, but that you can’t have these dependencies then. He mentioned literally like: ERP is an integral system. Everything is communicating with everything. From sales to distribution to whatever. You can’t throw that into one agile team. So you have to have separate teams that all have their own island’ Quotation 2.3.3, Conversation Report 10-03-2016

Again, dependencies and their role as a decisive impediment when applying agile methodologies are pointed out. However, there is a clear difference with respect to the second issue that was mentioned with respect to quotation 2.3.3. Instead of providing the inclusion of the dependency as a solution, the interviewee points out that ERP systems are often large and integral and ‘you can’t throw that into one agile team’. As a substitute for the ‘inclusion solution’, the existence of a ‘skeleton’ is required. This research reasons that such a skeleton serves basic structure which covers most of the dependencies. So the modular, end to end setup and the size of the project prevent the inclusion of dependencies in one agile team. To back this up, another quote from another interview with another manager from the SAP service line is presented. Interviewee: ‘When you are ‘greenfield’, what is your most major limitation? You can’t do integrated testing when you have completed a sprint. You can only test your own segment. You have no idea whether it fits into the bigger picture. But when the entire thing starts running you can do integrated testing for your additional segment. And then you can start to work much more agile. We can go through order entry, supply chain, and finance. It’s all up and running.’ Quotation 2.3.4, Conversation Report 23-03-2016

Greenfield in this regard is referred to as an initial state in which there is no legacy or preconfigured system present. Again we see that the integral aspects of ERP systems, in general, impede the conduct of agile delivery. And again the existence of a skeleton-like, basic version of the system (i.e. no greenfield situation) is pointed out as a solution. The basic skeleton fixes the wide configuration space of the implemented ERP solution to a more limited set of instances. These instances may not be
optimal and may be revised many times over. However, this provides a point of departure for agile project teams to start building add-ons and adaptions for the current instances. In this manner, dependencies are mitigated and those that occur due to required adaptions can be solved one by one. In addition, there is an illustrative quote originating from the interview which was primarily responsible for the trail of thought presented in this section. The interview was conducted with a senior manager from the Enterprise Architecture (EA) service line. In the presented anecdote, the customer of a bank was awarded a new customer number when he moved from one local department of the bank to another.

Interviewee: ‘You move, new customer number. That’s not a problem within the context of a CRM system. Until you realize that this customer number is used in another fifty to hundred other systems. … Agile decision making, Yes. We are going to implement a change of location. A working piece of software, successful within the agile scope. But dramatic in the EA scope, because we don’t look at whether or not it works. No, we look at the larger landscape.’ Quotation 2.3.5, Conversation Report 04-03-2016

This quote and the interview from which it originates do not explicitly point at dependencies as a central factor. Rather, they point out how the structural principles (set out in a target EA) should limit the solution space of an agile project. This research reasons that this need for structure originates from a desire to obtain knowledge of and control over the current state of the EA landscape. In this regard, the ‘deregulated’ fulfillment of requirements creates new dependencies that impede the proper conduct of EA projects. This sums up the body of qualitative data that initiated the development of the hypothesis discussed in this section.

The literature supporting the presented hypothesis is elaborated on below. Please note that this literature is discussed in the context of pointing out that dependencies are a prime determinant of the usefulness of agile methodologies. In this regard, literature regarding the handling of dependencies in large-scale agile projects is discussed. The second part of this paragraph argues why this relation can be expected to be more relevant in ERP projects.

There have been some papers to pose dependencies as a central problem either with respect to technical issues (Evbota & Sekitoleko, 2015) or extremities such as distributed agile projects (Wagstorm & Herbsleb, 2006). The most descriptive, well documented and most generalizable papers are those on the Salesforce (Babinet & Ramanathan, 2008) and Spotify cases (Kniberg & Ivarsson, 2012). Salesforce.com published an interesting case on the transformation of their R&D department. The resulting paper ‘dependency management in a large scale agile environment’, illustrates the central role dependencies start to play when teams work with Scrum. They initially used Scrum of Scrums as a solution to their dependency problem. This did however not enable them to scale Scrum
to the thirty teams they employed. They utilized centralized information gathering and sharing in order to make dependencies visible. Salesforce remained, however, true to the Scrum spirit by encouraging teams to be autonomous and decentralized in the handling of dependencies (Babinet & Ramanathan, 2008). In addition, the Spotify case provides a different view on the handling of dependencies. Their scaled agile methodology includes team surveys on the nature and severity of dependencies experienced by a team. In this manner, Spotify was able to map and target the most problematic dependencies. Spotify also uses ‘Scrum of Scrums’ (a coordinating meeting between Scrum teams) when teams are expected to have regular interactions during a project (Kniberg & Ivarsson, 2012). In conclusion, it can be stated that there is both empirical and theoretical basis for assuming that dependencies form a problem for the usefulness of agile methodologies.

RQ3 endeavors to relate a set of distinctive ERP project characteristics to the degree to which the application of agile methodologies is useful. The author reasons that ERP system components and served business processes have an integral nature. This integral nature causes us to point out dependencies are a likely candidate for such a ‘distinctive characteristic’. As an example, one could imagine two 10 person teams working on a finance module and a supply chain module. It would be impractical to merge these teams on the ground of shared dependencies. Both because the team size would be too large and because their areas of expertise are functionally separated. It would, however, be difficult for these teams to work in Scrum agile separate from each other. The autonomy and agility of their potential progress would, in that case, be limited by the fact that they are interdependent on each other. This dependency originates, on a product level, from their shared business processes and shared system components. On a project operation level, their agility and autonomy would be hampered by the fact that they may be interdependent on each other’s deliverables. There have been several general (i.e. not company specific) attempts to address these problems by developing frameworks aimed at mitigating these dependencies. Leeuwen created an applicable overview of the different agile scaling methodologies in this regard (Leeuwen, 2015). Her research resulted in a shortlist of the most relevant methodologies. The requirements overlap with the current research (i.e. Scrum applicable and with some degree of scientific or empirical underpinning). However, a structured analysis of agile scaling methodologies and their potential in the context of ERP projects falls outside the scope of the current research. This should, however, be a topic of future research. The second part of this paragraph argues, among other things, that ERP projects are even more problematic in this regard.
Hypothesis

Based on the presented sources and reasoning set out above one can expect a negative relation between the level of project dependencies and the usefulness of agile methodologies. Larger IT projects in general experience this problem and there have been numerous attempts at developing a solution (i.e. agile scaling) during the past decade. These solutions cover IT projects in general. One can reason that there may be an important and distinct characteristic of ERP projects in this regard (i.e. with regard to the ‘distinctive attributes’ problem, dependencies in particular). In software development projects (which is often the type of project referred to when discussing IT projects), one is expected to organize pieces of code into separate modules. This practice has the purpose of reducing complexity by limiting the dependencies between certain modules of code. Some dependencies will however remain, and this is one of the problems agile scaling addresses. One must note that the above still covers software development projects. ERP projects specifically have an inherent added layer of complexity that originates from the interfunctional business processes the (often shared) systems that serve them. These business processes may go end to end through the business. And even if they do not, they may require a variety of modules for a single process. So, even if the software development part of the ERP system was conducted along the lines of structured programming, then there is still a layer of dependencies originating from the intermodular nature of the business processes itself. E.g. the Spotify methodology included the goal of cutting interteam dependencies as soon as they became a problem (Kniberg & Ivarsson, 2012, p. 7). The intermodular nature of business processes prevents this up to some extent. This fact is recognized by Strode and Huff in their taxonomy of dependencies in agile software development. They conclude, based on a case study, that these ‘business process dependencies’ add complexity to the development of the target system (Strode & Huff, 2012, p. 6). And it must be noted that this study does not even cover an ERP system, but a solely customer facing system. The current research reasons that these business process dependencies are a subset of the ‘distinctive attributes’ since these also cover the dependencies between the business processes and the ERP modules. Furthermore, it is important to note that agile projects are more susceptible to these dependencies than waterfall methodologies. This is because the extensive planning phase ensures waterfall projects are better equipped to map and handle the aforementioned dependencies. Salesforce approaches this problem from a (semantically) different angle by arguing that it is the dynamic character of agile conduct that makes dependencies harder to manage in agile projects (Babinet & Ramanathan, 2008, p. 402). As of today, there seems to be no attempt at providing a solution to this specific problem within the context of agile methodologies. It may very well be that an adapted version of a scaled agile solution will be able to address this problem. Again, it must be noted that such endeavors lie outside of the scope of this
research. This research does include a study into the problem itself. If there is a relation between these distinctive ERP project attributes (e.g. the aforementioned dependencies) and the usefulness of agile methodologies then this is bound to frame the discussion on the relation between methodology and ERP project outcomes (discussed in RQ2). Please note that this argument is a justification for the inclusion of RQ3 in the current research. In summarization: This section proposes a negative relation between the distinctive attributes of ERP projects (specifically dependencies) and the usefulness of agile methodologies. The qualitative data and reasoning behind this hypothesis have been discussed. Some overlap with contemporary literature has been demonstrated. And the argument that ERP projects are different in this regard has been elaborated on. A formalization of this hypothesis can now be presented.

The qualitative data presented earlier in this paragraph suggested that the larger/the more integral the project becomes, the less agile practices became useful. This relation could be abstracted to the one presented in figure 2.3.3.

![Diagram](https://via.placeholder.com/150)

*Figure 2.3.3, Dependencies and usefulness theorized relation, Author’s observation*

Dependencies are represented on the $x$-axis. The usefulness of agile is represented on the $y$-axis. A start-up in software development (SD) represents the lower bound value on the $x$-axis. There are no pre-existing dependencies that need to be accounted for and the target solution can have any possible form or configuration. Being a start-up, the project consists most likely of a single team (i.e. no interteam dependencies). Costumer-facing enterprise software projects will face more dependencies than their start-up counterparts. However, as quotation 2.3.1 and accompanying interview illustrated, there is often still enough room to apply near pure agile methodologies. This can be explained by the fact that these customer facing systems (e.g. web applications) can be built relatively independently.
of the integral back end of the enterprise. ERP systems on, the other hand, cannot be built in this manner because they largely comprise the integral backend of the enterprise.

Figure 2.3.3 signifies a distinction between ERP projects were a preconfigured solution is present (i.e. basic dependencies have been covered) and projects with a ‘greenfield’ starting point. Since this greenfield starting point does not provide a coverage of even basic dependencies the usefulness of agile becomes more and more limited. The right end of the dependency spectrum is occupied by large EA projects like ERP consolidations. In these projects the requirements, interests and desires of multiple local ERP adopters need to be incorporated into a new, consolidated ERP. Interdependencies do not exist only between modules, but between local adaptions of the ERP as well. Along the lines of the hypothesis posed in this section, there would even be less benefit from agile methodologies due to its point on the curve.

Figure 2.3.3 covers the central line of reasoning that forms the basis for this part of the research. It has been mentioned earlier that this hypothesis should help to frame the second research question. If confirmed, the hypothesis described in this section has implications for the expected usefulness of agile methodologies in ERP projects. The foremost implication being that an agile methodology should bring some but limited benefits in ERP projects, depending on the dependencies inherent to the project. This implies that the results of the second research question could be moderated by ‘the distinctive attributes of ERP projects’ as a variable. And the hypothesis does not only provide a guideline for single ERP projects. EA projects which can be estimated to be on the high end of the dependency spectrum would be provided with a framework that explained why they could apply some but a relatively limited amount of agile practices. The methodology that is employed in order to test the hypothesis originating from this hypothesis is elaborated on in section 3.3.
Chapter III. Methodology of the study

This chapter covers the methodology of all of the three research questions in the current research. Each section has theoretical roots in its respective section in chapter two. Section 3.1, section 3.2 and section 3.3 cover the first, second and third research question respectively. The specific role of each research question and accompanying section is illustrated in figures 3.1 and 3.2. Details on variables and relations are elaborated on in their respective sections. Please review section 1.3 for a complete overview of the variable sets. Relations between variables are denoted as \((x, y)\), implying an effect of \(x\) on \(y\). Below we present the conceptual model which illustrates the role of every variable in relation to their respective research questions.

![Conceptual Model](image)

*Figure 3.1., Relational model, RQ1, RQ2, RQ3, Author’s observation*
3.1 Methodology on the success defining project outcomes in ERP projects from the consulting parties’ perspective

This section discusses the methodology regarding the first research question. The location of this segment in relation to the rest of the research is displayed in figure 3.1.1, with the bold print indicating the subject of the current research question and light printing indicating irrelevant elements.

![Figure 3.1.1, Relational model RQ1, RQ2, RQ3, Author’s observation](image)

![Figure 3.2., Relational model second line RQ3, Author’s observation](image)

The position of this section in the current research is indicated in table 2.1.1.
3.1.1 Research Design
The research design of this part of the current research (RQ1) was centered around developing a grounded theory based on semi-structured interviews. The qualitative research design of grounded theory was used in order to determine the relevant project outcomes that would be measured as dependent variables. This research method prescribes that open observation should be the basis of theory development. An initial population of potential interviewees was chosen and the structure for the interviews was drafted. This interview structure was devised with the main goal of having interviewees express their perception on the relevant outcomes in Deloitte Consulting projects. The conduct of these interviews was approached iteratively. Both the potential population and the instrument were adjusted as a result of evaluating earlier interviews.

3.1.2 Population and Sampling
The target population was adapted according to the insights of the researcher. The original target population (i.e. all potential interviewees) included all employees of Deloitte Consulting B.V. (the consulting branch of the Dutch member firm). The initial plan was to interview at least two employees/partners of every of the three service areas (Technology, Human Capital (HC), Strategy & Operations (S&O)). One being an expert in agile methodologies and the other being an expert in waterfall methodologies. Interviewees were expected to hold at least a senior consultant position. This was an attempt to ensure that statements were underpinned with sufficient experience.

This plan was adjusted as several things became clear: The HC service area primarily followed the planning and choices set out by the technology service area. Two interviews were conducted with both a waterfall and an agile expert. During these interviews, both interviewees indicated (one implicitly and one explicitly) that the HC service area had a hard time including perceived relevant points in the project planning. It is the opinion of the author that these interviews were less dense in terms of relevant information with regard to ERP project outcomes. This can be attributed to the fact that the very nature of the HC service area implies a different focus. Furthermore, contacts within S&O service area were unable to refer the researcher to any interviewees with relevant methodology experience. The pursuit of potential interviewees was discontinued since it was expected that the

Table 3.1.1, Core structure, Author’s observation

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<th>RQ1 (Success Definition)</th>
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<tr>
<td>RQ2 (Methodology Outcomes)</td>
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obtained results would be less relevant than those obtained within the technology service area.

Interviews were conducted with several interviewees active in the technology service area. Mainly service lines that worked with some form of package software were included. In total nine eligible interviews were performed. Interviewees were active within multiple service lines including Digital, Enterprise Architecture, SAP, and Oracle. Though the interviews with Digital and Enterprise Architecture were relevant, the Oracle and SAP proved by far the most insightful. It was determined that these service lines should be the focus of future interviews as their views on project outcomes proved to be most focused on ERP projects specifically.

3.1.3 Instruments

Several instruments were used to turn the conducted interviews into analysable data. These instruments included a priming email on the subject of the conversation, an interview format and an audio recorder. Alternatively, digital or handwritten notes were drafted in combination with an audio conversation report (e.g. if interviewees did not want to be recorded directly).

The priming email includes, among other things, a notion on the subject of the upcoming conversation. The note informs the reader that ERP project outcomes are discussed and that the reader is welcome to communicate any remarks on the issue before or during the interview. This notion was mailed to all but the first three interviewees and is included in appendix 3.1.1. The setup of the first interview was guided by email correspondence that proceeded the conversation. For all following interviews, a format was drafted which served as a loose guideline and which is included in appendix 3.1.2. Interviews were recorded with an audio recorder if permission was obtained from the interviewee. Only two of the total of nine interviewees did not grant permission for an audio recording of the conversation. In these cases, handwritten or digital notes were made during the interview. Subsequently, an audio recording of a conversation report was created based on the interview.

3.1.4 Data Gathering Procedure

The goal of this part of the research was to determine the most relevant project outcomes in ERP projects from the perspective of the consulting party (e.g. Deloitte). Interviews are used to obtain a list of the total of relevant project outcomes. And in turn, these project outcomes could then be translated into dependent variables for the use in RQ2 and RQ3. Some remarks on the data gathering procedure have been provided above but the central setup consists of:

1. Selecting specific individuals within the selected population based on either advice by employees, authorship interesting project proposals (for example those that include hybrid agile proposals) and other information that sparked interest for a specific person.

2. Requesting a meeting with the selected individuals.
3. If accepted: Priming them for the subject matter and requesting permission to record the conversation (appendix 3.1.1).

4. Conducting the interview along the lines of the prescribed format (appendix 3.1.1) if desirable and recording either the interview itself or a conversation report based on the interview.

3.1.5 Data Processing

Audio files were turned into transcripts from which person names, company names and other sensitive information was removed. The transcripts and other relevant documents (e.g. emails on the subject that preceded the conversation) are included in one file and uploaded to the Atlas.ti heuristic unit. The Atlas.ti software was used in order to codify the project outcomes that were mentioned during the interview. These codes were then grouped and arranged in families. The results of this process are presented in section 4.1. This paragraph covers the general lines along which this process occurred.

Though the interviews contained hours of discussions on a variety of topics, only the instances where project outcomes were mentioned were coded. Initially, the entire file (including the interview transcript and other relevant communication) was coded. It later became obvious that this resulted in undue weight added to e.g. interviewees that emailed their thoughts prior to the interview. The interview transcript (or in some cases conversation report) was chosen as the main source of codes. Only codes that not occur in the interview but which were in other sources (communication outside the interview) were coded in addition.

Families were generated to group the codes into sensible sets. It was the author’s insight and bias that resulted in an iron triangle oriented coding set of sets. The theoretical reasoning behind these choices was elaborated on in section 2.1. This implied that budget and duration comprised the core of the coding families. The ‘duration’ family was the one family that remained intact during the process. The ‘budget’ family was made a subset of ‘financial’ which included profit. The third family proved unsurprisingly, to be the hardest family to define. The eventual rationale produced a family which included all codes that could be classified as an indicator of the product of a project. Separate families and one corresponding superfamily consisting of these sets were created: \{Customer Satisfaction, Other Product Indicators\}. The ‘Other Product Indicators’ family was used as the initial family for all codes that showed a relation to the product of the project. Separate families were allowed to evolve out of (and devolve into) this family. Several code groups evolved into separate families during this process. Only the ‘Customer Satisfaction’ family persisted till the end of the process, since it was the only family which kept coming up as the number of interviews grew.
3.1.6 Statistical Analysis
The number of individual interviewees that have mentioned a certain dependent variable is considered the main determinant of the value of the dependent variable. Thus the sum of interviews that contain a specific code is the leading value in the determination of the relevance. Several codes have an ‘is part of’ relation to other codes. For example: ‘budget personnel’ is part of ‘budget overall’. Any quotations to child codes were also linked to the parent codes. The structure these child-parent relations are presented in appendix 3.1.3. So according to our previous example, any quotation that carried a link to ‘budget personnel’ was also linked to ‘budget overall’. The values of these child codes are effectively added to the value of their parent codes, potentially increasing their indicated relevance as a dependent variable. A code must occur in two separate interviews and/or conversation reports in order to be eligible for the status of a dependent variable. The result of the conduct described above can be found in section 4.1.

3.1.7 Validity and Reliability
The researcher was unable to provide a second coder with the available resources. In this regard, the coding process was highly susceptible to personal biases. The application of peer debriefing provided some guard against structural errors in coding. The researched population (limited professional groups in only a single company) implies a limited generalizability due to the incorporation of company-specific elements into the eventual results. The minimal requirement of having codes occur in two separate interviews (mentioned earlier in this section) constitutes another measure to guard specifically the reliability of this research. On the micro level, the validity and reliability of this part of the research were seriously hampered by the lack of a second coder. The process of population selection has been elaborated on in this section. Please note that the adjustment of interview populations and the lack of a sample representative of the entire industry or even company introduce the possibility for sample specific or company specific deviations to persist. This, in turn, hampers the attainment of a generalizable answer to the first research question.
3.2 Methodology on the relation between the applied methodology and ERP project outcomes

This section discusses the methodology regarding the second research question. The location of this segment in relation to the rest of the research is displayed in figure 3.2.1, with the bold print indicating the subject of the current research question.

![Relational model RQ1, RQ2, RQ3, Author’s observation](image)

The position of this section in the current research is indicated in table 3.2.1.

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<tr>
<th>Research Question</th>
<th>Ch. II Theory</th>
<th>Ch. III Method</th>
<th>Ch. IV Results</th>
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*Table 3.2.1, Core structure, Author’s observation*
3.2.1 Research Design

The research design of this part of the current research was centered on analyzing the \((IV, DV)\) relations with data originating from surveys. This paragraph commences by discussing the theoretical design and operationalizing the set of applicable variables and indicators \(\{IV, \{IV_0, IV_1, \ldots, IV_{19}\}, \{DV_0, DV_1, DV_2\}\}\). These operationalized variables are then summarized in an operationalization table (appendix 3.2.1). Hypotheses will be formulated subsequently in order to make the research falsifiable.

Operationalization of variables

All questions that cover variables are viewed from the Deloitte perspective. This is made explicit in the applicable research tools. In addition, all variables that have a quantifiable value are measured by their planned and actual values in the project. This approach has several reasons. First, data sets may not be large enough to be compared based on absolute numbers only. By observing the fractional discrepancy between the planned and the actual value one can obtain some comparable metrics. One could even argue that it is actually the discrepancy that matters most (see section 4.1 for elaboration). E.g. it does not matter if personnel cost stack 2 in project one to 10 in project two if the first project went 100% over budget while the latter project was on-budget and just ten times as large as the former.

‘Methodology’/\(IV\), is the only independent variable in the second part (RQ2) of the current research. The operationalization of this variable is aimed at measuring the applied methodology in a project. The operationalization of an abstract concept such as methodology is in no way trivial. In addition, there is no strict dichotomy between the agile and the waterfall methodology. Practices of both methodologies are not always mutually exclusive (and hardly ever fully mutually exclusive) and can thus be mixed. Furthermore, there is no definitive set of practices to describe either methodology. Agile methodologies in particular can vary wildly in the aspects which are applied. On top of that there seems to be no clear definition to determine if a certain practices is applied. For example: The Scrum methodology contains daily stand up meetings in which each person is to state their accomplishments of the day before, his actions for the upcoming day and issues that might impede these actions. One could legitimately ask whether you could determine the application of this practice when the daily stand up covers slightly or entirely different matters. One should note that the ambiguity thus ranges from the theoretical to the practical. It is therefore necessary to be somewhat crude in the operationalization of this variable, while recognizing the problems that this crude approach implies. The operationalization of methodology is based on methodological tools provided by Deloitte. These
tools are in turn based on the Scrum methodology. Fifteen Scrum practices have been selected and explicitly incorporated into the agile methodology. These practices are presented in figure 3.2.2.

![Figure 3.2.2, Agile practices, Deloitte internal source](image)

Please note that these are optional supplements. Projects will still have a waterfall structure and can thus contain any combination of agile practices. This study uses the total number of practices that are stated to have been applied during the project as a metric. In addition, respondents are offered the opportunity to mention utilized agile practices that were not in the prescribed set. To validate these results, respondents are also asked to rate the project on the perceived level of ‘agileness’ of the project. This should cover some of the ambiguities regarding the practical application of practices. Respondents are offered the option to elaborate on their answer. The value of the $IV$ based on the average number of agile practices applied. The aforementioned scale value is then used to ‘correct’ this value. The weighted average of both normalized values is calculated to determine the ‘Corrected average agile practices’ ($\bar{IV}$). The reasoning behind this calculation is that respondent can correct the value of the $IV$ for an inconsistently applied methodology. The set of practices displayed in figure 3.2.2 forms the basis of the set $\{I_0^{IV}, I_1^{IV}, \ldots, I_{19}^{IV}\}$. These and five additional practices are used to obtain an accurate picture of to what extent the project applied a (hybrid) agile methodology. A more detailed elaboration on the separate practices can be found in appendix 3.2.2.2.

$DV_0$/'Duration discrepancy' is operationalized by the question ‘What were your planned and actual durations for the project?’ For these and all following indicators respondents have the option to indicate that they cannot give an estimate of the absolute figures. As an alternative, they can provide an estimate percentage of the discrepancy. In addition, respondents are given the option at the end of the survey to refer to documents and/or persons that might otherwise provide this information. The eventual value of this variable is determined by calculating the percentage discrepancy produced by the planned figure and the actual figure. If this number was not available due to missing values, the estimated percentage would be used. The combination of these value series resulted in the variable ‘Combination exact and estimated duration discrepancy data’. This variable
will henceforth be referred to as \(DV_0\) /‘Duration discrepancy’. In a similar way \(DV_1\) /‘Budget discrepancy’ is operationalized by the question ‘What were your planned total project costs and actual total project costs?’ Since this research has a more international focus, respondents are asked to state the applicable currency. Again, rough percentages can be provided as an alternative. Like with \(DV_0\), the eventual value of this variable is determined by calculating the percentage discrepancy produced by the planned figure and the actual figure. Again, a percentage could be provided as an alternative. The combination of these value series resulted in the variable ‘Combination exact and estimated budget discrepancy data’. This variable will henceforth be referred to as \(DV_1\) /‘Budget discrepancy’.

\(DV_2\) /‘Profit discrepancy’ is operationalized with the same measurement setup. Furthermore, respondents are requested to state the profit in their preferred currency. By combining these data points as described with \(DV_0\) and \(DV_1\) the ‘Combination exact and estimated budget discrepancy data’ variable is created. This variable will henceforth be referred to as \(DV_2\) /‘Profit discrepancy’.

The paragraphs above described the operationalization of the dependent variable and set out a rough sketch for the criteria the research tools should adhere to. This information can be summarized in an operationalization table (appendix 3.2.1). Please note that the regular columns reason from the theoretical variables to the indicator variables, to the empirical variables. The applicable data tools have been added as a fourth column. This provides the reader with an overview of which empirical variable is measured by which tool.

**Hypotheses**

The second part of this research poses a question on the relation between the applied methodology and ERP project outcomes. After discussing the suggestions originating from the literature we can now start addressing the second sub-question: Do the values of ERP project outcomes change as a function of the applied methodology? This paragraph contains the hypotheses required to provide answers to these questions. The variables that have been operationalized and elaborated on in the former paragraph will be used for this purpose. The hypotheses are formulated from \(IV\) to the set of \(\{DV_0, DV_1, DV_2\}\) in a \(H_0, H_1\) structure. \(H_0\) states, by default, that no relation is present whereas \(H_1\) states that a relation is present. The set of hypotheses on every relation will be referred to as a hypotheses test \((HT_i^{(IV,DV)})\) for the relation \((IV,DV)\).
Research Question 2

\[ HT^{(IV,DV)}_0: \]
- \( H_0: \) The value of Duration discrepancy does not change as a function of the applied methodology
- \( H_1: \) The value of Duration discrepancy changes as a function of the applied methodology

\[ HT^{(IV,DV)}_1: \]
- \( H_0: \) The value of Budget discrepancy does not change as a function of the applied methodology
- \( H_1: \) The value of Budget discrepancy changes as a function of the applied methodology

\[ HT^{(IV,DV)}_2: \]
- \( H_0: \) The value of Profit discrepancy does not change as a function of the applied methodology
- \( H_1: \) The value of Profit discrepancy changes as a function of the applied methodology

The hypotheses posed above are tested in section 4.2 (i.e. in the results chapter). The remainder of this section will discuss the research populations, instruments and further data treatment. Please note that the values of the set \( \{I_0^{IV}, I_1^{IV}, ..., I_{19}^{IV}\} \) are not directly included in these test. These values will be tested in relation to some of the dependent variables. The relations set out in the hypotheses described above will however be the leading method for the derivation of conclusions.

3.2.2 Population and Sampling

This section covers the population and sampling with respect to the second research question. Projects need to include ERP systems. The project should cover some form of ERP project. This could vary from an ERP consolidation to a single ERP implementation to just the addition of add-ons to an existing ERP. Furthermore, respondents are asked to provide a short description of the project at the start of the survey. This enabled the current research to categorize the ERP and non-ERP projects. For a more in-detail look at the questions that help define the project type and scope see appendix 3.2.2.4. The population for the part of the study was limited to ERP projects in which Deloitte was involved. A further requirement was that respondents were able to report on the applied methodology (IV) and project outcomes (DV).
3.2.3 Instrument

This paragraph covers the various research tools used in the current research. The content of the applicable survey (survey 1.1) can be found in appendix 3.2.2. The survey is based on the results (i.e. the set of $DV$) presented in section 4.1, and the operationalization in the current section (paragraph 3.2.1). The tool segments relating to different variables are presented separately in appendix 3.2.2.1 to 3.2.1.4. Please note that these elements have been duplicated in survey 2.1 (see section 3.3). The survey contains three main elements relevant for RQ2. The first element requests general information about the project. This information was used in order to classify and categorize the projects into useful categories. The second element attempts to measure (among other things) the value of the independent variable and its respective indicators $\{IV_0, IV_1, ... IV_{19}\}$. After this measurement of the independent variable, the dependent variables can be measured. The measurement of the dependent variables $\{DV_0, DV_1, DV_2\}$ comprises the last element of survey 1.1. In this element discrepancies are measured by a combination of absolute values and estimates of discrepancies.

3.2.4 Data Gathering Procedure

Respondents were looked up through a (global) internal network and were selected based on the results of search queries such as ‘Agile ERP’. During the data collection phase around 1300 respondents from $35 < (predominantly western)$ countries were contacted. Around 3000 emails were sent, including all replies after the initial request. Around 1000 emails were received. This resulted in a $N$ /data set of 187 returned surveys. The data gathering focussed, initially, on finding professional who had experience with the application of agile methodology in ERP projects. The reason being that this population could be expected to be rather scarce. It turned out at the end of the data collection phase that this focus had persisted for too long and that the instances of agile application far outnumbered the instances in which this application was not prevalent.

3.2.5 Data Processing

After the termination of the data collection process, the processing of the data could start. This proved to be a time intensive process. Different form formats caused a fraction of the total data set to be manually inserted into an excel database. In this database, the data was processed. Some variables, such as the ‘project category’ ($I_4^{MV}$, see section 3.3), were manually coded based on project descriptions. In total five project categories were defined. Project category 1 contained ‘pure’ ERP projects. Project category 2 contained ERP projects which included affiliated COTS (Commercial of-the-shelf) software components. These two categories were defined as the population that would be tested. Other variables were ‘cleaned’. This implied that spelled figures were replaced with the actual
or logically derived numerical. Entries like ‘five’ would then become ‘5’ and the entry ‘not sure, 5 to 7’ were transformed into ‘6’. Furthermore, data series have been combined and in some cases corrected. This process has been described with respect to the IV and DV set in paragraph 3.2.1. After the preparations in excel, the database was converted to and SPSS data format to be prepared for further analysis.

3.2.6 Statistical Analysis

This section covers the statistical analysis that was performed on the obtained data. It has already been determined that the (IV, DV) relations are central to answering RQ2. The hypothesized relations are tested with a (Pearson) regression test. A summary of the test and its interpretation can be found in section 4.2. The results are then subjected set of hypotheses \( \{ HT_0^{(IV,DV)}, HT_1^{(IV,DV)}, HT_2^{(IV,DV)} \} \) and results are drawn accordingly. In addition to these regression tests and their results, the separate indicators of the independent variable were tested against the set of dependent variables as well. The Mann Whitney U test was be utilized for this purpose. This test requires the formation of two populations. Populations are defined based on their application (‘yes’ or ‘no’). The test is aimed at determining whether the mean between the two differing populations (that is, the population who did use a certain practice against the population who did not) differs significantly. It must again be mentioned that the latter series of tests had no effect on the treatment of the hypotheses. The evidences thus is treated as merely suggestive.

3.2.7 Validity and Reliability

This section covers the reliability and validity of the second part of this study. Issues with respect to the validity and the reliability of the data are discussed. This part of the current research aims to analyze the relation between methodology and project outcomes from the perspective of third party consulting firms. However, due to practical restrictions, measurements occur only in the environment of one such firm. Deloitte is one of the market leaders in this industry. The obtained results can however not be expected to be representative of the whole industry. This implies that the validity of this research is harmed. Specifically: this research is not analyzing a relation present in an industry, but a relation present in a certain company in that industry. In addition to this point, the samples are obtained by the generosity of respondents, interviewees etc. Random sampling can thus not be implemented. Other validity issues include the operationalization of less tangible variables and indicators of variables. The most worrisome being the independent variable ‘Methodology’. The researchers observe that the main problem originates from the fact that the definitions of methodologies can vary in both nature and the degree of specificities. This makes it, for example, hard to define what is, and what is not agile. Another problem originates from the fact that agile concepts,
principles, and practices are not known by heart industry wide. In a specific example: interviews contained numerous instances in which it became clear that agile practices were applied, just under a different name. This research attempts to control for this problem by adding a more abstract description to the agile practices. In this way, the researchers hope to obtain a more valid measurement of the ‘agileness’ of the applied methodology. In addition, there is the problem of careless and uninterested input of data. To combat the problems mentioned above, a filter has been applied to all tests presented in the current research (both RQ2 and RQ3): Cases were excluded if the value of the average application of agile practices differed more than 0.4 from the (normalized) value on the agile scale.

The same fallacies that plague the establishment of validity also adversely affect the establishment of reliability. This research field (application of agile methodologies in ERP projects) is still premature to non-existent. Application in the industry is neither widespread nor mature. The obtainment of large data sets is thus resource-intensive or even impossible. This harms the reliability of this research.
3.3 Methodology on the moderating relation between distinctive characteristics of ERP projects and the strength of the relation between methodology and ERP project outcomes

This section discusses the methodology regarding the RQ3 (i.e. the third part of this research). This part of the current research contains two separate ‘lines’ of research. The content of the first line is indicated in figure 3.3.1. In this line of research, the relation between the moderation variable (distinctive attributes of ERP projects/$MV$) and the $(IV, DV)$ relation set will be discussed. The total set of relations can be described as $(MV, (DV, IV))$.

The second line of research is illustrated in figure 3.3.2. In this second line of research, the relation between the original independent variable and the dependent variable is substituted with a proxy variable $(PV^{(IV, DV)})$. The reasoning behind this proxy variable has been explained in section 2.3 and will be elaborated on further below. For now, it is important to understand the following: The proxy variable intends to simulate the behavior of $(IV, DV)$. The relation set $(MV, (DV, IV))$ is thus simulated by $(PV^{(IV, DV)}, MV)$.
Section 3.3

Figure 3.3.2., Relational model second line RQ3, Author’s observation

The position of this section in the current research is indicated in table 3.3.1.

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<th>Ch. II Theory</th>
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Table 3.3.1, Core structure, Author’s observation

3.3.1 Research Design

The research design of this part of the current research was centered on analyzing the relations between selected variables with surveys. This paragraph commences by discussing the theoretical design and operationalizing the set of applicable variables and indicators. Subsequently, relevant hypotheses will be formalized.

The most important variable is the moderating variable; distinctive attributes/MV. Please note that this variable fulfills the role of an independent variable in the second line of research. It remains however unclear what these distinctive attributes would be (if they exist at all). Dependencies originating from the integral nature of ERP projects have been hypothesized to be such a distinctive attribute. These dependencies are defined and operationalized as indicators of MV: \( \{I_0^{MV}, I_1^{MV}, I_2^{MV}, I_3^{MV}, I_4^{MV}\} \) Indicators, because they are hypothesized to be a subset of MV. Four of the five indicators variables that comprise MV measure some sort of dependency. The fifth indicator \( I_4^{MV} \) measures the project category. The elements of the complete indicator set \( \{I_0^{MV}, I_1^{MV}, I_2^{MV}, I_3^{MV}, I_4^{MV}\} \) and their operationalization will be discussed below.

Operationalization of variables

\( I_0^{MV} \) /’Team dependency’ and \( I_1^{MV} \) /’Average dependency’ are operationalized as the percentage of deliverables for which external input (e.g. by other teams) was required. Respondent are requested...
to estimate this percentage for their team \((I_0^{MV})\) and for all teams on average \((I_1^{MV})\). Answer can be provided on a 5 point scale ranging from ‘\(\leq 20\%\)’ to ‘\(\leq 100\%\)’. \(I_2^{MV} = \text{‘System dependency’}\) was operationalized as the level of dependency originating from the target systems involved in the respondents’ project. Respondents were requested to rate this level of dependency on a six point scale ranging from ‘completely independent’ to ‘completely dependent’. In a similar manner, the level of dependencies originating from the business processes involved was operationalized. This resulted in the formulation of indicator \(I_3^{MV}\). To conclude this set of indicators we attempt to operationalize the project category. This indicator effectively ‘zooms out’ from the dependency perspective provided so far. By measuring the project category we hope to measure whether there is a difference between ERP and non-ERP projects at all. The categorization process is based on the provided project description (see appendix 3.2.2 and 3.3.1). The systems and respective components mentioned in this description are set against a categorization list (appendix 3.2.3). The project is then placed in to one of 5 categories. The categories range from category 1, implying only ERP, to category 5, implying only unrelated systems.

With the definition of the \(MV\) indicators in place we can commence de operationalization of the \(PV\) variable set. The total set is defined in paragraph 1.3.3 as

\[
\{PV_{(IV, DV)}(IV, DV), I_0^{PV_{(IV, DV)}}, I_1^{PV_{(IV, DV)}}, \ldots, I_{19}^{PV_{(IV, DV)}}\}\]

This implies that there is one proper proxy value and 20 respective indicators. The structure of the operationalization is similar to that of the set \(\{IV, I_0^{IV}, I_1^{IV}, \ldots, I_{19}^{IV}\}\). The set \(\{I_0^{PV_{(IV, DV)}}, I_1^{PV_{(IV, DV)}}, \ldots, I_{19}^{PV_{(IV, DV)}\}}\), consisting of 20 questions on agile practices is rated on their perceived usefulness in each specific project (see appendix 3.2.2.2). The average of these values forms the ‘average usefulness’ variable: \(PV_{(IV-DV)}\).

An operationalization table has been produced in order to obtain a structured overview of the operationalization process. Appendix 3.3.1 contains a table that presents the relations between theoretical variables, indicator variables, and empirical variables, with the addition of the applicable research tools. For simplicity, research tools that solely measure variables regarding the second research question have been omitted.
Hypotheses

RQ3 comprises questions on the moderating relation from distinct ERP project attributes (MV) to the (IV, DV) relations central to RQ2. This paragraph contains the hypotheses required to provide answers to these questions. The variables that have been operationalized and elaborated on in the former paragraph will be utilized here. The hypotheses are to be formulated from set of \(\{I_0^M, I_1^M, I_2^M, I_3^M, I_4^M\}\) to the set \(\{PV^{(IV-DV)}, I_0^{PV^{(IV-DV)}}, I_1^{PV^{(IV-DV)}}, \ldots I_{19}^{PV^{(IV-DV)}}\}\) in a \(H_0, H_1\) structure. The set of hypotheses on the (MV, (IV, DV)) relations will be referred to as a hypothesis test/HT\(^{(MV,(IV,DV))}\). Subsequently, the hypothesis test set \(HT_i^{(MV,PV)}\) will be formulated.

**HT\(^{(MV,(IV,DV))}\):**

- \(H_0\): The value of the (IV, DV) relation set does not change as a function of the level of dependency in a project
- \(H_1\): The value the (IV, DV) relation set changes as a function of the level of dependency in a project

**HT\(^{(MV,(IV,DV))}\):**

- \(H_0\): The value of the (IV, DV) relation set does not change as a function of the project category
- \(H_1\): The value of the (IV, DV) relation set changes as a function of the project category

**HT\(^{(MV,PV)}\):**

- \(H_0\): The perceived usefulness of agile methodologies does not change as a function of the level of dependency in a project
- \(H_1\): The perceived usefulness of agile methodologies changes as a function of the level of dependency in a project

**HT\(^{(MV,PV)}\):**

- \(H_0\): The perceived usefulness of agile methodologies does not change as a function of the project category
- \(H_1\): The perceived usefulness of agile methodologies changes as a function of the project category

These hypotheses are tested in section 4.3. The remainder of this section discusses the research populations, instruments, and further data treatment. Like with the \(\{I_0^V, I_1^V, \ldots I_{19}^V\}\) set in RQ2 the \(\{PV^{(IV-DV)}, I_0^{PV^{(IV-DV)}}, I_1^{PV^{(IV-DV)}}, \ldots I_{19}^{PV^{(IV-DV)}}\}\) set is not directly included in these test.
3.3.2 Sampling, Instruments and Data Gathering and Processing

The processes and procedures regarding sampling, instrument development, data gathering and data processing were largely similar to the processes and procedures described in paragraph 3.2.2 to 3.2.5. The reason being that the majority of data regarding RQ3 was collected with the same ‘Survey 1.1’ research tool. Data was subsequently processed simultaneously in the same database. Therefore, only deviations from these procedures, specific to RQ3, are elaborated on. Initially, respondents outside the (ERP) target population of RQ2 were requested to fill in survey 2.1 (see appendix 3.3.2). But the similarities with survey 1.1 were substantial. So it was decided to make one population set multifunctional by inserting the non-intersecting part of survey 2.1 into survey 1.1. Section 3.2 already discussed how the total population was categorized in five subpopulations. In contrast to RQ2, RQ3 contains tests on all project category populations, and they are therefore presented below.

- \( Pop(1) \): ERP
- \( Pop(2) \): ERP and non-ERP COTS or limited overlap
- \( Pop(3) \): non-ERP COTS or limited overlap
- \( Pop(4) \): COTS or limited overlap and unrelated activities/systems
- \( Pop(5) \): unrelated activities/systems

Please note that this project categorization is based on the system categorization presented in appendix 3.2.3.

3.3.3 Statistical Analysis

The \( HT_{i}^{(\text{MV},(IV, DV))} \) set on hypotheses was tested using a moderation (regression based) test. For replicational purposes it must be mentioned that this test was performed with a custom SPSS plugin called ‘PROCESS’. The \( HT_{i}^{(\text{MV},PV)} \) set was tested with a regular regression test. Please note that regression tests for \( HT_{i}^{(\text{MV},PV)} \) were possible (unlike with \( HT_{i}^{(\text{MV},(IV, DV))} \)) since the \((\text{MV}, PV)\) for all practical purposes equates to an independent-dependent variable relation.

3.3.4 Validity and Reliability

Concerns with respect to validity and reliability are largely similar to those mentioned in paragraph 3.2.7. The environment may not be representative of the industry and the samples were not randomly obtained. The same definition problems that plagued the second part of this research are relevant in the current study (RQ3). This problem originates from the fact that moderator influences the relation between the independent and the dependent variable (i.e. is based on their definition). There is a lack of formerly validated measurement tools for variables like ‘distinctive attributes’ or ‘usefulness of agile practices’. New variables have been operationalized and validated with peers and professionals.
in the field. In this way, the researchers hoped to obtain a more valid measurement tool. In addition to this, there are no pre-existing data sources that seem applicable as baselines to this research. There is thus no other way of confirming reliability than by performing additional research.
Chapter IV. Presentation, Analysis, and Interpretation of Data

This chapter covers the result sections of the corresponding research questions separately. The resulting body of evidence is summarized in the conclusion (chapter five).

4.1 Results on the success defining project outcomes in ERP projects from the consulting parties’ perspective

This section present and interprets the results for RQ2. The position of this section in the current research is indicated in table 4.1.1.

Table 4.1.1, Core structure, Author’s observation

<table>
<thead>
<tr>
<th>RQ1 (Success Definition)</th>
<th>2.1</th>
<th>3.1</th>
<th>4.1</th>
</tr>
</thead>
<tbody>
<tr>
<td>RQ2 (Methodology Outcomes)</td>
<td>2.2</td>
<td>3.2</td>
<td>4.2</td>
</tr>
<tr>
<td>RQ3 (Distinctive Attributes)</td>
<td>2.3</td>
<td>3.3</td>
<td>4.3</td>
</tr>
</tbody>
</table>

4.1.1 Presentation of Data

Relation to Problem Statement

The data presented in this section aims to provide an answer to the first research question of this research: What are the success defining project outcomes of ERP projects from the consulting perspective? The results are viewed as an indicator set $I^{SD}$ to the success definition $SD$ who in turn comprises the set of indicators: $SD = \{I_0^{SD}, I_1^{SD} \ldots I_n^{SD}\}$. The answers to this question aims to pave the way for the second and the third part of this research (RQ2 and RQ3). The dependent variables (being a subset of $\{I_0^{SD}, I_1^{SD} \ldots I_n^{SD}\}$) are thus based on the theory described in section 2.1 and the research performed according to the elaboration in section 3.1. As mentioned in section 2.1, there has hardly been any prior research in this area. Thus, results do in itself constitute an instance of knowledge creation. A relevant subset of the data report is presented in table 4.1.1. When looking at the results, it becomes clear that the codes of the ‘overall’ type dominated the list. This follows logically from the fact that these codes all fulfill a parent function to several child codes. From the total list of 50 codes, less than 10 are mentioned in more than two documents. Only 15 codes in total occur in more than one document. Thus, only 15 codes are eligible to be included as dependent variables in the second part of the current research.
<table>
<thead>
<tr>
<th>$i$ in $I_{SD}^i$</th>
<th>Success definition Indicator/ $I_{SD}^i$</th>
<th>D1</th>
<th>D4</th>
<th>D5</th>
<th>D6</th>
<th>D7</th>
<th>D8</th>
<th>D9</th>
<th>D10</th>
<th>D11</th>
<th>Quotation Total:</th>
<th>Documents occurring - 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Project Quality Overall</td>
<td>1</td>
<td>7</td>
<td>2</td>
<td>5</td>
<td>3</td>
<td>9</td>
<td>2</td>
<td>5</td>
<td>4</td>
<td>38</td>
<td>8</td>
</tr>
<tr>
<td>1</td>
<td>Customer Satisfaction Overall</td>
<td>12</td>
<td>1</td>
<td>3</td>
<td>4</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>4</td>
<td>28</td>
<td>7</td>
</tr>
<tr>
<td>2</td>
<td>Project Duration Overall</td>
<td>20</td>
<td>3</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>4</td>
<td>0</td>
<td>30</td>
<td>5</td>
</tr>
<tr>
<td>3</td>
<td>Project Financial Overall</td>
<td>11</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>1</td>
<td>3</td>
<td>10</td>
<td>2</td>
<td>29</td>
<td>5</td>
</tr>
<tr>
<td>4</td>
<td>Project Budget Overall</td>
<td>7</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>5</td>
<td>0</td>
<td>16</td>
<td>4</td>
</tr>
<tr>
<td>5</td>
<td>KPI Development</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>4</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>8</td>
<td>3</td>
</tr>
<tr>
<td>6</td>
<td>Project Profit Overall</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>9</td>
<td>3</td>
</tr>
<tr>
<td>7</td>
<td>Project Business Readiness</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>8</td>
<td>Project Budget Versus Actual</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>3</td>
<td>0</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>9</td>
<td>Customer Satisfaction Accepts Product</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>10</td>
<td>Project Costs Personnel</td>
<td>5</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>6</td>
<td>1</td>
</tr>
<tr>
<td>11</td>
<td>Project Duration per Phase</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>12</td>
<td>Project Duration Versus Actual</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>3</td>
<td>0</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>13</td>
<td>Project Duration Time to Market</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>14</td>
<td>Project Technical Readiness</td>
<td>0</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>15</td>
<td>Customer Satisfaction Availability</td>
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<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
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<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>50</td>
<td>Technology Debt</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
</tbody>
</table>

Table 4.1.1, Success indicators interview occurrence, Author’s observation
4.1.2 Interpretation of Data

Connections among data

As described section 3.1, the number of documents in which a code occurs is the main determinant of its relative value. The last column represents the number of documents in which a code occurs minus one. Due to the variety of interviewees, especially in the first half of the data gathering phase, overlap between interviewees is posed as a minimal requirement. A substantial subset of the codes is too abstract to be operationalized as dependent variables. This part of the research aims to find the relevant outcomes of ERP projects within the context of Deloitte. Two considered exclusion principles must, however, be taken:

1. Variables which cannot be operationalized without starting a separate study should be excluded from the list. ‘Quality’ is an excellent example of such a non-operationalizable variable. In addition, ‘KPI development’, ‘Project business readiness’, ‘Project duration time-to-market’ and ‘Customer satisfaction’ were excluded based on this principle. The exclusion of the latter justifies some explanation, for it was initially included in the research plan and a separate customer survey was developed. It turned out that reaching out or providing contact details of the customer was an undesired step that almost none of the respondents were willing to take. Based on this knowledge the variable was excluded to relieve some of the burden of the ‘total’ request.

2. Dependent variables need to offer the prospect of comparative results. The high variance in project size will imply a high variance in budget sizes as well. This makes the project budget value size less dependent on the methodology used and more on the scope and quality (both excluded based on the former consideration). Instead, relative discrepancies on these absolute values should be measured. This ensures that they can be hypothesized to be, up to some extent, dependent on the independent value. Based on this reasoning ‘Project Duration Overall’, ‘Project Costs Overall’, ‘Project Profit Overall’ and ‘Project Duration per Phase’ are excluded and replaced with a relative dependent variable (e.g. ‘Profit discrepancy’) if not already present in the current list. Note that this rule of exclusion aligns with the PMBOK citation (referred to in section 2.1) which states that: ‘... the success of the project should be measured in terms of completing the project within the constraints of scope, time, cost, quality, resources, and risk as approved ...’ Absolute values are thus measured, but not included in the set of dependent variables.

In addition, project cost personnel was removed based on the input of professionals in the field. The main argument for this removal was the fact that these costs were proportional to the overall project costs/budget. Furthermore, ‘Project duration per phase’ was excluded after a lack of meaningful
results indicated that the standard phase structure did not apply for most purely (hybrid) agile projects. Based on these criteria we can interpret the data in order to obtain a list of workable dependent variables. We first discuss the two sets of excluded variables. The first set consists of the codes $S_0 = \{I_{15}^{SD}, I_{16}^{SD}, \ldots, I_{49}^{SD}\}$, which are excluded due to a lack of inter-interview overlap. After this limitation the set of applicable indicators (and thus the success definition) can be derived. $SD = \{I_0^{SD}, I_1^{SD}, \ldots, I_{14}^{SD}\}$. But this set of indicators is however not yet fit to be operationalized as dependent variables in RQ2. The set of indicators $\{I_6^{SD}, I_8^{SD}, I_9^{SD}, I_{10}^{SD}, I_{11}^{SD}, I_{13}^{SD}\}$, are excluded due to their level of abstraction, impracticality or lack of relevance. The remaining set of codes produces a workable lists of variables of the dependent variable for the second part of this research. This set comprises the elements $\{I_2^{SD}, I_4^{SD}, I_6^{SD}, I_8^{SD}, I_{12}^{SD}\}$. We must account for the fact that some results become equivalent due to the fact that absolute values are translated to relative discrepancies. These results will henceforth be known as dependent variables (i.e. outcomes):

- $\{I_2^{SD}, I_{12}^{SD}\}$: Project Duration Planning Versus Actual → Duration discrepancy/$DV_0$
- $\{I_4^{SD}, I_8^{SD}\}$: Project Cost Budget Versus Actual → Budget discrepancy/$DV_1$
- $\{I_6^{SD}\}$: Project Profit Planning Overall → Profit discrepancy/$DV_2$

The resulting set of dependent variables (or $DV$) consists thus of $\{DV_0, DV_1, DV_2\}$. It must be noted that this set of dependent variables is far from ideal. This is illustrated by the fact that 3 out of the top 5 codes were excluded during the process described above. The limited scope and available resources forced these limitations however. It must therefore be noted that the set of dependent variables (in contrast to the set $SD = \{I_6^{SD}, I_8^{SD}, \ldots, I_{14}^{SD}\}$) does not suffice for a comprisable answer on RQ1. It only represents the scoped decided and forced upon the remainder of the research (RQ2 and RQ3).

Relation Present Findings to Previous Literature

Both the ‘on-time’ and the ‘on-budget’ criteria that were mentioned in the study of, limited, pre-existing literature are reflected in the set of variables. There is, however, one discrepancy. The interpretation of Teo, Singh, and Cooper focusses clearly on the functionality of the product and whether these fulfill to the contractual agreements of the project. The codes that come close semantically are ‘Project Meeting Statement of Work’ and ‘Project Product Correspondence Customer Demand’. The researchers’ interpretations, in contrast, show a predominant focus on customer satisfaction. The origin of this discrepancy is not clear. The two most likely explanations are: Company specific, Deloitte is a relatively ‘client-oriented’ organization. The fact that the former study focussed mainly on vendors rather than implementation partners (Teo et al., 2009) which could explain a more technical focus (i.e. functional requirements rather than organizational requirements).
4.2 Results on the relation between the applied methodology and ERP project outcomes

The position of this section in the current research is indicated in table 4.2.1.

<table>
<thead>
<tr>
<th>RQ1 (Success Definition)</th>
<th>Ch. II Theory</th>
<th>Ch. III Method</th>
<th>Ch. IV Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>RQ2 (Methodology Outcomes)</td>
<td>2.2</td>
<td>3.2</td>
<td>4.2</td>
</tr>
<tr>
<td>RQ3 (Distinctive Attributes)</td>
<td>2.3</td>
<td>3.3</td>
<td>4.3</td>
</tr>
</tbody>
</table>

Table 4.2.1, Core structure, Author’s observation

4.2.1 Presentation of Data

Relation (Solution) to Problem Statement

The data presented in this section covers the hypothesized relation between the independent variable (methodology, measured in the degree of ‘agileness’) and a subset of the relevant dependent variables (project outcomes, measured in duration, budget and profit discrepancies). Please note that this subset of the $DV$ has been defined section 4.1. This section should answer this question by showing whether the project population of ERP projects differs based on the used methodology. In this regard, a significant relation between the methodology and/or separated practices would suggest that there is a relation of either positive or negative nature and refute the zero hypothesis which states by default that there is no significant difference. The data aims to provide a quantitative foundation for answers to the second research question (RQ2). The data has been categorized based on the analysed relation. The first category covers the direct relations between the independent variable/$IV$ (being the value of ‘corrected average agile practices’) and the dependent variables/$\{DV_0, DV_1, DV_2\}$. The second category is discussed afterward and covers data on the relations between agile practices/$\{I_1^{IV}, I_2^{IV}, \ldots, I_{19}^{IV}\}$ and dependent variables/$\{DV_0, DV_1, DV_2\}$.

Data on the methodology-outcomes relations ($IV, \{DV_0, DV_1, DV_2\}$)

Data regarding the second research question is presented in table 4.2.1. We will first present the outcomes of regression analysis performed on the hypothesized relation between the independent and the dependent variables ($IV, \{DV_0, DV_1, DV_2\}$). The data points comprise a subset of the total output. Please note that tough an elaboration is covered here, the analysis and interpretation are covered in paragraph 4.2.2.
### Table 4.2.1*, (IV, DV) Regression test, Author’s observation

<table>
<thead>
<tr>
<th>DV in (IV, DV)</th>
<th>N</th>
<th>Mean (discrepancy as fraction of planned value)</th>
<th>Standard deviation</th>
<th>Correlation/R (Pearson) with IV (Corrected average agile practices)</th>
<th>Adjusted R square</th>
<th>Pearson correlation Significance (1-tailed)</th>
<th>ANOVA significance</th>
<th>Unstandardized Beta coefficient (discrepancy as fraction of planned value) with corrected average agile practices (IV)</th>
</tr>
</thead>
<tbody>
<tr>
<td>DV0/Duration discrepancy</td>
<td>77</td>
<td>0.126</td>
<td>0.254</td>
<td>0.217</td>
<td>0.034</td>
<td>0.029</td>
<td>0.058</td>
<td>0.200</td>
</tr>
<tr>
<td>DV1/Budget discrepancy</td>
<td>35</td>
<td>0.203</td>
<td>0.264</td>
<td>0.283</td>
<td>0.052</td>
<td>0.050</td>
<td>0.099</td>
<td>0.048</td>
</tr>
<tr>
<td>DV2/Profit discrepancy</td>
<td>42</td>
<td>-0.050</td>
<td>0.218</td>
<td>-0.246</td>
<td>0.037</td>
<td>0.059</td>
<td>0.117</td>
<td>-0.186</td>
</tr>
</tbody>
</table>

* Filters: Discrepancy agile values < 0.4 (see section 3.2), Project category < 3 (see section 3.2)
Sample sizes for the measurement of relations range between the 42 and 77 whereas the total dataset has a $N$ of 183. This relatively low $N$ range is a result of applied filters (see table 4.2.1) and missing values (mostly on the side of the dependent variable). We observe that mean discrepancies on duration, budget and profit ranges from -0.050 to 0.218 with a relatively high standard deviation on all variable values (range: 0.218 to 0.264). $R$ values (i.e. correlations) have a similar strength, ranging from 0.217 to 0.283. Duration discrepancy/$DV_0$ and budget discrepancy/$DV_1$ seem to be positively correlated with an increase in the application of agile practices. In light of these correlations, it makes intuitive sense that the profit discrepancy (i.e. how much more or less profit was actualized than planned) seem to be negatively correlated with the application of agile practices. Please note that the latter only refers to the numeric relation. This study defines ‘discrepancies’ as unfavorable deviations (i.e. the two have a positive relation since the discrepancy increases as the $IV$ value increases). Apart from the relation $(IV, DV_0)$, none is significant in either the Pearson or the ANOVA significance test. Though it must be noted that there seems to be a clear direction since the range of non-significant results start at 0.050 and stops at 0.117 for both the Pearson and ANOVA test. These intuitively corresponding figures suggest results could be made significant if the filtered population was increased. The unstandardized beta coefficients (indicating the $y$-axis intersection) are rather close to zero. More interestingly, the unstandardized beta coefficients for the variables (indicating the change as a result of a changing $x$ value) suggest sizable changes in discrepancies as a result of a changing methodology. This, so far insignificant, data suggests that full agile ERP projects can expect a 19% higher duration discrepancy, 27% higher budget discrepancy and a 19% lower profit margin when moving to a full agile methodology. Figure 4.2.1, 4.2.2 and 4.2.3 illustrate the scatterplots on which the regressions are based. The large standard deviation is illustrated in these plots. A regression line has been added which corresponds to the values of the unstandardized beta coefficient.
Figure 4.2.1, Duration as function of methodology, Author’s observation

Figure 4.2.2, Budget as function of methodology, Author’s observation
Data on the agile practices – project outcomes relations \((\{I_0^{IV} \ldots I_{19}^{IV}\}, \{DV_0 \ldots DV_2\})\)

Data regarding the relations between indicators of the independent variable and the dependent variables \((\{I_0^{IV} \ldots I_{19}^{IV}\}, \{DV_0 \ldots DV_2\})\). The categorization is elaborated on in 3.3. The categories 1 and 2 cover ‘pure’ ERP projects and ERP projects that include affiliated COTS (such as CRM) as well (respectively). Table 4.2.2 contains all significant, or close to significant, relations that emerged as a result of a series of Mann-Whitney U test. This test is used indicate whether population means differ based on the value of a certain practice (applied: yes/0 or no/1). The total set of possible relations consists of \(20 \times 3 = 60\) elements. Due to the rather substantial output that these relations entail, only significant or ‘close to significant’ relations (one-tailed significance \(\leq 0.059\)) have been displayed.

Figure 4.2.3, Profit as function of methodology, Author’s observation
<table>
<thead>
<tr>
<th>$H_i^{IV}$ in ($I^{IV}, DV_i$)</th>
<th>$DV_i$ in ($I^{IV}, DV_i$)</th>
<th>N</th>
<th>Value of indicator of the independent variable</th>
<th>Mean rank</th>
<th>One-tailed significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>$H_0^{IV}$/Scrum master role</td>
<td>$DV_2$/Profit discrepancy</td>
<td>20</td>
<td>No</td>
<td>17.53</td>
<td>0.057**</td>
</tr>
<tr>
<td></td>
<td></td>
<td>19</td>
<td>Yes</td>
<td>22.61</td>
<td></td>
</tr>
<tr>
<td>$H_3^{IV}$/Time boxed sprints</td>
<td>$DV_0$/Duration discrepancy</td>
<td>25</td>
<td>No</td>
<td>30.26</td>
<td>0.024</td>
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<td></td>
<td></td>
<td>48</td>
<td>Yes</td>
<td>40.51</td>
<td></td>
</tr>
<tr>
<td>$H_6^{IV}$/Iterative sprint planning (PMO driven)</td>
<td>$DV_2$/Profit discrepancy</td>
<td>7</td>
<td>No</td>
<td>11.36</td>
<td>0.050</td>
</tr>
<tr>
<td></td>
<td></td>
<td>10</td>
<td>Yes</td>
<td>7.35</td>
<td></td>
</tr>
<tr>
<td>$H_7^{IV}$/Team capacity</td>
<td>$DV_2$/Profit discrepancy</td>
<td>8</td>
<td>No</td>
<td>12.94</td>
<td>0.023</td>
</tr>
<tr>
<td></td>
<td></td>
<td>11</td>
<td>Yes</td>
<td>7.86</td>
<td></td>
</tr>
<tr>
<td>$H_9^{IV}$/Daily stand up meeting</td>
<td>Duration discrepancy</td>
<td>29</td>
<td>No</td>
<td>33.33</td>
<td>0.007</td>
</tr>
<tr>
<td></td>
<td></td>
<td>46</td>
<td>Yes</td>
<td>42.84</td>
<td></td>
</tr>
<tr>
<td>$H_{11}^{IV}$/Impediments list</td>
<td>$DV_2$/Profit discrepancy</td>
<td>14</td>
<td>No</td>
<td>23.93</td>
<td>0.038</td>
</tr>
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<td></td>
<td></td>
<td>25</td>
<td>Yes</td>
<td>17.80</td>
<td></td>
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<tr>
<td>$H_{12}^{IV}$/Team velocity</td>
<td>Budget discrepancy</td>
<td>14</td>
<td>No</td>
<td>13.61</td>
<td>0.025</td>
</tr>
<tr>
<td></td>
<td></td>
<td>20</td>
<td>Yes</td>
<td>20.23</td>
<td></td>
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<tr>
<td></td>
<td>$DV_2$/Profit discrepancy</td>
<td>16</td>
<td>No</td>
<td>24.47</td>
<td>0.046</td>
</tr>
<tr>
<td></td>
<td></td>
<td>25</td>
<td>Yes</td>
<td>18.78</td>
<td></td>
</tr>
<tr>
<td>$H_{14}^{IV}$/Agile Definition of Done</td>
<td>$DV_2$/Profit discrepancy</td>
<td>18</td>
<td>No</td>
<td>22.28</td>
<td>0.050</td>
</tr>
<tr>
<td></td>
<td></td>
<td>20</td>
<td>Yes</td>
<td>17.00</td>
<td></td>
</tr>
<tr>
<td>$H_{16}^{IV}$/Sprint review</td>
<td>$DV_0$/Duration discrepancy</td>
<td>25</td>
<td>No</td>
<td>31.38</td>
<td>0.050</td>
</tr>
<tr>
<td></td>
<td></td>
<td>48</td>
<td>Yes</td>
<td>39.93</td>
<td></td>
</tr>
</tbody>
</table>

*Filters: Discrepancy agile values < 0.4 (see section 3.2), Project category < 3 (see section 3.2)

**Significant results indicating a favourable effect of agile practice
Please note that the significances are reported ‘one-tailed’ even though both of the 0.05 significance ranges are populated by the result set described above. Only one result indicates a favorable relation between the dependent and independent variable. We define a favorable relation to the independent variable in this regard as either a positive relation with profit discrepancy and/or a negative relation with duration discrepancy and/or budget discrepancy. A total of nine unfavorable effects are presented in this table. It must however once more be noted that these results stem from a total of 20 \( \times 3 = 60 \) tests. We can, therefore, expect the random occurrence in the confidence range to account for 0.1 \( \times 60 = 6 \) results on average.

4.2.2 Interpretation of Data

**Connections among data**

The regression data on the \((IV, \{DV_0, DV_1, DV_2\})\) relations indicate that a more agile methodology will result in less favourable outcomes for ERP projects. A rough analysis of the total output leads to the suggestion that the size of these discrepancies can be expected in the 10%-30% magnitude. These are however mere suggestions since the lack of significant results prohibits us from discarding any zero hypotheses. The \((IV, DV_0)\) relation did provide a significant result on a one-tailed test. This study did however not hypothesize a specific nature (positive or negative) regarding this relation. And based on the literature discussed in section 2.2 on would expect the exact opposite effect. Therefore, the two-tailed ANOVA test must be taken as the one and only decision factor regarding the posed hypotheses. This leads us to the following series of results regarding the hypotheses presented in section 3.2.1.

\[
HT^{(IV,DV)}_0: \\
\quad H_0: \text{The value of Duration discrepancy does not change as a function of the applied methodology} \rightarrow \text{Maintained} \\
\quad H_1: \text{The value of Duration discrepancy changes as a function of the applied methodology} \rightarrow \text{Discarded}
\]

\[
HT^{(IV,DV)}_1: \\
\quad H_0: \text{The value of Budget discrepancy does not change as a function of the applied methodology} \rightarrow \text{Maintained} \\
\quad H_1: \text{The value of Budget discrepancy changes as a function of the applied methodology} \rightarrow \text{Discarded}
\]

\[
HT^{(IV,DV)}_2: \\
\quad H_0: \text{The value of Profit discrepancy does not change as a function of the applied methodology} \rightarrow \text{Maintained} \\
\quad H_1: \text{The value of Profit discrepancy changes as a function of the applied methodology} \rightarrow \text{Discarded}
\]
It must, however, be noted that the data does leave little room for hypothesizing about a strongly favorable relation between agile methodology and outcomes in ERP projects. This suggestion stands in contrast to the (limited) findings and predictions that huge gains can be made when moving to a more agile methodology. The data on the \((IV, DV)\) relations can, up to some extent, be viewed as an in-detail look at the data presented on \((IV, \{DV_0, DV_1, DV_2\})\). This in-detail look at the indicators and relations involved does not paint a particularly telling picture. Nine out of ten relations follow the directions suggested by the regression analysis: A negative relation for profit discrepancies and a positive relation for duration discrepancies and budget discrepancies. The number of significant results relative to the total testing number implies that none of the suggested relations can be adopted with certainty. The measured relations and their hypothetical plausibility will be discussed. Effects measured with respect to duration-, budget- and profit discrepancies will be discussed in sequence.

Time boxed sprints seem to be associated with an increase of duration discrepancy. This seems rather counterintuitive in the author’s observation, since the fixed nature of the sprints would imply a greater control of time discrepancies. One could, however, reason that the fixed nature of sprints could lead to a less gradual and a more ‘leap-like’ development of duration discrepancies. It could be considered a revelation when time-boxed sprints are proven to be positively correlated with duration discrepancies. In line with this reasoning, one could explain why a sprint review would also contribute to an increase in duration discrepancies. These are formal meetings in which progress is demonstrated and discussed with the relevant stakeholders. If there is a clear decision point at which extension is decided upon then it will logically be this meeting. The measured difference in duration discrepancies based on the practice of daily stand-up meetings does not seem to have an intuitive explanation. Only one indicator seems to be related to the development of budget discrepancies: The team velocity practice prescribes that progress should be publicly displayed (e.g. chartwise) based on a metric such as velocity points. This display could induce a consulting party like Deloitte to allocate more resources in order to keep progress on track. It does, however, seem unlikely that such practices could have a significant determining value on the total budget overrun. The dependent variable profit dependency seems to be associated with six different indicators. There are many ways in which profit discrepancies can develop. But one can assume that often comes down to a consulting/implementation party incurring more costs than previously anticipated. Either due to unexpected (unavoidable) cost and/or due to the conscious decision to ‘take a step back’ profitwise and invest more in the quality delivery of the product. Profit discrepancies seem to be related to practices such as team capacity, iterative sprint planning and agile definition of done. These three practices are all directly related to what can and should be done and what resource allocation should be accommodated to make this happen.
These practices all involve negotiations that apparently seem to work out unfavorably with respect to profit development. The fact that the team velocity practice seems to be associated with a larger profit discrepancy seems to be the result of a correlation between profit discrepancies and budget discrepancies. This leaves us with only two remain relations between indicators and profit discrepancies. The Scrum master role practice seems to be negatively associated with profit discrepancies. Please take note of the fact that we have previously defined as discrepancies as undesired/unfavorable. The numerically the relation is thus positive. This marks the only favorable relation between a separate practice and the dependent variables. This seems to contradict the relations hypothesized above since the Scrum master role practice should ensure the consistent enforcement of all other agile practices. In addition to this enforcement task, the Scrum master is responsible for removing occurring impediments. The practice of impediments listing is, in contrary to the former practice, negatively associated with the development of profit discrepancies. There seems to be no intuitive explanation with which these results would both correspond.

None of the results relation sets discussed above (neither \((IV, \{DV_0, DV_1, DV_2\})\) nor \((\{I_0^{IV} ... I_1^{IV}\}, \{DV_0 ... DV_2\})\) seems to provide conclusive or solid evidence to found the conclusion that the application of agile in ERP project populations increases unfavourable discrepancy levels. Hence, all hypotheses have been discarded. The results do however consistently suggest that dependent values need to be sought in this direction. This in turn makes it seem less and less likely that substantial gains can be expected by moving ERP projects to a more agile point on the methodology spectrum.

Relation Present Findings to Previous Literature

The results presented in this study fail to confirm the suggestions put forth in studies, most notably Komus’ study (Komus, 2014), that there are clear outcome benefits associated with the use of a (Scrum) agile methodology. These results were not found in the studied population of ERP projects. Though it must be mentioned again that, apart from some case studies, there was no study with a similar (ERP centered) population of projects. This study did however not measure the same metrics as the aforementioned studies. Respondents in this study were solicited for their perception of success percentages (in relation to methodology). The current study only covers a subset of the metrics that are supposed to be determinants of success. The gains in productivity and time to market metrics posed by McKinsey (McKinsey, 2011) do not overlap and seem to contradict, or at least be out of line with the presented data. Again, it must be noted that the applicability of comparison is limited since populations and metrics differ. The vulnerabilities of these studies have however been highlighted in section 2.2 and this study attempts to improve on those vulnerabilities. The conclusion and discussion section will however also point out some of the numerous vulnerabilities of the current study.
4.3 Results on the moderating relation between distinctive characteristics of ERP projects and the strength of the relation between methodology and ERP project outcomes

The position of this section in the current research is indicated in table 4.3.1.

<table>
<thead>
<tr>
<th>RQ1 (Success Definition)</th>
<th>Ch. II Theory</th>
<th>Ch. III Method</th>
<th>Ch. IV Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>RQ2 (Methodology Outcomes)</td>
<td>2.1</td>
<td>3.1</td>
<td>4.1</td>
</tr>
<tr>
<td>RQ3 (Distinctive Attributes)</td>
<td>2.3</td>
<td>3.3</td>
<td>4.3</td>
</tr>
</tbody>
</table>

Table 4.3.1, Core structure, Author’s observation

4.3.1 Presentation of Data

Relation (Solution) to Problem Statement

The data presented in this section covers the hypothesized relation between a moderator variable (MV) and the set of (IV, DV) relations (MV, (IV, DV)). The moderating variable is measured by a set of indicator variables \( \{I_0^{MV}, I_1^{MV}, ... I_4^{MV}\} \). The (IV, DV) relations and their lack of significance have been discussed in section 4.2. Because the strength of this moderating relation is based in part on the strength of the (IV, DV) relation, insignificant result have been anticipated. This study has therefore attempted to construct a proxy variable (referred to as \( PV_{(IV-DV)} \)) for the (IV, DV) relation by surveying respondents on the perceived usefulness of a certain agile practice. The measurement of every practice serves an indicator resulting in the set \( \{PV_{(IV-DV)}^0, PV_{(IV-DV)}^1, ... PV_{(IV-DV)}^{19}\} \). This variable set has been defined and operationalized in section 3.3. The presentation of the data in this section intends to answer the question of whether the strength of (IV, DV) relations is dependent on the value of a moderating variable. This question in turn originates from the suspicion that ERP projects are fundamentally different from non-ERP projects. This would be a justification as to why the applicability of agile practices would differ in the ERP context. The measurement of the level of dependencies in an ERP projects is an attempt to single out such a fundamental difference. However, changes in the nature of the (IV, DV) relations dependent on the category (ERP/non-ERP), are measured as well. A significant relation between the level of dependencies and the relations measured in the second research question (presented in section 4.2) would suggest that there is a relation of either positive or negative nature and refute the zero hypothesis which states by default that there is no significant difference. The same process holds for the test outcomes on the relation between the dependencies in ERP projects and the perceived usefulness of the agile methodology and/or separate
practices. The data will be presented in two separate parts. The first part will cover the ‘moderator to 
\((IV, DV)\) relations’ (also referred to as \((MV, (IV, DV))\)). The second part will cover tests on the 
relations between the moderator variable and the proxy variable \((MV, PV^{(IV, DV)})\).

**Data on the \((MV, (IV, DV))\) relations**

The concept of dependencies as a distinctive attribute of ERP projects was formulated based on the 
researchers own observation, without any preexisting literature to back this concept up. The resulting 
questions on the measurement of these inherent dependencies are thus a first attempt at 
consolidating such a concept. As described in section 3.3, the first four indicators 
\(\{I^0_{MV}, I^1_{MV}, I^2_{MV}, I^3_{MV}\}\) concern deliverable dependencies, system based dependencies and business 
process based dependencies respectively. The test results on relations between these indicators and 
the \((IV, DV)\) relation are presented in table 4.3.1. Please note that for every test the \(IV\) is the value 
of corrected average agile practices.

The data in table 4.3.1 comprises no significant results. Apart from the ‘Average deliverables dependency, Budget discrepancy’ interaction there seem to be no sizable coefficients either. It is, 
therefore, safe to state that these results will not contribute to discarding the zero hypotheses. There 
is one indicator of the moderating variable that we have not yet discussed. Indicator \(I^4_{MV}\) represents 
the category value of the project. The categorization has been elaborated on in section 3.2. By defining 
the project category as \(I^4_{MV}\), the difference in the \((IV, DV)\) relation (based on the difference in project 
category) is analyzed. We effectively ‘zoom out’ from our initial focus on dependencies for it seemed 
unjustified (based on the results in table 4.3.1). Instead we compare the ERP project 
category/categories with the non-category/categories. Table 4.3.2 and table 4.3.3 below present the 
data on such a comparison. In all cases \(I^1_{MV} = I^4_{MV} = \) project category. However, the tests can differ 
based on the subsets of the total research population that is included. In the first moderation test the 
first population consists of project categories 1 to 2 \((Pop (1 – 2)), \) i.e. ERP projects and related COTS) 
with a second population consisting of 4 to 5 \((Pop (4 – 5)), \) i.e. COTS and unaffiliated systems). In the 
second moderation test the first population consists of project category 1: \(Pop (1)\) (i.e. only pure ERP 
projects). The second population consists of project category 5: \(Pop (5)\) (i.e. only unaffiliated 
systems/project types).
<table>
<thead>
<tr>
<th>$I_{1}^{MV}$ in $(I^{MV}, (IV, DV))$</th>
<th>$DV_{1}$ in $(I^{MV}, (IV, DV))$</th>
<th>N</th>
<th>Summary R</th>
<th>Summary R square</th>
<th>Summary one-tailed significance</th>
<th>Interaction coefficient</th>
<th>Interaction one-tailed significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Team deliverables dependency/$I_{0}^{MV}$</td>
<td>$DV_{1}/$Duration discrepancy</td>
<td>137</td>
<td>0.138</td>
<td>0.019</td>
<td>0.462</td>
<td>-0.047</td>
<td>0.876</td>
</tr>
<tr>
<td></td>
<td>$DV_{1}/$Budget discrepancy</td>
<td>65</td>
<td>0.191</td>
<td>0.036</td>
<td>0.513</td>
<td>0.093</td>
<td>0.819</td>
</tr>
<tr>
<td></td>
<td>$DV_{2}/$Profit discrepancy</td>
<td>78</td>
<td>0.205</td>
<td>0.042</td>
<td>0.361</td>
<td>0.014</td>
<td>0.967</td>
</tr>
<tr>
<td>Average deliverables dependency/$I_{1}^{MV}$</td>
<td>$DV_{0}/$Duration discrepancy</td>
<td>135</td>
<td>0.136</td>
<td>0.018</td>
<td>0.482</td>
<td>-0.062</td>
<td>0.847</td>
</tr>
<tr>
<td></td>
<td>$DV_{1}/$Budget discrepancy</td>
<td>65</td>
<td>0.249</td>
<td>0.061</td>
<td>0.270</td>
<td>-0.616</td>
<td>0.219</td>
</tr>
<tr>
<td></td>
<td>$DV_{2}/$Profit discrepancy</td>
<td>78</td>
<td>0.156</td>
<td>0.024</td>
<td>0.607</td>
<td>-0.040</td>
<td>0.901</td>
</tr>
<tr>
<td>System dependency/$I_{2}^{MV}$</td>
<td>$DV_{0}/$Duration discrepancy</td>
<td>138</td>
<td>0.118</td>
<td>0.014</td>
<td>0.591</td>
<td>0.010</td>
<td>0.879</td>
</tr>
<tr>
<td></td>
<td>$DV_{1}/$Budget discrepancy</td>
<td>66</td>
<td>0.181</td>
<td>0.033</td>
<td>0.554</td>
<td>0.009</td>
<td>0.937</td>
</tr>
<tr>
<td></td>
<td>$DV_{2}/$Profit discrepancy</td>
<td>78</td>
<td>0.192</td>
<td>0.037</td>
<td>0.424</td>
<td>0.077</td>
<td>0.340</td>
</tr>
<tr>
<td>Business process dependency/$I_{3}^{MV}$</td>
<td>$DV_{0}/$Duration discrepancy</td>
<td>135</td>
<td>0.124</td>
<td>0.015</td>
<td>0.563</td>
<td>0.001</td>
<td>0.983</td>
</tr>
<tr>
<td></td>
<td>$DV_{1}/$Budget discrepancy</td>
<td>66</td>
<td>0.231</td>
<td>0.054</td>
<td>0.330</td>
<td>0.120</td>
<td>0.247</td>
</tr>
<tr>
<td></td>
<td>$DV_{2}/$Profit discrepancy</td>
<td>78</td>
<td>0.168</td>
<td>0.028</td>
<td>0.543</td>
<td>0.035</td>
<td>0.616</td>
</tr>
</tbody>
</table>

* Filters: Discrepancy agile values < 0.4 (see section 3.2)
<table>
<thead>
<tr>
<th>Population 0 (comprising project categories)</th>
<th>Population 1 (comprising project categories)</th>
<th>$DV_i$ in $(I_4^{MV}, (IV, DV))$</th>
<th>N</th>
<th>Summary R</th>
<th>Summary R square</th>
<th>Summary one-tailed significance</th>
<th>Interaction coefficient</th>
<th>R squared change</th>
<th>Interaction one-tailed significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>$Pop$ (1 − 2)</td>
<td>$Pop$ (4 − 5)</td>
<td>$DV_0$/Duration discrepancy</td>
<td>118</td>
<td>0.241</td>
<td>0.0579</td>
<td>0.077</td>
<td>-0.172</td>
<td>0.008</td>
<td>0.309</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$DV_1$/Budget discrepancy</td>
<td>54</td>
<td>0.336</td>
<td>0.113</td>
<td>0.110</td>
<td>-0.171</td>
<td>0.009</td>
<td>0.329</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$DV_2$/Profit discrepancy</td>
<td>66</td>
<td>0.314</td>
<td>0.099</td>
<td>0.090</td>
<td>0.173</td>
<td>0.017</td>
<td>0.285</td>
</tr>
</tbody>
</table>

Table 4.3.2*, Project category and (IV, DV) moderation test, Author’s observation

<table>
<thead>
<tr>
<th>Population 0 (comprising project categories)</th>
<th>Population 1 (comprising project categories)</th>
<th>$DV_i$ in $(I_4^{MV}, (IV, DV))$</th>
<th>N</th>
<th>Summary R</th>
<th>Summary R square</th>
<th>Summary one-tailed significance</th>
<th>Interaction coefficient</th>
<th>R squared change</th>
<th>Interaction one-tailed significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>$Pop$ (1)</td>
<td>$Pop$ (5)</td>
<td>$DV_0$/Duration discrepancy</td>
<td>50</td>
<td>0.256</td>
<td>0.065</td>
<td>0.369</td>
<td>-0.101</td>
<td>0.025</td>
<td>0.369</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$DV_1$/Budget discrepancy</td>
<td>25</td>
<td>0.426</td>
<td>0.182</td>
<td>0.230</td>
<td>-0.334</td>
<td>0.003</td>
<td>0.429</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$DV_2$/Profit discrepancy</td>
<td>30</td>
<td>0.239</td>
<td>0.057</td>
<td>0.668</td>
<td>0.034</td>
<td>0.000</td>
<td>0.918</td>
</tr>
</tbody>
</table>

Table 4.3.3*, Project category and (IV, DV) moderation test, Author’s observation

* Filters: Discrepancy agile values < 0.4 (see section 3.2)
The data presented in table 4.3.2 and 4.3.3 seems to lack significant results as well. Though it must be noted that in table 4.3.2, p values on the model summary seem to be moving towards a significant level (comprising the range (0.077 – 0.110)). When analyzing the interaction between the moderator variable and the ($IV, DV$) relation, the lack of substantial change in R squared values stands out. It seems therefore unsurprising that significance levels on interaction are nowhere near reaching the 0.05 threshold.

It must, however, be noted that the respective regression lines do provide a suggestive picture. Figure 4.3.1 to 4.3.6 show the trend lines of the different populations. The blue trendline represents the trendline on category 0, which consist of either $Pop (1 – 2)$ or $Pop (1)$ (i.e. ERP or ERP and closely affiliated COTS). The green trendline is based on values of category 1, which is based on either $Pop (4 – 5)$ or $Pop (5)$ (i.e. unaffiliated systems/project types). In line with the one hypothesis, one would expect a flat/flatter green trendline and a (more) sloped blue trendline. This would indicate that discrepancies associated with the use of agile practices only occur in the ERP category. This in turn would support the reasoning that there is something different about ERP projects that makes them less suited for the application of agile practices.

*Figure 4.3.1, Methodology and duration with $Pop (1 – 2)$ and $Pop (4 – 5)$, Author’s observation*
**Figure 4.3.2, Methodology and duration with Pop (1) and Pop (5), Author’s observation**

**Figure 4.3.3, Methodology and budget with Pop (1 – 2) and Pop (4 – 5), Author’s observation**
**Research Question 3**

Figure 4.3.4, Methodology and budget with Pop (1) and Pop (5), Author’s observation

IV/Corrected average agile practices

Figure 4.3.5, Methodology and profit with Pop (1 – 2) and Pop (4 – 5), Author’s observation
Research Question 3

The trendlines presented in figures 4.3.1 to 4.3.6 do seem to illustrate this hypothesized effect with the exception of figure 4.3.6. It is hard to conclude anything based on this observation since the formal moderation variable tests have failed to produce any significant results. It would, however, be interesting to see how these moderation relations develop as \( N \) would increase since this could help the measurement reaching significance and determine the actual size and direction of the ‘observed’ effect.

Data on the \((MV, PV)\) relation

In this section the indicators of the moderating variable \(\{I_0^{MV}, I_1^{MV}, \ldots, I_4^{MV}\}\) are tested for relations with the proxy variable \(PV\), i.e. the average value of the ‘usefulness scores’ of \(\{I_0^{PV}, I_1^{PV}, \ldots, I_{19}^{PV}\}\) and its respective indicators \(\{I_0^{PV}, I_1^{PV}, \ldots, I_{19}^{PV}\}\). In this manner we hope to obtain a significant measurement on the effect of our hypothesized moderating variable. Below the results of regression tests between the set \(\{I_0^{MV}, I_1^{MV}, \ldots, I_3^{MV}\}\) and \(PV^{(IV, DV)}\) have been presented in table 4.3.4. The deliverables seem to merit no results at all. ‘System dependency’ and ‘Business process dependency’ (see appendix 3.2.2.2) do seem to have a certain relation with the proxy variable. With a near-significant value of 0.07 for system dependencies. The size of the R and especially that of the adjusted \(R^2\) are limited. The regression on business process dependencies does however enjoy a both significant \(p\) value (0.002) and a sizable \(R\) (0.236) and adjusted \(R^2\) (0.039).
<table>
<thead>
<tr>
<th>$I^M_V$ in $(I^M_V, P_V^{(IV, DV)})$</th>
<th>N</th>
<th>Mean</th>
<th>Standard deviation</th>
<th>Correlation/R (Pearson) with $P_V^{(IV, DV)}$</th>
<th>Adjusted R square</th>
<th>Pearson correlation Significance (1-tailed)</th>
<th>ANOVA significance</th>
<th>Unstandardized Beta coefficient Constant (y-axis intercept)</th>
<th>Unstandardized Beta coefficient with $P_V^{(IV, DV)}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Team deliverables dependency/$I^M_V_0$</td>
<td>146</td>
<td>0.486</td>
<td>0.251</td>
<td>-0.093</td>
<td>0.002</td>
<td>0.133</td>
<td>0.266</td>
<td>5.134</td>
<td>-0.253</td>
</tr>
<tr>
<td>Average deliverables dependency/$I^M_V_1$</td>
<td>143</td>
<td>0.505</td>
<td>0.251</td>
<td>-0.013</td>
<td>-0.007</td>
<td>0.440</td>
<td>0.879</td>
<td>5.046</td>
<td>-0.034</td>
</tr>
<tr>
<td>System dependency/$I^M_V_2$</td>
<td>147</td>
<td>3.63</td>
<td>1.111</td>
<td>-0.123</td>
<td>0.008</td>
<td>0.070</td>
<td>0.139</td>
<td>5.295</td>
<td>-0.074</td>
</tr>
<tr>
<td>Business process dependency/$I^M_V_3$</td>
<td>145</td>
<td>3.86</td>
<td>1.167</td>
<td>-0.236</td>
<td>0.049</td>
<td>0.002</td>
<td>0.004</td>
<td>5.535</td>
<td>-0.138</td>
</tr>
</tbody>
</table>

*Table 4.3.4*, Dependencies and usefulness regression test, Author’s observation

* Filters: Discrepancy agile values < 0.4 (see section 3.2)
When drilling down on these numbers, it seems useful to look at the figures relating \( \{I_2^{MV}, I_3^{MV}\} \) and \( \{I_0^{PV}, I_1^{PV}, \ldots I_{19}^{PV}\} \) (due to a lack of significance the subset \( \{I_0^{MV}, I_1^{MV}\} \) is excluded). The results are presented as simple (Pearson) correlations tests between an \( I_i^{MV} \) and to total set of \( \{I_0^{PV}, I_1^{PV}, \ldots I_{19}^{PV}\} \).

Table 4.3.6 and 4.3.7 display the correlations between the System dependency indicator and the set \( \{I_0^{PV}, I_1^{PV}, \ldots I_{19}^{PV}\} \). Table 4.3.8 and 4.3.9 display the relations between the Business process dependency indicator and \( \{I_0^{PV}, I_1^{PV}, \ldots I_{19}^{PV}\} \). The results of these correlation are mostly negative, with only 4 out of 40 correlations having a positive value. None of the positive values is significant however and the highest value tops at only 0.063. The 35 remaining negative values (there is one correlation equal to 0) have a range of up to -0.296 and include 10 correlations with a significant p value. The correlation between the twenty proxy indicators with the Business process dependency indicator seemed the strongest of the two. Only 16 out of 20 indicators were negative for System dependencies, against 19 out of 20 for Business process dependencies. Only 4 out of 10 relations produced significant results. These seem to correspond with the stronger effect measured and presented in table 4.3.4.

Based on these results, one can distinguish a strong tendency: The perceived usefulness of agile practices in a project is correlated with the level of ‘System dependency’ and especially ‘Business process dependency’.
| $I_1^{PV(IV, DV)}$ in $(I_2^{MV}, I_1^{PV(IV, DV)})$ | Product owner role/ $I_1^{PV(IV, DV)}$ | Scrum master role/ $I_1^{PV(IV, DV)}$ | Cross-functional team/ $I_2^{PV(IV, DV)}$ | Time-boxed sprints/ $I_4^{PV(IV, DV)}$ | Product backlog/ $I_4^{PV(IV, DV)}$ | Sprint backlog/ $I_5^{PV(IV, DV)}$ | Iterative sprint planning/ $I_5^{PV(IV, DV)}$ | Agile sprint planning/ $I_7^{PV(IV, DV)}$ | Story point estimation/ $I_8^{PV(IV, DV)}$ | Team capacity/ $I_{10}^{PV(IV, DV)}$ |
|-----------------|---------------------------------|---------------------------------|--------------------------------_|---------------------------------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|
| Pearson correlation | -0.125  | 0.222  | 0.011  | -0.108  | -0.138  | -0.094  | -0.088  | -0.192  | -0.048  | -0.225  |
| Sig. (2-tailed)     | 0.167   | 0.798  | 0.929  | 0.222   | 0.240   | 0.285   | 0.475   | 0.116   | 0.698   | 0.057   |
| N                  | 124     | 139    | 72     | 130     | 74      | 131     | 68      | 68      | 67      | 72      |

**Table 4.3.6**, System dependencies and practices regression test, Author’s observation

<table>
<thead>
<tr>
<th>$I_1^{PV(IV, DV)}$ in $(I_2^{MV}, I_1^{PV(IV, DV)})$</th>
<th>Stand-up meeting/ $I_2^{PV(IV, DV)}$</th>
<th>Impediment list/ $I_2^{PV(IV, DV)}$</th>
<th>Team velocity/ $I_2^{PV(IV, DV)}$</th>
<th>Sprint burndown/ $I_2^{PV(IV, DV)}$</th>
<th>Agile Definition of Done/ $I_2^{PV(IV, DV)}$</th>
<th>User stories/ $I_2^{PV(IV, DV)}$</th>
<th>Sprint review/ $I_2^{PV(IV, DV)}$</th>
<th>Sprint retrospective/ $I_2^{PV(IV, DV)}$</th>
<th>MVP/walking skeleton/ $I_2^{PV(IV, DV)}$</th>
<th>Continuous deployment/ $I_2^{PV(IV, DV)}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pearson correlation</td>
<td>-0.263*</td>
<td>0.014</td>
<td>-0.004</td>
<td>-0.119</td>
<td>0.000</td>
<td>-0.068</td>
<td>-0.065</td>
<td>-0.301*</td>
<td>-0.195*</td>
<td>-0.247*</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>0.002</td>
<td>0.872</td>
<td>0.965</td>
<td>0.331</td>
<td>0.997</td>
<td>0.599</td>
<td>0.455</td>
<td>0.011</td>
<td>0.031</td>
<td>0.039</td>
</tr>
<tr>
<td>N</td>
<td>132</td>
<td>131</td>
<td>133</td>
<td>69</td>
<td>123</td>
<td>63</td>
<td>134</td>
<td>70</td>
<td>123</td>
<td>70</td>
</tr>
</tbody>
</table>

**Table 4.3.7**, System dependencies and practices regression test, Author’s observation

* Significant result  
** Filters: Discrepancy agile values < 0.4 (see section 3.2)  
*** $I_2^{MV}$ representing the indicator ‘System dependencies’
<table>
<thead>
<tr>
<th>$I_i^{PV(I^4_{IV},DV)}$</th>
<th>Product owner role/ $I_0^{PV(I^4_{IV},DV)}$</th>
<th>Scrum master role/ $I_1^{PV(I^4_{IV},DV)}$</th>
<th>Cross-functional team/ $I_2^{PV(I^4_{IV},DV)}$</th>
<th>Time-boxed sprints/ $I_3^{PV(I^4_{IV},DV)}$</th>
<th>Product backlog/ $I_4^{PV(I^4_{IV},DV)}$</th>
<th>Sprint backlog/ $I_5^{PV(I^4_{IV},DV)}$</th>
<th>Iterative sprint planning/ $I_6^{PV(I^4_{IV},DV)}$</th>
<th>Agile sprint planning/ $I_7^{PV(I^4_{IV},DV)}$</th>
<th>Story point estimation/ $I_8^{PV(I^4_{IV},DV)}$</th>
<th>Team capacity/ $I_{10}^{PV(I^4_{IV},DV)}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pearson correlation</td>
<td>-0.246*</td>
<td>-0.091</td>
<td>0.063</td>
<td>-0.118</td>
<td>-0.115</td>
<td>-0.152</td>
<td>-0.015</td>
<td>-0.270*</td>
<td>-0.225</td>
<td>-0.173</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>0.006</td>
<td>0.289</td>
<td>0.603</td>
<td>0.185</td>
<td>0.334</td>
<td>0.083</td>
<td>0.907</td>
<td>0.027</td>
<td>0.072</td>
<td>0.153</td>
</tr>
<tr>
<td>N</td>
<td>123</td>
<td>157</td>
<td>71</td>
<td>128</td>
<td>72</td>
<td>130</td>
<td>67</td>
<td>67</td>
<td>65</td>
<td>70</td>
</tr>
</tbody>
</table>

**Table 4.3.8**, Business dependencies and practices correlation test, Author’s observation

<table>
<thead>
<tr>
<th>$I_i^{PV(I^4_{IV},DV)}$</th>
<th>Stand-up meeting/ $I_{10}^{PV(I^4_{IV},DV)}$</th>
<th>Impediment list/ $I_{11}^{PV(I^4_{IV},DV)}$</th>
<th>Team velocity/ $I_1^{PV(I^4_{IV},DV)}$</th>
<th>Sprint burndown/ $I_{12}^{PV(I^4_{IV},DV)}$</th>
<th>Agile Definition of Done/ $I_{13}^{PV(I^4_{IV},DV)}$</th>
<th>User stories/ $I_{14}^{PV(I^4_{IV},DV)}$</th>
<th>Sprint review/ $I_{15}^{PV(I^4_{IV},DV)}$</th>
<th>Sprint retrospective/ $I_{16}^{PV(I^4_{IV},DV)}$</th>
<th>MVP/walking skeleton/ $I_{17}^{PV(I^4_{IV},DV)}$</th>
<th>Continuous deployment/ $I_{18}^{PV(I^4_{IV},DV)}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pearson correlation</td>
<td>-0.285*</td>
<td>-0.029</td>
<td>-0.095</td>
<td>-0.183</td>
<td>-0.123</td>
<td>-0.023</td>
<td>-0.060</td>
<td>-0.286*</td>
<td>-0.296*</td>
<td>-0.256*</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>0.001</td>
<td>0.747</td>
<td>0.282</td>
<td>0.138</td>
<td>0.178</td>
<td>0.862</td>
<td>0.496</td>
<td>0.018</td>
<td>0.001</td>
<td>0.035</td>
</tr>
<tr>
<td>N</td>
<td>130</td>
<td>129</td>
<td>131</td>
<td>67</td>
<td>121</td>
<td>61</td>
<td>132</td>
<td>68</td>
<td>121</td>
<td>68</td>
</tr>
</tbody>
</table>

**Table 4.3.9**, Business dependencies and practices correlation test, Author’s observation

* Significant result

** Filters: Discrepancy agile values < 0.4 (see section 3.2)

*** $I_2^{MV}$ representing the indicator ‘System dependencies’
Earlier in this paragraph, we ‘zoomed out’ with respect to the dependency focus to assess whether the project category (ERP, non-ERP etc.) implied a moderating factor (and thus an effect) at all. The results presented above (table 4.3.5 to 4.3.9) provide some suggestions not found in data presented in table 4.3.1. It seems, therefore, logical to adopt the practice of zooming out on the \((MV, PV)\) relation set. Therefore the regression between the project category \((I_0^{MV(IV-DV)})\) and the proxy variable is presented in table 4.3.10. In addition, table 4.3.11 includes the values for an adapted test, where the value of the \(IV\) (corrected average agile practices) was controlled for. Filters were applied to all five project category populations in order to get the average value of \(IV\) as close as possible to 0.6. In this manner, it was attempted to prevent a strong effect from emerging solely because perceptions (i.e. the value of \(PV\) and its indicators) differed based on the application of agile practices. In the uncontrolled test population \(IV\) values ranged from 0.51 in ERP categories to 0.72 in unaffiliated categories. Please note that both the test in table 4.3.10 and in table 4.3.11 have \(PV\) (i.e. average perceive usefulness of agile practices) as a dependent variable. The results in table 4.3.10 show a rather sizable correlation of 0.282, which is reduced to 0.180 after controlling for the value of the \(IV\). The latter correlation is still significant, though the ANOVA significance has fallen above the 0.05 threshold. Please note that this could in part be explained by a reduced sample size (114 to 149). It is the author’s observation that the persistence of this correlation warrants a further drill down into the available data. The correlation between the project category variable and separate indicators of \(PV\) are presented in table 4.3.12 and table 4.3.13. Again, the analysis of these separate indicators does not result in any anomalies. Only one of the twenty \(PV\) indicators is negatively associated with the category value (-0.027). All other correlations indicate a positive relation with three significant results up to an R size of 0.418.
### Table 4.3.10*, Project category and usefulness regression test, Author’s observation

<table>
<thead>
<tr>
<th>$I_i^{MV}$ in $I_i^{MV}, PV_{IV, DV}$</th>
<th>N</th>
<th>Mean</th>
<th>Standard deviation</th>
<th>Correlation/R (Pearson) with $PV$</th>
<th>Adjusted R square</th>
<th>Pearson correlation Significance (1-tailed)</th>
<th>ANOVA significance</th>
<th>Unstandardized Beta coefficient (y-axis intercept)</th>
<th>Unstandardized Beta coefficient with $PV$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project category/$I_i^{MV}$</td>
<td>149</td>
<td>2.64</td>
<td>1.366</td>
<td>0.282</td>
<td>0.073</td>
<td>0.000</td>
<td>0.000</td>
<td>0.140</td>
<td>4.644</td>
</tr>
</tbody>
</table>

### Table 4.3.11**, Project category and usefulness controlled regression test, Author’s observation

<table>
<thead>
<tr>
<th>$I_i^{MV}$ in $I_i^{MV}, PV_{IV, DV}$</th>
<th>N</th>
<th>Mean</th>
<th>Standard deviation</th>
<th>Correlation/R (Pearson) with $PV$</th>
<th>Adjusted R square</th>
<th>Pearson correlation Significance (1-tailed)</th>
<th>ANOVA significance</th>
<th>Unstandardized Beta coefficient (y-axis intercept)</th>
<th>Unstandardized Beta coefficient with $PV$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project category/$I_i^{MV}$</td>
<td>114</td>
<td>2.34</td>
<td>1.302</td>
<td>0.180</td>
<td>0.024</td>
<td>0.028</td>
<td>0.056</td>
<td>0.89</td>
<td>4.758</td>
</tr>
</tbody>
</table>

* Filters: Discrepancy agile values < 0.4 (see section 3.2)

** Filters: Discrepancy agile values < 0.4 (see section 3.2), filter regarding the value of agile practices:

- $((@1.1.1ERPrjectmanualcoded1ERP2ERPandnonERP)COTSorlimitedoverlap = 1 & @3.1a3.20a.1AVGpractices > 0.1)
- $((@1.1.1ERPrjectmanualcoded1ERP2ERPandnonERP)COTSorlimitedoverlap = 2 & @3.1a3.20a.1AVGpractices > 0.175)
- $((@1.1.1ERPrjectmanualcoded1ERP2ERPandnonERP)COTSorlimitedoverlap = 3 & @3.1a3.20a.1AVGpractices < 0.9)
- $((@1.1.1ERPrjectmanualcoded1ERP2ERPandnonERP)COTSorlimitedoverlap = 4 & @3.1a3.20a.1AVGpractices < 0.9)
- $((@1.1.1ERPrjectmanualcoded1ERP2ERPandnonERP)COTSorlimitedoverlap = 5 & @3.1a3.20a.1AVGpractices < 0.9)
<table>
<thead>
<tr>
<th>Product owner role/ $I_0^{PV}$</th>
<th>Scrum master role/ $I_0^{PV}$</th>
<th>Cross-functional team/ $I_1^{PV}$</th>
<th>Time-boxed sprints/ $I_2^{PV}$</th>
<th>Product backlog/ $I_3^{PV}$</th>
<th>Sprint backlog/ $I_4^{PV}$</th>
<th>Iterative sprint planning/ $I_5^{PV}$</th>
<th>Agile sprint planning/ $I_6^{PV}$</th>
<th>Story point estimation/ $I_7^{PV}$</th>
<th>Team capacity/ $I_8^{PV}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pearson correlation</td>
<td>0.299*</td>
<td>0.129</td>
<td>0.199</td>
<td>0.194</td>
<td>0.157</td>
<td>0.039</td>
<td>0.173</td>
<td>0.194</td>
<td>0.228</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>0.004</td>
<td>0.184</td>
<td>0.134</td>
<td>0.056</td>
<td>0.239</td>
<td>0.701</td>
<td>0.029</td>
<td>0.167</td>
<td>108</td>
</tr>
<tr>
<td>N</td>
<td>92</td>
<td>107</td>
<td>58</td>
<td>98</td>
<td>58</td>
<td>99</td>
<td>52</td>
<td>52</td>
<td>51</td>
</tr>
</tbody>
</table>

Table 4.3.12**, Project category and practices correlation test, Author’s observation

<table>
<thead>
<tr>
<th>Stand-up meeting/ $I_9^{PV}$</th>
<th>Impediment list/ $I_{10}^{PV}$</th>
<th>Team velocity/ $I_1^{PV}$</th>
<th>Sprint burndown/ $I_2^{PV}$</th>
<th>Agile Definition of Done/ $I_3^{PV}$</th>
<th>User stories/ $I_4^{PV}$</th>
<th>Sprint review/ $I_5^{PV}$</th>
<th>Sprint retrospective/ $I_6^{PV}$</th>
<th>MVP/walking skeleton/ $I_7^{PV}$</th>
<th>Continuous deployment/ $I_8^{PV}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pearson correlation</td>
<td>0.161</td>
<td>0.085</td>
<td>0.054</td>
<td>0.213</td>
<td>0.178</td>
<td>0.352*</td>
<td>0.107</td>
<td>0.418*</td>
<td>0.164</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>0.109</td>
<td>0.403</td>
<td>0.591</td>
<td>0.125</td>
<td>0.086</td>
<td>0.014</td>
<td>0.284</td>
<td>0.002</td>
<td>0.121</td>
</tr>
<tr>
<td>N</td>
<td>101</td>
<td>100</td>
<td>101</td>
<td>53</td>
<td>94</td>
<td>48</td>
<td>102</td>
<td>54</td>
<td>91</td>
</tr>
</tbody>
</table>

Table 4.3.13***, Project category and practices correlation test, Author’s observation

* Significant result

** Filters: Discrepancy agile values < 0.4 (see section 3.2)

*** Filters: Discrepancy agile values < 0.4 (see section 3.2), filter regarding the value of agile practices:

((@1.1.1.ERPprojectmanualcoded1ERP2ERPandnonERPCOTSorlimitedoverlap = 1 & @3.1a3.20a.1AVGpractices > 0.1) | (@1.1.1.ERPprojectmanualcoded1ERP2ERPandnonERPCOTSorlimitedoverlap = 2 & @3.1a3.20a.1AVGpractices > 0.175)) | (@1.1.1.ERPprojectmanualcoded1ERP2ERPandnonERPCOTSorlimitedoverlap = 3 & @3.1a3.20a.1AVGpractices < 0.9)) | (@1.1.1.ERPprojectmanualcoded1ERP2ERPandnonERPCOTSorlimitedoverlap = 4 & @3.1a3.20a.1AVGpractices < 0.9)) | (@1.1.1.ERPprojectmanualcoded1ERP2ERPandnonERPCOTSorlimitedoverlap = 5 & @3.1a3.20a.1AVGpractices < 0.9))
4.3.2 Interpretation of Data

Connections among data

The data presented in the previous paragraph (table 4.3.1) indicated that it was seemingly impossible to obtain significant results on the hypothesized moderation relation between inherent dependencies and the \((IV, DV)\) relations. Whether this stems from the fact that our \(N\) should (ideally) be higher or due to the absence of such a relation is hard to determine. One thing can however be stated with conclusive certainty: the zero hypothesis regarding the dependency indicators \(\{I_0^{MV}, I_1^{MV}, I_2^{MV}, I_3^{MV}\}\) and the \((IV, DV)\) relations cannot be refuted. We do however find a significant effect between the perceived usefulness of agile methodologies and the value of \(I_3^{MV}\) (i.e. Business process dependencies). With a one-tailed significance of 0.004, we could account for the fact that we practically fired four measurements at one hypothesis since a multiplication of factor 4 would still yield a significant effect.

\[H_{T_0}^{(MV,(IV,DV))}\]:

- \(H_0\): The value of the \((IV, DV)\) relation set does not change as a function of the level of dependency in a project \(\rightarrow\) Maintained
- \(H_1\): The value the \((IV, DV)\) relation set changes as a function of the level of dependency in a project \(\rightarrow\) Discarded

\[H_{T_0}^{(MV,PV)}\]:

- \(H_0\): The perceived usefulness of agile methodologies does not change as a function of the level of dependency in a project \(\rightarrow\) Discarded
- \(H_1\): The perceived usefulness of agile methodologies changes as a function of the level of dependency in a project \(\rightarrow\) Accepted

One can, however, go not as far as discarding the role of these dependencies as irrelevant. Under the assumption that the representation of \((IV, DV)\) by \(PV^{(IV,DV)}\) holds, one can expect to find some moderating relation comprised by- or related to dependencies based on the results presented in table 4.3.4 and 4.3.9.

When it comes to the question of whether project categories \(I_4^{MV}\) are a relevant moderating variable at all the results remain inconclusive. The data in table 4.3.2 and 4.3.3 provided no solid foundation for suggesting that the nature of the \((IV, DV)\) relation changes as a function of the project category. The graphs presented in figure 4.3.1 to 4.3.6 did provide some insignificant but illustrative suggestions. Five out of six trendlines show a clear difference in in the nature of the \((IV, DV)\) relation dependent on the project category. In the latter case, the effect was similar in nature though far less powerful. The following conclusion with regard to the stated hypothesis need to be drawn:
Research Question 3

\( H_{T1}^{(MV,(IV,DV))} \):

- \( H_0 \): The value of the \((IV, DV)\) relation set does not change as a function of the project category \(\rightarrow\) Maintained

- \( H_1 \): The value of the \((IV, DV)\) relation set changes as a function of the project category \(\rightarrow\) Discarded

Again, we held these relations against a different light with the representation of \((IV, DV)\) by \(PV^{(IV,DV)}\) and its respective indicators. Like with the first set of indicators the results with respect to the proxy variable were substantially stronger. The regression analysis presented in table 4.3.10 and table 4.3.11 show a clear and sizable association between the project category indicator and the value of the proxy variable/average usefulness. However, the \(H_0\) hypothesis must again be maintained since the level of significance goes (slightly) above the 0.05 threshold when applying the ANOVA two-tailed test. Like we observed in paragraph 4.2.1, we are not allowed to use a one-tailed test as a measure of significance since we did not previously justify and hypothesize a specific direction of the measured effect.

\( H_{T1}^{(MV,PV)} \):

- \( H_0 \): The perceived usefulness of agile methodologies does not change as a function of the project category \(\rightarrow\) Maintained

- \( H_1 \): The perceived usefulness of agile methodologies changes as a function of the project category \(\rightarrow\) Discarded

A subsequent drill down on the usefulness scores of separate practices reveals a consistent picture. The perceived usefulness of agile practices increases as the project becomes less and less ERP centered. Again, it must be noted that the validity of these relations (due to the role of \(PV^{(IV,DV)}\)) are deemed unfit to provide a concluding answer the third research question. They do however provide a solid suggestion regarding the likelihood that such a relation exists.

Relation Present Findings to Pre-existing sources

It became clear during the course of the current research that even though there was little to no literature on the application of agile methodologies in ERP projects there were enough pre-existing suspicions. The general ‘mood’ found in the ERP environment was skeptical, though it was often recognized that this originated from a lack of knowledge rather than a lack of potential. The current research set out to find the proponents of applying agile methodologies in ERP projects as well as its opponents. The main arguments of professionals opposed/skeptical of applying the agile methodology cited the differences in nature between ERP and regular IT projects. Section 3.3 describes how the qualitative process of interviewing people on this issue led to the formulation of
RQ3. In this is virtually the only background that this part of the research had. Though a significant effect could not be detected, the data seems to suggest that the opponents of applying agile in the ERP context have it for now. The results seem to indicate that the application of agile practices leads to an unfavorable increase in all measured discrepancies RQ2. A clear cause or even a moderating effect itself have so far not been pointed out due to a lack of significant results. There are however enough suggestive results that seem in favor of the arguments that ERP projects are inherently different. This research ought to be seen in the light of this discussion and aims to catalyze the knowledge creation process in that context.
Chapter V. Conclusion, Discussion, and Recommendations

This chapter covers a summation of the research’s current findings in relation to the selected knowledge problem(s). The first section covers the knowledge problem, the research design and the resulting findings in relation to each other. Potential flaws, instances of misconduct and other issues threatening the validity and reliability of the results will be covered in the discussion (section 5.2). Suggestions for further research on this topic and recommendations for the practical application of the ideas and findings in the current research will be discussed in section 5.3.

5.1 Summary of Findings

Knowledge Problem
The determination of the optimal methodology in ERP projects has been the overarching and context providing knowledge problem for this study. The current study focuses specifically on determining the potential of emerging hybrid agile methodologies (RQ2). Simultaneously, the study attempts to find an explanation for potential discrepancies by testing the potential of moderating variables distinctive to ERP projects as well as the project category itself (RQ3). In order to facilitate the required measurements, a success definition is derived and implementable dependent variables are selected. Based on these dependent variables, the measurement of the hypothesized relations is conducted.

Research Design & Findings
The author observes that the three research questions (RQ1, RQ2, and RQ3) are sequentially dependent. That is, we require the success definition of RQ1 to determine the set of dependent variables in RQ2. Furthermore, we need the \((IV, DV)\) relation measured in RQ2 to measure the moderation relation in RQ3. The exception to this rule is provided by the second line of research in RQ3 that studies the \((MV, PV)\) relation (since \(PV\) aims to substitute \((IV, DV)\). The total set of studies utilizes a mixed arsenal of research methods. RQ1 utilizes qualitative methods, grounded theory specifically. RQ2 and RQ3 are predominantly quantitative in nature, with the theory behind RQ3 derived from the qualitative sources in RQ1.

This paragraph aims to provide a comprehensive summarization of the results in relation to the conceptual framework. The framework (figure 5.1.1 and figure 5.1.2) shows the mapping of the hypotheses test sets \(HT_i^{(x,y)}\) and the success definition \(SD\), presented in section 4.1) on the respective relations. The success definition (table 5.1.1), its mapping to the dependent variables, and the stated hypotheses will be presented sequentially. Related suggestions and indications are
presented afterwards. The final paragraph will discuss the aforementioned in relation to the problem statement.

**Figure 5.1.1, Relational model RQ1, RQ2, RQ3, Author’s observation**

**Figure 5.1.2, Relational model second line RQ3, Author’s observation**

The conceptual framework depicts how the sum of our findings should consist of four separate elements. The first element being the success definition (table 5.1.1) derived as an answer to research question one. The remaining elements comprise the three sets of hypothesis tests, with two to three elements each (thus totaling seven hypotheses).
We will commence with a summarization of the success definition. The table below cannot be expected to be exhaustive. Furthermore, it suffers from a range of validity and reliability problems (discussed in paragraph 3.1.7). One can, however, expect this to be a reasonable starting point when conducting studies that incorporate these variables from the consulting parties’ perspective.

<table>
<thead>
<tr>
<th>$i$ in $I_{i}^{SD}$</th>
<th>Success definition Indicator/$I_{i}^{SD}$</th>
<th>Operationalization</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Project Quality Overall</td>
<td>discarded</td>
</tr>
<tr>
<td>1</td>
<td>Customer Satisfaction Overall</td>
<td>discarded</td>
</tr>
<tr>
<td>2</td>
<td>Project Duration Overall</td>
<td>$DV_0$</td>
</tr>
<tr>
<td>3</td>
<td>Project Financial Overall</td>
<td>discarded</td>
</tr>
<tr>
<td>4</td>
<td>Project Budget Overall</td>
<td>$DV_1$</td>
</tr>
<tr>
<td>5</td>
<td>KPI Development</td>
<td>discarded</td>
</tr>
<tr>
<td>6</td>
<td>Project Profit Overall</td>
<td>$DV_2$</td>
</tr>
<tr>
<td>7</td>
<td>Project Business Readiness</td>
<td>discarded</td>
</tr>
<tr>
<td>8</td>
<td>Project Budget Versus Actual</td>
<td>$DV_1$</td>
</tr>
<tr>
<td>9</td>
<td>Customer Satisfaction Accepts Product</td>
<td>discarded</td>
</tr>
<tr>
<td>10</td>
<td>Project Costs Personnel</td>
<td>discarded</td>
</tr>
<tr>
<td>11</td>
<td>Project Duration per Phase</td>
<td>discarded</td>
</tr>
<tr>
<td>12</td>
<td>Project Duration Versus Actual</td>
<td>$DV_0$</td>
</tr>
<tr>
<td>13</td>
<td>Project Duration Time to Market</td>
<td>discarded</td>
</tr>
<tr>
<td>14</td>
<td>Project Technical Readiness</td>
<td>discarded</td>
</tr>
</tbody>
</table>

*Table 5.1.1, Success definition, Author’s observation*

In all but one of hypotheses tests presented below we are obliged to discard the $H_1$ and maintain $H_0$.

$H_{T_0}^{(IV,DV)}$:  
- $H_0$: The value of Duration discrepancy does not change as a function of the applied methodology → Maintained  
- $H_1$: The value of Duration discrepancy changes as a function of the applied methodology → Discarded
Research Question 3

$H_{T1}^{(IV,DV)}$:
- $H_0$: The value of Budget discrepancy does not change as a function of the applied methodology → Maintained
- $H_1$: The value of Budget discrepancy changes as a function of the applied methodology → Discarded

$H_{T2}^{(IV,DV)}$:
- $H_0$: The value of Profit discrepancy does not change as a function of the applied methodology → Maintained
- $H_1$: The value of Profit discrepancy changes as a function of the applied methodology → Discarded

$H_{T0}^{(MV,(IV,DV))}$:
- $H_0$: The value of the $(IV, DV)$ relation set does not change as a function of the level of dependency in a project → Maintained
- $H_1$: The value the $(IV, DV)$ relation set changes as a function of the level of dependency in a project → Discarded

$H_{T1}^{(MV,(IV,DV))}$:
- $H_0$: The value of the $(IV, DV)$ relation set does not change as a function of the project category → Maintained
- $H_1$: The value of the $(IV, DV)$ relation set changes as a function of the project category → Discarded

$H_{T0}^{(MV,PV,(IV,DV))}$:
- $H_0$: The perceived usefulness of agile methodologies does not change as a function of the level of dependency in a project → Discarded
- $H_1$: The perceived usefulness of agile methodologies changes as a function of the level of dependency in a project → Accepted

$H_{T1}^{(MV,PV,(IV,DV))}$:
- $H_0$: The perceived usefulness of agile methodologies does not change as a function of the project category → Maintained
- $H_1$: The perceived usefulness of agile methodologies changes as a function of the project category → Discarded

This means that, regarding the scientific facts, we will conclude the following: There is insufficient evidence to discard the hypotheses that there is no relation between the application of agile methodologies and the development of discrepancies in either duration, budget or profit when it comes to the execution of ERP projects. We are unable to disprove that there is no moderating effect on the
aforementioned relationship by the level of dependencies in ERP projects, nor any other distinctive characteristic of said projects. The data furthermore fails to prove any relation between the project category and the perceived usefulness of agile methodologies. We can, however, conclude that there is a relation between the level of dependencies and the perceived usefulness of aforementioned hybrid agile methodology and its practices. In addition to these conclusions, there are some important suggestions that need to be mentioned. These suggestions have not been incorporated into hypotheses results due to the strict observation of academic discipline in this regard. We would, however, fail to do justice to the bigger picture by omitting some of the results that did not qualify for said incorporation in the hypotheses. Regarding RQ2, the results on the three hypotheses tests were rather close to significance. Especially $HT_{0}^{(IV, DV)}$ resulted in a discarding of $H_{1}$ by a margin of only 0.008 on a two-tailed test. $HT_{1}^{(IV, DV)}$ and $HT_{2}^{(IV, DV)}$ were rejected by larger margins (0.049 and 0.067 respectively). But when incorporating their $< 40\%$ smaller sample size (35 and 42 respectively against 77 for $HT_{0}^{(IV, DV)}$) the value of $N$ becomes a more likely cause of insignificance. More importantly, the results corresponded intuitively. They all seemed to indicate larger discrepancies (i.e. worsening project outcomes) as the application of agile practices increased. We interpret this as a strong suggestion that the outcomes for ERP projects, when utilizing (hybrid) agile, need to be estimated at ‘below normal’ levels when comparing them to traditional waterfall methodologies. The current data failed to relate the project category to the perceived usefulness by a margin of 0.006 on a two-tailed test. We thus have no solid evidence but a substantial suggestion to state that: Professionals in the field with an equal level of agile methodology application (see control filters table 4.3.11) might perceive that the usefulness of said methodology decreases as projects become more ERP centered.

Under the assumption that substitution of $(IV, DV)$ with $PV^{(IV, DV)}$ is valid, we can suspect that there should be a moderating relation between distinctive ERP project attributes and the $(IV, DV)$ relations. Please note that we cannot conclude this based on the actual $(MV, (IV, DV))$ relation tests.

Findings and relation to problems

The current study has successfully provided a success definition against which the success of ERP projects can be measured and evaluated from the consulting parties’ perspective. Only a subset of the potential variables has been operationalized in this study. The excluded indicators could serve as a groundwork for other performance assessment studies that are conducted in the field. Some reservations in this regard will be elaborated on in the following section. The study provides academics and professionals with suggestive insights about the (disadvantageous) potential of applying hybrid agile methodologies and its practices in ERP projects. This study fails to provide an indication, let alone proof, that the distinctive characteristics of ERP projects have a moderating effect on this relation. The study is, however, able to prove that dependencies are negatively related to the perceived usefulness
of agile methodologies and practices thereof. This study fails to answer the central knowledge question in the context of which it is executed. But this has never been a goal since it was recognized at the start that the selected set of research questions (RQ1, RQ2, and RQ3) were not a full partition of the central knowledge question but rather a small subset thereof. It is the author’s hope and observation that there is much more to be done in the current research field. Recommendations for further research will, therefore, be genuinely provided and elaborated on in section 5.3. But only after the flaws and weaknesses of the current study have been pointed out and discussed in the following section.
5.2 Discussion

This section aims to discuss the implications as well as the fallacies of the current research. It has already been pointed out that the success definition provided in RQ1 cannot be considered exhaustive. Furthermore, the grounded theory process by which it was derived was plagued by issues originating from either the method or the limited resources with which the research was conducted. The fact that the study was conducted in the environment of a single company, adds to these problems. The sum of these considerations leads to the conclusions that the success definition presented in section 4.1 should be updated based on relevant future studies in order to increase the validity and generalizability of these results.

The first and foremost fallacy that is to be pointed out with respect to RQ2 is the omission of undisputedly important indicators included the success definition (section 4.1). To illustrate this problem and its relation to the implications of the current research please consider the following. The current research measures and points out a close-to-but-insignificant relation between the application of (hybrid) agile methodologies and the magnitude of duration, budget and profit discrepancies. The current research does, however, fail to measure the quality and scope of the project in any significant way. It could be the case that a high degree of interaction between client and provider could lead to a higher degree of conscious project expansion (e.g. to increase the scope, or the quality of a product). It could very well be that the measured discrepancies implied (on average) a more optimal set of outcomes when taking all variables into account. The only contradiction in this regard is the fact that profit discrepancies seem to move along with the other discrepancies. This would thus imply that at the very least, the consulting party would lose by applying agile in ERP projects. Again, we base this reasoning on suggestions instead of hard evidence.

Another problem originates from the fact that the experience with agile methodologies can be expected to vary substantially between project categories. This is illustrated by the fact that table 4.3.11 included a filter to control for the average application of agile practices. This does however not equal to correcting category wide experience levels. And we can thus expect the measured effects to be disturbed by this phenomenon. The same phenomenon also threatens the generalizability of the conclusion in RQ2 over time. The fact that professionals in the ERP project category are, most likely, less experienced with the application of agile methodologies implies that the measured effects could disappear. Hence, the presented relations might only be valid for a limited timeframe.

It must, in addition, be mentioned that some suspiciously consistent responses were observed during the data conversion. For example, people that entered the same value on the ‘usefulness scale’ for every agile practice. The current research applied a filter to the current data set that excluded
examples based on certain inconsistent values (see elaboration in 3.2). Individual evaluation of surveys was however not performed.

The current research assumed that a waterfall structure was in place with regard to ERP projects. The applied survey, however, failed to measure the exact or global properties of the complete methodological tool apparatus outside the application of agile practices. It is the author’s observation (in hindsight) that this was an error and that a more comprehensive measurement tool should have been applied.

The final discussion point that must be brought up in the light of this study (RQ3 specifically) is the substitution of \((DV, IV)\) by \(PV^{(DV, IV)}\). The demand for a ‘shortcut’ was justified in order to account for (anticipated) insignificant results in RQ2. This does however not equate to observing academic standards of validity in this regard. The first problem is the fact that the simplification leads to a wider range of possible interpretations. This could lead to a less-than-valid measurement of the variable itself. And this is assuming that the substitution itself is valid at all. It is the researcher’s observation that, even though the substitution has been peer reviewed with both professionals and academics, there is still too much uncertainty surrounding this assumption. Up to the point that further research confirms the validity of this substitution they should be regarded as mere hypothetical suggestions.
5.3 Recommendations

This section covers the recommendations resulting from the current study. Recommendations are divided along academic and professional lines and will be discussed sequentially.

**Academic recommendations**

The current study recognizes that it fails to provide an exhaustive answer to the question of how to determine the optimal methodology for ERP projects. This recognition implies that there are many recommendations on further research to be made. We have already pointed at the problems with the success definition presented in RQ1. It seems likely that there could be much to gain by constructing a more generalizable success definition. More importantly, a majority of the indicators in the success definition have not been utilized. This implies that several more studies could be conducted on the behavior of variables such as customer satisfaction dependent on project methodology. Please review section 4.1 for more details. There are several recommendations, in addition to the former, to be made when evaluating the study on RQ2. An interesting angle to approach the same (IV, DV) relations would be the application of agile scaling. Especially since the results seemed to indicate unfavourable relations with respect to project outcomes. Agile scaling methods could be viewed as an option with the potential to mitigate those unfavourable relations. The former section discussed how the project categories most likely differed with respect to the experience on the application of agile practices. The fact that the suggested relation might erode over time implies the need to verify this suspicion. It would, in addition, be interesting to see if additional training/experience with the application of (hybrid) agile methodologies would have any measurable effect. Further research on this topic seems therefore justified. The recommendations that can be derived from the study on RQ3 are far less substantive. This results in part from the fact that the theoretical framework was much less well-defined. The results on business process dependencies and the near to significant result regarding project categories indicate that we might be on to something when It comes to the theoretical notions posed in RQ3. This subfield still needs a lot of additional research to provide these ideas with an opportunity to solidify. And up to the point that a moderating relation can be statistically proven there may be no solidification at all. The latter poses a clear recommendation for further research.

**Professional recommendations**

The results posed in the study on RQ2 (section 4.2) should prove to be the central takeaway of this study. The lack of temporal generalizability regarding these results has been pointed out in previous sections. In addition, we observe the professional perception that an increase in business process based dependencies would make agile practices less useful. The combination of these observations leads to the following professional recommendation: Professionals should carefully consider the
application of agile practices in ERP projects. The suggestion that unfavorable results regarding duration, budget, and profit discrepancies are to be expected should be taken into account. This consideration should gain extra weight as a higher level of business process dependencies is observed. These should however not be the sole considerations when developing/choosing an ERP project methodology. One must take note of the fact that the presented results are unable to found a solid conclusion on this topic. More importantly, the anticipated effect on other variables such as customer satisfaction should be factored into the decision-making process. It should furthermore be considered that the utilization of experienced resources (i.e. experienced in the application of agile methodologies) and/or agile scaling methods could make the application of hybrid agile methodologies a rewarding element of the projects’ execution. The knowledge production process (i.e. further research) should, therefore, be adequately monitored by professionals in the field.
References


Appendix

Appendix 3.1.1: Email Extract

Verder nog twee verzoeken in categorie ‘niets moet alles mag’:

-De centrale vraag draait om de criteria en bijbehorende variabelen (van metriek tot ‘guts feeling’) waarop jij als professional een project als succesvol beoordeeld. Mocht je hier per mail al dingen over willen delen/mededelen dan ben je van harte welkom.

-Ik zou het gesprek graag opnemen zodat ik de (geanonimiseerde) transcripten uit kan werken. Nogmaals, notities voldoen ook mocht je dat prettiger vinden!
Appendix 3.1.2: Interview Setup

Position towards optimal methodology

- First so as to let people ‘express preferences’?

Perception of relevant project outcomes

- Metrics?

- Intangible outcomes?

Relation between the two

- Examples?

Other

Interesting person within own SL with a different methodology?
Appendix 3.1.3: Network Views
Appendix 3.2.1: Operationalization table RQ2

<table>
<thead>
<tr>
<th>Theoretical Variable</th>
<th>Indicator Variable</th>
<th>Empirical Variable ((range))</th>
<th>Applicable data tools</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Independent Variable: Methodology</strong></td>
<td>The degree to which a project applies agile methodologies</td>
<td>(IV): value ‘Corrected average agile practices’</td>
<td>Survey 1.1</td>
</tr>
<tr>
<td></td>
<td>The application of the ‘Scrum master role’ practice</td>
<td>(IV_0): value ‘Scrum master role’</td>
<td>Survey 1.1</td>
</tr>
<tr>
<td></td>
<td>…</td>
<td>….</td>
<td>Survey 1.1</td>
</tr>
<tr>
<td></td>
<td>The application of the ‘Continuous deployment’ practice</td>
<td>(IV_{19}): value ‘Continuous deployment’</td>
<td>Survey 1.1</td>
</tr>
<tr>
<td><strong>Dependent Variable: ERP Project Outcomes</strong></td>
<td>The degree to which the project was completed on-time</td>
<td>(DV_0): value ‘Duration discrepancy’</td>
<td>Survey 1.1</td>
</tr>
<tr>
<td></td>
<td>The degree to which the project was completed within budget</td>
<td>(DV_1): value ‘Budget discrepancy’</td>
<td>Survey 1.1</td>
</tr>
<tr>
<td></td>
<td>The degree to which the project was completed ‘on-profit’</td>
<td>(DV_2): value ‘Budget discrepancy’</td>
<td>Survey 1.1</td>
</tr>
</tbody>
</table>
Appendix 3.2.2: Research Tool, Survey 1.1

22-04, Survey 1.1

You are invited to answer the following questions regarding the last completed project that you participated in while being with Deloitte. Please provide your best estimates regarding the requested figures (i.e. even if you do not know the exact value of a variable). You will be provided with several options to elaborate on your choices in case you feel the available options do not capture your answers. There will be the possibility to refer to persons and or documents that may be able to provide any information you were unable to provide at the end of this survey.

- Project Information, Inclusion Criteria (appendix 3.2.4)
- Measurement of \{MV_0, MV_1, MV_2, MV_3, MV_4\}, Distinctive Attributes (Appendix 3.2.1)
- Measurement of \left\{ \{IV, IV_0, IV_1, ... IV_{19}\}, \left\{ PV^{(IV-DV)}, PV^{(IV-DV)}_0, PV^{(IV-DV)}_1, ... PV^{(IV-DV)}_{19}\right\} \right\} \\
  Methodology, Perceived Usefulness (appendix 3.2.2)
- Measurement of \{DV_0, DV_1, DV_2\}, Project Outcomes (appendix 3.2.4)

What was your position during this project?

- Options: {B.A. or up, Senior consultant or up, Senior manager or up, Partner}

Some of the information asked in this survey may have been outside the scope of your professional activities. Would you like to refer to persons and/or documents to complement the information requested in this survey? Please note that relevant contact details and/or documents can be emailed to bgoedhard@deloitte.nl. Please state the subject line of the email below. This way, the information can be linked to these results. Please do not send client information/contact details over this (i.e. google form) channel.

- ...
Appendix 3.2.2.1: Research Tool, $MV$

22-04, Measurement of $\{I_0^{MV}, I_1^{MV}, I_2^{MV}, I_3^{MV}, I_4^{MV}\}$

Dependencies

The following questions cover your estimate of the level of inter-team dependencies in this specific project. The questions focus on dependencies between project teams (e.g. other functional teams, enterprise architecture teams, etc.).

2.1) How many project teams did the project contain (excluding PMO)?

- ...

2.2) What was the average team size within the project?

- ...

2.3) What percentage of your project team’s deliverables were directly dependent on actors (and consequently their deliverables) inside the enterprise but outside the project team?

- Scale: $\{< 10\%, < 20\%, < 30\%, < 40\%, < 50\%, < 60\%, < 70\%, < 80\%, < 90\%, < 100\%\}$

2.4) What was the level of dependency for all project teams on average? I.e. what percentage of a project team’s deliverables were directly dependent on actors (and consequently their deliverables) outside the project team?

- Scale: $\{< 10\%, < 20\%, < 30\%, < 40\%, < 50\%, < 60\%, < 70\%, < 80\%, < 90\%, < 100\%\}$

2.5) Please complement the following statement: The systems that were involved in this project ensured teams were ...

- Options: {Extremely independent, mostly independent, mostly dependent, extremely dependent}

2.6) Please complement the following statement: The business processes that were involved in this project ensured teams were ...

- Options: {Extremely independent, mostly independent, mostly dependent, extremely dependent}
Appendix 3.2.2.2: Research Tool, \( \{IV, MV\} \)

\[ \text{Measurement of } \left\{ IV, \{I_0^{IV}, I_1^{IV} \ldots I_{19}^{IV}\} \right\} \]

**Methodology, Perceived Usefulness**

The following twenty practices are commonly applied in agile projects. Please note that the set of practices is based on the Scrum oriented agile EVD. You are free to elaborate on different (non-Scrum) practices that you may have used at the end of this section. You are invited to answer two questions with respect to every practice:

- 1) Please indicate whether a practice was applied in your project. Note that the practices might have been referred to differently in your project. So please check the description to assess whether there is a sufficient overlap with the practices used in your project.
- 2) Please rate the usefulness of this practice in your last project, incorporating the extent to which the application of such a practice was possible: The application of such a practice was/would have been useful.

3.1) Scrum master role - Was there a person who guided the conduct of the applied agile practices and who guarded the discipline required to effectively apply these principles (i.e. enforce (daily) Scrum practices; remove/manage impediments etc.).

- Was the 'Scrum master role' practice applied?
  - Options: {yes/no}
- Please rate the statement: This practice was or would have been useful (incorporating application constraints).
  - Options: {Strongly agree, Agree, Slightly agree, Slightly disagree, Disagree, Strongly disagree, Unable to judge}

3.2) Product owner role - Was there a committed client resource which was able/mandated to singlehandedly represent the interest of the client regarding the product. And was this person able to determine and update requirements for the project?

- Was the 'product owner role' practice applied?
  - Options: {yes/no}

This practice was or would have been useful (incorporating application constraints).
3.3) cross-functional team - Were the project teams composed of members with varying disciplinary and professional backgrounds with the goal to provide the project teams with the capability of iteratively changing the scope of the project?

- Was the 'cross-functional team' practice applied?
  - Options: {yes/no}

- This practice was or would have been useful (incorporating application constraints).
  - Options: {Strongly agree, Agree, Slightly agree, Slightly disagree, Disagree, Strongly disagree, Unable to judge}

3.4) time-boxed sprints - Were there several cyclical phases within the project which were fixed in duration, with a negotiated scope for each phase, and with every phase delivering an element of functionality/product?

- Was the 'time-boxed sprints' practice applied?
  - Options: {yes/no}

- This practice was or would have been useful (incorporating application constraints).
  - Options: {Strongly agree, Agree, Slightly agree, Slightly disagree, Disagree, Strongly disagree, Unable to judge}

3.5) product backlog - Was there an iteratively prioritized (i.e. during the project) list/document containing all the functionalities/products that were to be delivered during the entire project?

- Was the 'product backlog' practice applied?
  - Options: {yes/no}

- This practice was or would have been useful (incorporating application constraints).
  - Options: {Strongly agree, Agree, Slightly agree, Slightly disagree, Disagree, Strongly disagree, Unable to judge}

3.6) sprint backlog - Was there a prioritized list/document containing all the functionalities/products that were to be delivered after each sprint/phase of the project?

- Was the 'sprint backlog' practice applied?
  - Options: {yes/no}

- This practice was or would have been useful (incorporating application constraints).
  - Options: {Strongly agree, Agree, Slightly agree, Slightly disagree, Disagree, Strongly disagree, Unable to judge, I can’t provide a judgment}
3.7) iterative sprint planning (PMO driven) - Was there a planning of upcoming sprints/phases and the corresponding functionalities/products which were reviewed and iteratively revised by the Product Owner based on changes in the environment (e.g. scope, business drivers, etc.)?

- Was the ‘iterative sprint planning’ practice applied?
  - Options: {yes/no}
- This practice was or would have been useful (incorporating application constraints).
  - Options: {Strongly agree, Agree, Slightly agree, Slightly disagree, Disagree, Strongly disagree, Unable to judge}

3.8) agile sprint planning (by the team, just in time) - Was each sprint/phase planned by the team, that is responsible for the realization of the product, and negotiated with the Product Owner of the functionalities/products?

- Was the ‘agile sprint planning’ practice applied?
  - Options: {yes/no}
- This practice was or would have been useful (incorporating application constraints).
  - Options: {Strongly agree, Agree, Slightly agree, Slightly disagree, Disagree, Strongly disagree, Unable to judge}

3.9) story point estimation - Was there a system to estimate the relative time required to complete tasks during the sprint/phase (i.e. relative to the other tasks)?

- Was the ‘story point estimation’ practice applied?
  - Options: {yes/no}
- This practice was or would have been useful (incorporating application constraints).
  - Options: {Strongly agree, Agree, Slightly agree, Slightly disagree, Disagree, Strongly disagree, Unable to judge}

3.10) team capacity - Was the sprint/phase planning established based on an estimation of the capacity of the responsible team.

- Was the ‘team capacity’ practice applied?
  - Options: {yes/no}
- This practice was or would have been useful (incorporating application constraints).
  - Options: {Strongly agree, Agree, Slightly agree, Slightly disagree, Disagree, Strongly disagree, Unable to judge}

3.11) daily stand-up meeting - Were there daily stand-up meetings in which people stated (1) their progress of the last day, (2) their planning for this day, (3) issues that might impede them when conducting their work?
3.12) impediment list - Was there a system/document to keep track of impediments or other issues that prevented project members from working effectively?

- Was the ‘impediment list’ practice applied?
  - Options: (yes/no)
  - This practice was or would have been useful (incorporating application constraints).
    - Options: {Strongly agree, Agree, Slightly agree, Slightly disagree, Disagree, Strongly disagree, Unable to judge}
3.16) user stories - Were functionalities/products defined as tasks based on ‘user stories’ which described functionalities or a process use case from the users’ perspective? E.g. in the form: I (business role) want (functionality) because (goal).

- Was the ‘user stories’ practice applied?
  - Options: {yes/no}

- This practice was or would have been useful (incorporating application constraints).
  - Options: {Strongly agree, Agree, Slightly agree, Slightly disagree, Disagree, Strongly disagree, Unable to judge}

3.17) sprint review - Was there a demonstration to stakeholders of the produced functionalities/products during and/or after every sprint/phase?

- Was the ‘sprint review’ practice applied?
  - Options: {yes/no}

- This practice was or would have been useful (incorporating application constraints).
  - Options: {Strongly agree, Agree, Slightly agree, Slightly disagree, Disagree, Strongly disagree, Unable to judge}

3.18) sprint retrospective - Was there a retrospective session after each sprint/phase in which project members reflected on the process and committed to related improvements for upcoming sprints?

- Was the ‘sprint retrospective’ practice applied?
  - Options: {yes/no}

- This practice was or would have been useful (incorporating application constraints).
  - Options: {Strongly agree, Agree, Slightly agree, Slightly disagree, Disagree, Strongly disagree, Unable to judge}

3.19) minimal viable product (MVP)/(walking) skeleton - Was there a working product/prototype delivered at the end of each sprint/phase? Please note that this does necessarily not imply a go-live of the product.

- Was the ‘minimal viable product’ practice applied?
  - Options: {yes/no}

- This practice was or would have been useful (incorporating application constraints).
  - Options: {Strongly agree, Agree, Slightly agree, Slightly disagree, Disagree, Strongly disagree, Unable to judge}

3.20) continuous deployment - Was the delivered functionality/product deployed at the end of each sprint/phase?
3.21) Would you like to add any applied practices that you consider agile but which were not mentioned before? – (e.g. because you used a non-Scrum agile methodology)

2. Please mention which practices were applied.

   ○ ...

   ▷ These practices were on average useful (incorporating application constraints).

   ▷ Options: {Strongly agree, Agree, Slightly agree, Slightly disagree, Disagree, Strongly disagree, Unable to judge}

3.22) Please rate the degree of ‘agileness’ of this project. Choose a point on the scale from 0, implying pure waterfall, to 5, implying pure agile. With some degree of ‘hybrid agile’ represented by the scale 1 to 4.

   ▷ Scale: {0,1,2,3,4,5}

3.23) Would you like to elaborate on the rating provided above?

   ▷ ...

○ Was the ‘continuous deployment’ practice applied?

   ▷ Options: {yes/no}

○ This practice was or would have been useful (incorporating application constraints).

   ▷ Options: {Strongly agree, Agree, Slightly agree, Slightly disagree, Disagree, Strongly disagree, Unable to judge}
Appendix 3.2.2.3: Research Tool, $DV$

24-04, Measurement of \{DV_0, DV_1, DV_2\}

Project Outcomes

This section discusses project outcomes represented by time and finance related variables. Please provide your best estimate of the requested variables. Note that the requested variables (e.g. costs, profit) are observed from the Deloitte perspective.

4.1) Duration - Please fill in c) if you are not certain about the absolute figures but when you are able to provide an estimate of the percentage wise discrepancy

a) What was the planned duration of the project in number of months?
   ○ ...

b) What was the actual duration of the project in number of months?
   ○ ...

c) Alternatively, rate the discrepancy on the following scale
   ○ \{≤ 0\% (i.e. on time or earlier than scheduled), < 25\%, < 50\%, < 75\%, < 100\%, > 100\%\}

4.2) Costs (for Deloitte)

a) What were the planned total project costs?
   • ...

b) What were the actual total project costs?
   • ...

c) Alternatively, rate the cost discrepancy on the following scale
   • \{≤ 0\% (i.e. on costs or below costs), < 25\%, < 50\%, < 75\%, < 100\%, > 100\%\}

4.3) Profit (for Deloitte)

a) What was your planned total project profit deducting all costs that were directly attributable to the project?
   • ...

b) What was your actual total project profit after deducting all costs that were directly attributable to the project?
   • ...

c) Alternatively, rate the profit discrepancy on the following scale
4.4) Personnel costs (for Deloitte)

a) What were the planned total personnel project costs?
b) What were the actual total personnel project costs?
c) Alternatively, rate the personnel cost discrepancy (i.e. budget overruns) on the following scale
   - \{ \leq 0\% \text{ (i.e. on costs or below costs)}, < 25\%, < 50\%, < 75\%, < 100\%, > 100\% \}

4.5) What were your expected and actual durations for separate phases of the project? Please note that the phases are based on the EVD for SAP 3.9 method.

a) What was the 'Project Preparation' phase duration overrun?
   - \{ \leq 0\% \text{ (i.e. on time or earlier than scheduled)}, < 25\%, < 50\%, < 75\%, < 100\%, > 100\% \}
b) What was the 'Business Blueprint' phase duration overrun?
   - \{ \leq 0\% \text{ (i.e. on time or earlier than scheduled)}, < 25\%, < 50\%, < 75\%, < 100\%, > 100\% \}
c) What was the 'Realization' phase duration overrun?
   - \{ \leq 0\% \text{ (i.e. on time or earlier than scheduled)}, < 25\%, < 50\%, < 75\%, < 100\%, > 100\% \}
d) What was the 'Final Preparation' phase duration overrun?
   - \{ \leq 0\% \text{ (i.e. on time or earlier than scheduled)}, < 25\%, < 50\%, < 75\%, < 100\%, > 100\% \}
e) If the above phase structure did not apply in your project, please explain why:
   - \[ ... \]
Appendix 3.2.2.4: Research Tool, Inclusion Criteria

22-04, Inclusion Criteria

Project Information

1.1) What currency do you prefer to express your answers in? Some questions cover estimates of financial project metrics. Please state the currency applicable to your answers (e.g. U.S. dollars, Euro’s etc.).

d) ...

1.2) Please rate the technical scope size of the project on the provided scale.

e) Options: {Covering modular system segments, Covering complete systems (e.g. ERP), Covering a complete IT landscape, Covering multiple IT landscapes}

1.3) Please rate the initial position of the project on the provided scale.

• Options: {Enhancements and/or extensions of existing system(s), Building from template/preconfigured solutions, Building from greenfield (i.e. no usable pre-existing solutions}

1.4) Please provide a short description of the project which includes the main systems involved in the project. Please explicitly mention ERP systems and the main modules if applicable.

• ...

1.5) Please provide a short description of the role of Deloitte in the project. Please include the applicable phases.

• ...

1.6) What was the total revenue for Deloitte?

• ...
## Appendix 3.2.3: Categorization list

<table>
<thead>
<tr>
<th>ERP</th>
<th>COTS or limited overlap</th>
<th>No overlap</th>
</tr>
</thead>
<tbody>
<tr>
<td>MS Dynamics AX</td>
<td>Adobe Lifecycle</td>
<td>AEM CMS</td>
</tr>
<tr>
<td>Oracle EBS</td>
<td>ALE (Application Link Enabling)</td>
<td>CORONA</td>
</tr>
<tr>
<td>Oracle JD Edwards</td>
<td>BI</td>
<td>IBM TRIRIGA</td>
</tr>
<tr>
<td>Oracle JDE AP</td>
<td>Design Studio</td>
<td>Hadoop</td>
</tr>
<tr>
<td>Oracle JDE AR</td>
<td>Dell Boomi</td>
<td>Mongo DB</td>
</tr>
<tr>
<td>Oracle JDE GL</td>
<td>Documentum CMS</td>
<td>Outsystems platform</td>
</tr>
<tr>
<td>Oracle JDE FA</td>
<td>Cerner EHR</td>
<td>Sitecore</td>
</tr>
<tr>
<td>Oracle JDE SO</td>
<td>EDI (Electronic Data Interchange)</td>
<td>TIBCO</td>
</tr>
<tr>
<td>Oracle JDE PO</td>
<td>Guidewire PAS</td>
<td></td>
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<tr>
<td>SAP AA</td>
<td>IBM Cognos</td>
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<tr>
<td>SAP Basis</td>
<td>Informatica Data Quality</td>
<td></td>
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<tr>
<td>SAP Business One</td>
<td>Informatica ETL</td>
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<tr>
<td>SAP CO</td>
<td>Informatica PowerCenter</td>
<td></td>
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<tr>
<td>SAP CS (customer service)</td>
<td>MS Dynamics CRM</td>
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<tr>
<td>SAP ECC</td>
<td>Oracle EBS</td>
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<tr>
<td>SAP ERP</td>
<td>Oracle Siebel</td>
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<td>SAP Fi</td>
<td>Omnitracker</td>
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<tr>
<td>SAP FICO</td>
<td>P45, MPP, MP1, P41, P24, AQ5</td>
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<td>SAP HR</td>
<td>Salesforce</td>
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<tr>
<td>SAP LE (logistics execution)</td>
<td>SAP ARIBA</td>
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<td>SAP MM</td>
<td>SAP Bank Analyzer</td>
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<td>SAP PP</td>
<td>SAP BW</td>
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<td>SAP PS</td>
<td>SAP BO (Business Objects)</td>
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<td>SAP PSM</td>
<td>SAP BOBJ</td>
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<td>SAP EIS</td>
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<td>SAP TR</td>
<td>SAP EM (Event Management)</td>
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<td>SAP WF</td>
<td>SAP EWM</td>
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<td>Unit4 Business World Milestone 4</td>
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<td>SAP MES</td>
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<td>SAP PI/XI (Process Integration)</td>
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<td>SAP Succesfactors</td>
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<td>SAP Vistex</td>
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<td>Workday HR</td>
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### Appendix 3.3.1: Operationalization table RQ3

<table>
<thead>
<tr>
<th>Theoretical Variable</th>
<th>Indicator Variable</th>
<th>Empirical Variable</th>
<th>Applicable data tools</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moderator Variable: Distinctive Attributes of ERP projects</td>
<td>Level of dependencies in a project</td>
<td>$I^M_0$: value ‘Team dependencies’</td>
<td>Survey {1.1, 3.1}</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I^M_1$: value ‘Average dependencies’</td>
<td>Survey {1.1, 3.1}</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I^M_2$: value ‘Business process dependencies’</td>
<td>Survey {1.1, 3.1}</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I^M_3$: value ‘System dependencies’</td>
<td>Survey {1.1, 3.1}</td>
</tr>
<tr>
<td></td>
<td>Project category</td>
<td>$I^M_4$: value ‘Project category’</td>
<td>Survey {1.1, 3.1}</td>
</tr>
<tr>
<td>Independent Variable: Methodology</td>
<td>The degree to which a project applies agile methodologies</td>
<td>$IV$: value ‘Corrected average agile practices’</td>
<td>Survey 1.1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The application of the ‘Scrum master role’ practice</td>
<td>$I^V_0$: value ‘Scrum master role’</td>
</tr>
<tr>
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<td>...</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The application of the ‘Continuous deployment’ practice</td>
<td>$I^V_{19}$: value ‘Continuous deployment’</td>
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<tr>
<td>Dependent Variable: ERP Project Outcomes</td>
<td>The degree to which the project was completed on-time</td>
<td>$DV_0$: value ‘Duration discrepancy’</td>
<td>Survey 1.1</td>
</tr>
<tr>
<td></td>
<td>The degree to which the project was completed within budget</td>
<td>$DV_1$: value ‘Budget discrepancy’</td>
<td>Survey 1.1</td>
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<tr>
<td></td>
<td>The degree to which the project was completed ‘on-profit’</td>
<td>$DV_2$: value ‘Budget discrepancy’</td>
<td>Survey 1.1</td>
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<tr>
<td>Proxy Variable: Usefulness of Agile Methodology</td>
<td>The perceived usefulness of agile methodologies</td>
<td>$PV^{IV-DV}$: value ‘Average usefulness’</td>
<td>Survey {1.1, 3.1}</td>
</tr>
<tr>
<td></td>
<td>The perceived usefulness of the ‘Scrum master role’ practice in the project</td>
<td>$I^{PV^{IV-DV}}_0$: value ‘Scrum master role’</td>
<td>Survey {1.1, 3.1}</td>
</tr>
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<td></td>
<td>...</td>
</tr>
<tr>
<td></td>
<td>The perceived usefulness of the ‘Continuous deployment’ practice in the project</td>
<td>$I^{PV^{IV-DV}}_{19}$: value ‘Continuous deployment’</td>
<td>Survey {1.1, 3.1}</td>
</tr>
</tbody>
</table>
Appendix 3.3.2: Research Tool, Survey 2.1

22-04 Survey 2.1

You are invited to answer the following questions regarding the previously discussed project. Please provide your best estimates regarding the requested values (i.e. even if you do not know the exact value of a variable). You will be provided with several options to elaborate on your choices in case you feel the available options do not capture your answers. There will be the possibility to refer to persons and or documents that may be able to provide any information you were unable to provide at the end of this survey.

- Project Information, Inclusion Criteria (appendix 3.2.2.4)
- Measurement of \( \{ I_0^{MV}, I_1^{MV}, I_2^{MV}, I_3^{MV}, I_4^{MV} \} \), Distinctive Attributes (Appendix 3.2.2.1)
- Measurement of \( \{ I_V, \{ I_0^{IV}, I_1^{IV}, \ldots, I_{19}^{IV} \} \}, \{ PV^{(IV-\bar{DV})}, I_0^{PV^{(IV-\bar{DV})}}, I_1^{PV^{(IV-\bar{DV})}}, \ldots, I_{19}^{PV^{(IV-\bar{DV})}} \} \)\)

Methodology, Perceived Usefulness (appendix 3.2.2.2)

What was your position during this project?

- Options: {B.A. or up, Senior consultant or up, Senior manager or up, Partner}

Some of the information asked in this survey may have been outside the scope of your professional activities. Would you like to refer to persons and/or documents to complement the information requested in this survey? Please note that relevant contact details and/or documents can be emailed to bgoedhard@deloitte.nl. Please state the subject line of the email below. This way, the information can be linked to these results. Please do not send client information/contact details over this (i.e. google form) channel.

- ...

Would you have any colleagues who would be able (with regard to time constraints) to fill in this survey? Potential respondents should have some professional overlap with technology in enterprises. The more diversity in professional views the better! Please note that relevant contact details can be emailed to bgoedhard@deloitte.nl. Again, please do not send contact details over this (i.e. google form) channel.

- ...

Thank you for your participation!