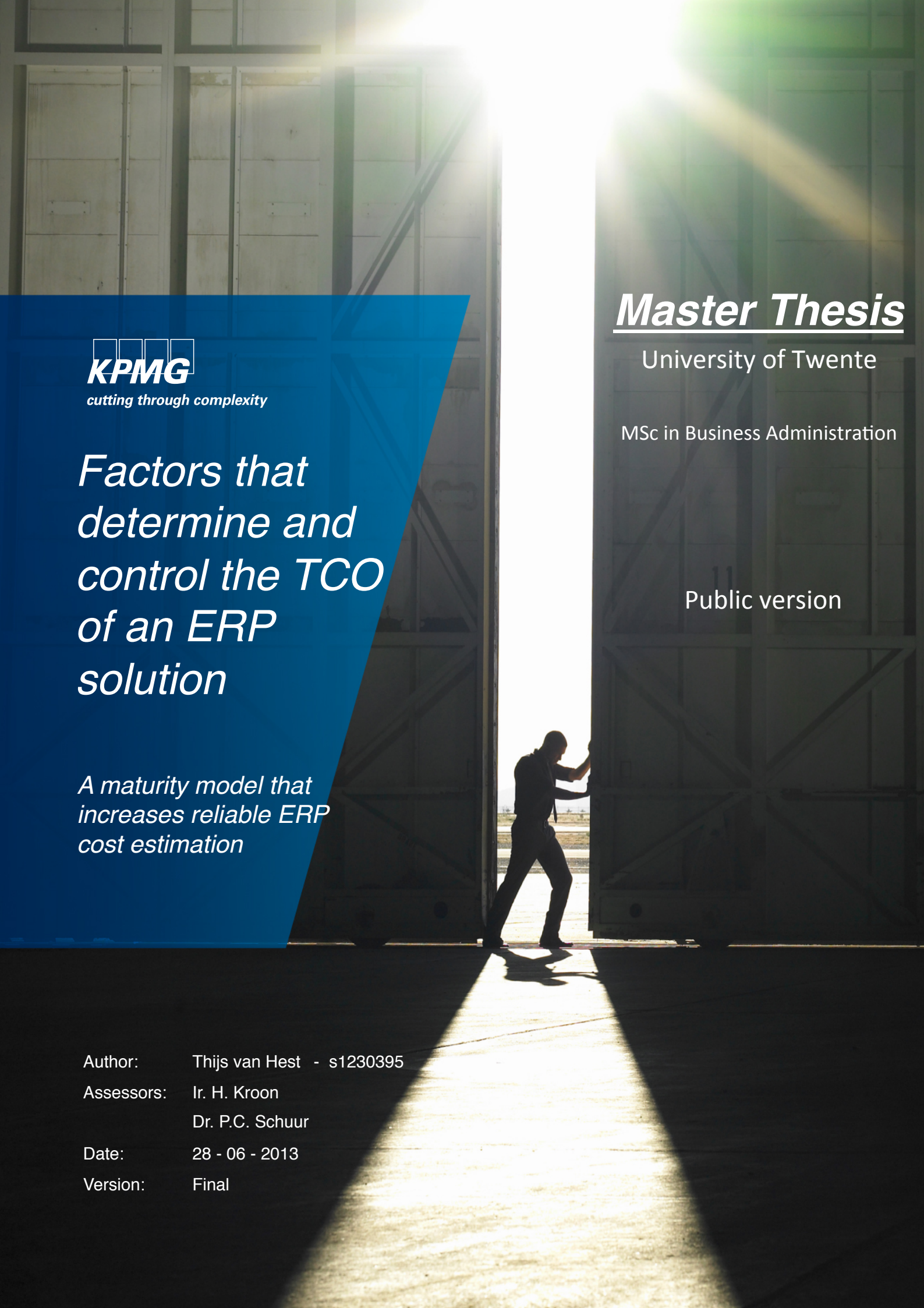

KPMG
cutting through complexity

Factors that determine and control the TCO of an ERP solution

A maturity model that increases reliable ERP cost estimation

Master Thesis

University of Twente

MSc in Business Administration

Public version

Author: Thijs van Hest - s1230395

Assessors: Ir. H. Kroon
Dr. P.C. Schuur

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Acknowledgements

As a student studying a Master's degree in Business Administration at the University of Twente (Enschede, the Netherlands), I was not expecting to write my master thesis within KPMG IT Advisory in Amstelveen, the Netherlands. Especially since I followed the specialized courses in Financial Management, which make up for a third of the obligatory courses. However, due to my affinity for IT I came across a very exciting challenge at KPMG IT Advisory, specifically at KPMG ERP Advisory. This thesis bridges the often present gap between Financial Management and IT, since it concerns the Total Cost of Ownership of an ERP solution. It is therefore an exciting and very interesting combination between my financial specialization courses, my affinity for IT, and a great organization to work for.

The objectives when writing this thesis were not only to graduate at the University of Twente with a Master's degree, although this was of course my main objective. A second goal was to get to know KPMG, and especially to let KPMG get to know me. After this thesis and my great experiences with KPMG, I hope that there is a function available for me within KPMG Management Consulting. At the time of submission of this thesis, I applied for a job within KPMG Financial Management, which is also a part of KPMG Management Consulting. The coming weeks will show whether KPMG is willing and able to offer me a contract as an associate consultant, which I sincerely hope. A great development during my graduating period was that some of my research findings were already used in practice, and one of my supervisors at KPMG was actually able to win a project at a large client partially due to my cost model. I expect the delivered model in this research to lead to many new insights in the coming years, and it would be great to see such a model being further developed using more data and eventually being integrated in the proposition of KPMG ERP Advisory.

During the project I received all possible help and comments of an extensive amount of colleagues at KPMG. Since I cannot mention every single colleague, I would like to thank anyone within KPMG IT Advisory, and especially ERP Advisory, for any possible help on this research and to find my way around KPMG generally. I would like to especially thank Edwin Buscher and Edward van Kleef at KPMG for their efforts, fast comments and quick responses, and great overall cooperation. The same appreciation goes for my supervisors at the University of Twente: Henk Kroon and Dr. Peter Schuur. Especially Henk Kroon, my first supervisor, was always available for any questions regarding the research and I had many pleasant and highly useful meetings with him in both Enschede and Amstelveen.

I would like to wish all readers an interesting time reading my Master Thesis. I would also like to seize this opportunity to point out that I am open to any suggestions and open-minded discussions regarding this research in the future. I developed a mainly conceptual model, based on only a small amount of data. It would be great to see others students pick up this subject in the future to test the model extensively, to make it even more reliable.

Abstract

The implementation of an ERP system, and especially its cost management, is often described to be a project with a high degree of risk. This is likely to be partially caused by the magnitude of change the effective implementation of an ERP system often demands of an organization. ERP implementing firms are not always aware of the necessary changes to effectively implement and use ERP, to reap the benefits of these expensive solutions. Phelan (2006) found that 40% of all ERP implementations exceed budgets and time with at least 50%. Considering the magnitude of investments in ERP projects, which often concerns investments of over a million euro's, such budget overruns are of a major impact on an organization. This was more than enough reason for KPMG ERP Advisory, to request further research on this topic from a university.

The main question of this research is: *Which factors determine and control the Total Cost of Ownership of an ERP solution?*

After extensive literature reviews on the costs, risks, and cost drivers of ERP, and the conduction of a questionnaire within KPMG IT Advisory, a maturity model that rates an organization's maturity on the aspect of future ERP cost estimation was developed. This model shows the level of ERP cost-estimation maturity of an organization on four perspectives and on 4 levels of each perspective. An organization with a higher level of maturity in this aspect is expected to estimate the TCO of ERP more accurately than an organization with a lower maturity. The higher the level of ERP cost-estimation maturity of a firm, the less the realized TCO of ERP is expected to deviate from the pre-estimated budget. Such a maturity model or similar tool that describes action for more reliable ERP cost management has until now been inexistent. The Total Cost of Ownership (TCO) concerns all costs of an investment throughout its entire life cycle. Ignoring the significant costs that occur after the implementation of an ERP solution, such as licensing, maintenance, and support costs, might negatively influence decision-making. The life cycle of ERP was distinguished in the acquisition-, the implementation, and usage phase. First, all costs that are applicable to these phases were identified from literature. Acquisition was divided in consultancy and other acquisition costs. Implementation costs were divided in consultancy, software & licenses, hardware, business process redesign, training and other costs. Usage costs were divided in software & licenses, hardware, training, usage, maintenance, support and personnel costs. These divisions in costs were maintained throughout the entire design process. Cost-misestimation risks and cost drivers of ERP were identified in an extensive literature review and added to these divided cost categories.

The maturity model of ERP cost estimation is divided in four perspectives: Management, IT, Process, and People. All cost drivers, critical success factors and cost-misestimation risks of ERP were plotted on these four perspectives. The extent to which these cost drivers and risks

are controlled, controls the extent to which the TCO of ERP can reliably be estimated. The amount of risk that is involved in all cost drivers was identified in an internal survey at KPMG ERP Advisory, determining the order of cost drivers. The required investment to control each cost driver, and the risk in terms of probability and potential impact were identified. A remarkable finding was that Management was not indicated as containing high risks, contradicting literature. This can possibly be explained by the high maturity and there perceived self-evident cost drivers of the respondents. Especially process standardization and harmonization, under the Process perspective was found to require high investments and contained high risks.

Based on critical success factors, risks and cost drivers of ERP implementation and usage from an extensive literature review and their weights as collected in a questionnaire, an organization that is rated with a level four maturity on all four perspectives is characterized by:

Management: high prioritization of ERP and sustained top management support, a perfectly defined project scope, project plan, implementation approach, and the management of these aspects, the presence of a highly sophisticated cost management system and a careful selection of both consultants and project team.

IT: SaaS contracts and possible leasing of equipment, an extensive and formal ERP testing plan and execution, a perfect match between the ERP system and the demands and characteristics of the organization and the awareness of possible future demands, with adequate response possibilities.

Process: an excellent fit between the ERP system and the organization, a minimum amount of customization and a high degree of vanilla ERP, and therefore a perfect amount of Business Process Redesign and a minimization of the frequency with which processes change.

People: a high degree of user involvement and participation, also in decision-making that concerns ERP, a high amount of employee support of ERP and extensive and formal training procedures for existing and new employees to use ERP.

A point of rationality could be found on the extent to which it is necessary for an organization to always score the highest possible rating on each perspective. The acceptance of a certain degree of risk to avoid a certain investment can be seen as a rational decision as long as both are certain. An overall finding is that an ERP project can no longer be seen as an IT project. The required investment of an ERP project was indicated the highest at Process, and not at the IT perspective. The IT component of an ERP project has always been significantly present, which is only logical, but the other aspects of Management, Process, and People can no longer be left uncovered. Only if an organization scores a high maturity on all four perspectives, a high organizational readiness for ERP is developed, which leads to a higher reliability of the estimation of the TCO of ERP.

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Introduction

Enterprise Resource Planning (ERP) solutions are organization-wide and fully integrated Information Technology (IT) software products, which allow for information to flow more efficiently throughout an organization and therefore also an organization's processes. ERP solutions use a single database, highly standardized procedures and are focused on efficient data sharing between departments. Due to the efficient exchange of information, ERP solutions offer great operational benefits for enterprises, such as decreased production costs through more advanced lean manufacturing (Aloini, Dulmin & Mininno, 2012) and an overall greater ability to control the company's resources, enabling many other cost reductions and other operational advantages.

However, the actual costs and the involved risk of ERP solutions have been widely debated throughout its entire existence in both literature (e.g. Daneva, 2011; Verhoef, 2005; Wagle, 1998) and practice. Given the fact that many significant costs occur during and after the implementation of ERP, e.g. licence-, hosting-, and maintenance costs, the concept of the Total Cost of Ownership (TCO) of ERP receives a lot of attention. The TCO calculates all costs of an investment throughout the entire life cycle of this investment.

Justification

Aberdeen Group (2007) found that the total costs of ERP software include a wide range of factors. However, based on a survey using a sample of over 1680 midsize companies they discovered that only the costs of software, services and maintenance are often considered and measured. This might lead to a suboptimal choice of ERP selection since many other cost-factors play a role (e.g. Aloini et al., 2012; Evestes, Carvalho & Santos (2001); Monczka, Handfield, Giunipero, Patterson, & Waters, 2010; Pisello & Strassman 2001; Wu, Ong, & Hsu, 2008). Zuckerman (1999) found that ERP implementations at organization with a turnover of € 500.000 or more exceed budgets with an average of 17%. Phelan (2006) found that 40% of the ERP projects exceeded time and budget with at least 50%. Considering the magnitude of an ERP implementation, these numbers often have huge consequences for organizations dealing with such a budget overrun.

Research question

Many factors that determine the costs of ERP are known, but most of them are highly uncertain and difficult to estimate and control (Kulk, Peters & Verhoef, 2009). KPMG is interested in finding out which (cost) factors together determine the TCO of an ERP solution and to what extent these costs and the underlying risks can be controlled. The following main research question is therefore formulated:

- *Which factors determine and control the Total Cost of Ownership of an ERP solution?*

The main research question will be answered through an extensive literature review, combined with a survey and a small number of interviews. The goal is to determine the cost categories that together form the TCO of ERP. Since these cost categories are influenced by risks, they will be combined with the estimation risk of each cost category from the survey. A maturity model will be developed to indicate the extent to which an organization is able to control the estimation risks and cost drivers of the TCO of ERP.

The goal of this research is the development of a maturity model that rates an organization's maturity to estimate the total future costs (TCO) of ERP. The maturity of an organization is expected to control the TCO of ERP. An organization with a higher maturity is expected to be in a higher degree of control of the factors that determine the TCO of ERP, and can therefore estimate the TCO of ERP with a greater reliability than an organization with a lower maturity. A higher level of maturity is therefore expected to lead to a decrease in the maximum amount with which the TCO of ERP can deviate from the pre-estimated budget. Such a more reliable estimation of the TCO of ERP allows a more effective and realistic capital budgeting of an entire organization due to the immediate magnitude of an ERP budget overrun, with all consequences considered.

Sub research questions

Based on the main research questions, the following sub research questions are derived, and will be answered in the theoretical framework. An extensive review of the existing literature is required to shape the model. The research was started on the next principle research questions. The design-oriented aim and the therefore iterative character of the research allows for new insights to originate during the process of research on a maturity model of estimating the TCO of ERP. The principle questions as derived from the main question are:

1. *What is according to the literature the appropriate, or least problematic, valuation model for valuating all cash flows out, related to an ERP investment over its entire life cycle?*

2. *What is the duration of the entire life cycle of an ERP solution, and from what stages does it exist?*

3. *Which are the different types and categories of costs over the entire life cycle of an ERP solution, both direct and indirect, and internal and external?*

4. *What is the influence of the risks involved in controlling the costs of implementing and using an ERP solution on the calculation of the TCO of ERP and on the weighing factor of the different cost factors?*

Considering the order of the research questions, the first step is to describe how the literature proposes to valuate the TCO of ERP, and to what extent financing considerations should be included in this calculation. To answer sub-questions 3 and 4, all the costs that are related to the full life cycle of ERP must be described and categorized, and assigned to the stages of which an ERP solution exists. This part is fully based on an extensive literature review and information of past implementations from KPMG. While preserving the chronological division in costs of the life cycle of ERP, cost-misestimation risks are assigned to the cost categories of ERP based on a second extensive literature review.

As explained, the steps that have been taken during this design-oriented process allow for new insights to arise during the process of doing research on the desired deliverable due to the iterative character of this research. As expected, these steps have led to new insights and therefore new sub research questions after completing literature reviews on the costs and risks of ERP. The following questions will be repeated in the methodology section and discussed afterwards:

5. *Which perspectives should be applied in a maturity model that describes an organization's ERP cost-estimation maturity?*

6. *What cost drivers and related risks need to be controlled to provide organizations with a more reliable estimation of the TCO of ERP, which improves the cost-estimation maturity of ERP of an organization?*

7. *What can be seen as success factors for reducing estimation risks of the TCO of ERP, indicating the maximum level of maturity of ERP cost-estimation?*

Deliverable

The main goal deliverable of this research will be an ERP cost-estimation maturity model, which is expected to be related to organizational readiness for ERP. The maturity model will describe a number of levels of maturity of ERP cost estimation. A higher level of maturity indicates a higher organizational readiness for ERP, which is expected to influence the degree to which the TCO of ERP can reliably be estimated. It is therefore expected, that at an organization with a higher level of maturity, the realized TCO of ERP will deviate significantly less from the pre-estimated budget than at an organization with a lower level of maturity.

1. Theoretical framework

The following sub research questions will be discussed in this order, while reviewing the theory on these matters in this order:

1. *What is according to the literature the appropriate, or least problematic, valuation model for valuating all cash flows out, related to an ERP investment over its entire life cycle?*

2. *What is the duration of the entire life cycle of an ERP solution, and from what stages does it exist?*

3. *Which are the different types and categories of costs over the entire life cycle of an ERP solution, both direct and indirect, and internal and external?*

4. *What is the influence of the risks involved in controlling the costs of implementing and using an ERP solution on the calculation of the TCO of ERP and on the weighing factor of the different cost factors?*

These questions will be answered on the basis of literature. Especially sub research questions three and four will be based on extensive literature reviews of the costs (sub research question four) and the risks (sub research question five) of the TCO of ERP. A table will be constructed of both these factors and will therefore distinguish all costs and risks within the TCO of ERP, since these are expected to highly determine the TCO of ERP. Both tables will be based on the life cycle stages that are identified on the basis of sub research question two, to organise these tables and therefore this research on the basis of a chronological distinction of all factors concerning of the TCO of ERP.

Due to the design-oriented and therefore iterative nature of this research, the methodology that follows the theoretical framework will first reflect on the used theory, and identify the next steps and therefore the next sub research questions that are necessary to be asked within this research. These steps are necessary to design the aimed deliverable of a maturity model that is expected to determine and control the TCO of ERP. This iterative setup allows for new insights to be developed and therefore new research questions to be derived during the design process of this model.

1.1 Enterprise Resource Planning

"*ERP systems are described as computer-based information systems designed to process an organization's transactions and facilitate integrated and real-time planning, production and customer response*" (Amid, Moalagh & Ravasan, 2012). This definition of an ERP system describes the way such a system is used, but does not mention a very important feature that is one of the underlying causes why it enables higher efficiency: a single database, and therefore the removed necessity of multiple entries of the same data in the system. "*An Enterprise Resource Planning system is a suite of integrated software applications used to manage transactions through company-wide business processes, by using a common database, standard procedures and data sharing between and within functional areas*" (Aloini et al., 2012, p.183). There are about 500 ERP applications available (Bingi, Sharma, & Godla, 1999) and even though they show many resemblances and share many of the core concepts that underlie ERP, there are also big differences that make the valuation of the total costs of an ERP implementation difficult to generalize solution-wise. Furthermore, one would expect a certain correlation between the size of the ERP deployment and costs (Aberdeen Group, 2007), which is confirmed. However, economies of scale are rarely met since the costs per user usually increase as the size of the ERP deployment increases, due to the fast increasing complexity of the ERP solution. Depending on the right implementation strategy, which is of a significant influence, economies of scale can however be achieved. Size can be determined through for example the total number of users on the system.

Implementing an ERP system is an expensive and risky investment (Aloini et al., 2012), which has a big impact on the organization in terms of primary and support processes, organizational structure and the personnel's roles and tasks. The implementation of an ERP system forces an organization to work according to standard processes. This process standardization often causes a high degree of disruptive organizational change, considering the high amount or organizational processes that are touched and influenced by ERP. During implementations of ERP solutions, there are significant risks of failures, cost- and time-overruns and the IT specific risks of requirements creep and/or time compression (Verhoef, 2005). A study of 7400 Information Technology (IT) companies showed that 34% of the projects were either late or over budget, 31% were scaled back, modified or abandoned, whereas only 24% of the projects was completed within budget and on time (Cunningham, 1999). Phelan (2006) found that 40% of the ERP projects exceeded time and budget with at least 50%.

1.2 The valuation of IT investments

When estimating the value or TCO of an ERP solution, Wagle (1998) states that it is important to calculate the IT costs that are related to ERP. This means that only the costs of ERP solutions should be calculated, since not all IT-costs are necessarily ERP costs. A

company also requires a certain amount of IT assets without an ERP system running. However, this argument is also valid the other way around, since not all ERP costs are IT costs. For example, Business Process Redesign (BPR)- and consultancy costs account for a significant proportion of the TCO of ERP, as will be explained later. These costs are largely underestimated by Wagle (1998).

"*ERP can reduce the financial reporting, purchasing, and support expenses of management information systems (MIS), and lead to more timely analysis and reporting of sales, customer, and cost data*" (Wagle, 1998, p.131). There is an extensive amount of literature available on the benefits of implementing and using ERP (e.g. Poston & Grabski, 2000; Hu & Quan, 2005), and is mainly focused on operational benefits such as decreased production costs. Such benefits due to ERP only are difficult to measure because they are usually influenced by other internal and external factors other than ERP, especially on the long-term. Results might therefore produce a biased result of the ERP-related benefits only. Davern and Wilkin (2010) propose that multiple measures need to be employed to capture the value that is generated by IT. Verhoef (2005) describes how to quantify the value of IT-investments. His research is focused on tailor-made software and therefore related to ERP software, since a certain degree of customization and configuration is almost always necessary. There is little empirical research on valuating IT investments. The lack of data for determining and valuating IT investments is a primary reason for the lack of qualitative analysis for major IT-investments. Many organizations have an immature level of IT-development and maintenance and lack an overall metrics program that produces data (Verhoef, 2005).

Many (IT) projects are appraised using the Net Present Value (NPV). The NPV is the sum of the present value of all future cash flows minus the present value of the cost of the investment (Hillier, Ross, Westerfield, Jaffe, & Jordan, 2010). Future cash flows are discounted to their present value, using a specific discount factor. This discount factor is based on financing considerations, but also on the amount of risk that is involved in the project. An investment with a riskier profile usually has a higher expected return to justify the risk of the project. As mentioned, ERP investments have a high risk-profile. A sensitivity analysis can examine how sensitive a particular NPV calculation is to changes in underlying assumptions, which are the expected cash flows, the discount rate, and the time horizon (Hillier et al., 2010).

1.2.1 The Total Cost of Ownership of ERP

The way the TCO is described and defined in the literature differs significantly. Degraeve and Roodhooft (1999) define TCO as follows: "*The Total Cost of Ownership quantifies all costs associated with the purchasing process*" (Degraeve & Roodhooft, 1999, p.43). They do not explicitly acknowledge the costs of an investment over its entire life cycle, and therefore perhaps oversimplify the concept of TCO by not putting enough emphasis on usage costs. Monczka et al. (2010) define TCO as "*the present value of all costs associated with a product that are incurred over its expected life*" (Monczka et al., 2010, p.263). TCO provides

an understanding of future costs that may not be apparent when an item is initially purchased (Nucleus Research, 2007). An often-mentioned disadvantage of TCO is that it only focuses on costs (Aberdeen Group, 2007; Nucleus Research, 2007; Verhoef, 2005) and therefore ignores the benefits of ERP. This is a valid argument, but not of any influence on this research since the operational benefits of ERP are outside the scope. A study of Rosa, Packard, Krupanand, Bilbro and Hodal (2013) shows that of the twenty companies in their sample, only seven provided costs for all implementation phase activities, indicating a low maturity of cost estimation and (capital) budgeting in this domain.

It was explained that the NPV uses the present value of future cash flows, while TCO does not. This is an important disadvantage of TCO. Monczka et al. (2010) are of the few who propose to discount costs that determine TCO to their present value, thereby eliminating this simplified representation of TCO. Related to this, TCO does not give any insight in the timing of future costs (Nucleus Research, 2007; Monczka et al., 2010; Verhoef, 2005). The owners of ERP implementations may be highly interested in the timing when costs occur due to e.g. financing issues and capital budgeting. A popular unit to express TCO is the average TCO per month. This however does not show insight in the timing of the costs of ERP (Nucleus Research, 2007). As a result of the high fluctuations in cash flows per month, such as average cash flows are from a management perspective very unreliable. Finally, TCO does not include the risks that are related to some costs. These risks cause many projects to run over budget or time, so they are likely to significantly influence the total costs of an ERP project. Despite these important disadvantages, the construct that represents TCO is very useful to express all costs related to the entire life cycle of an investment in for example an ERP solution.

1.2.2 The PV of the Total Cost of Ownership of ERP

Due to the described disadvantages of the TCO, the PV-TCO is proposed, which is the Present Value (PV) of the TCO. The PV-TCO calculates the PV of all future costs, eliminating the disadvantage of TCO that it ignores the time-value of future cash flows. Furthermore, it can show the financing needs of the project per time-unit (e.g. monthly); since this information is already available due to calculating the PV of future costs.

The appropriate discount rate to discount future costs is dependent on the costs of capital and the risks that are involved in the investment. Verhoef (2005) illustrates the problem using the Weighted Average Cost of Capital (WACC) as a discount rate, as proposed by Wagle (1998). The risk of an ERP solution, which is likely to be significantly higher than the risk of the entire enterprise, is not included in the WACC. Using the WACC for valuating IT investments is likely to be suboptimal, since this lower discount rate gives a too positive NPV given the higher risk-profile of IT investments (Verhoef, 2005). The Weighted Average Cost of Information Technology (WACIT) is therefore proposed by Verhoef (2005), which is to be used as a premium added on the WACC. This combination can essentially be seen as a risk-adjusted WACC for appraising IT investments. In the original example of Verhoef (2005) the

WACC was 10%, but the proposed WACIT was 24,74%, resulting in a discount rate of 34,7% for this specific ERP project. Pisello and Strassman (2003) propose rough guidelines for such a premium: 0% for no-risk investments, 10-15% for low-risk investments, 15-30% for medium risk investments and 30% or higher for high-risk investments. Comparing both, we could argue that the example of Verhoef (2005) might have been a medium to high-risk ERP implementation.

The time frame is of importance in a PV-TCO analysis, since the calculation should capture all costs related to the ERP system over its entire life cycle. Organizations typically select a new system every seven to ten years (Computable, 2006). Furthermore, the term 'costs' can lead to misinterpretation, since this research focuses on cash flows instead of costs that result from an ERP implementation. This mix-up between costs and cash flows is often seen in TCO analyses. The approach differs significantly compared to if it were focused on costs. Some assets that resulted in a negative cash flow at the date of purchase are activated and included as costs through depreciations in the profit and loss account. Since this construction reduces profit, it influences the taxation of the entire corporation. Taxes are ignored in the calculation by Wagle (1998), which produces a biased result considering the influence of taxes and the magnitude of an ERP solution.

1.3 Phases of the ERP solution life cycle

As explained, the TCO of ERP considers all costs of an ERP solution throughout its entire life cycle. It therefore contains several types of costs, some of which might require different approaches of cost management. It is therefore useful to establish different phases of costs within the ERP life cycle, to categorize these costs in a logical, preferably chronological, order.

Evestes, Carvalho and Santos (2001) distinguish acquisition costs, implementation costs, usage and maintenance costs, evolution costs, and retirement costs. Considering the scope of this research, the latter two categories might not be applicable, but the first three cost categories provide a first step to categorize the TCO of ERP. Evestes et al. (2001) enhance these phases with examples of costs, which will be discussed in section 1.5. Monczka et al. (2012) distinguish four categories of costs that are applicable to the TCO of ERP: purchase price, acquisition costs, usage costs, and end-of-life costs. Pisello and Strassman (2001) propose a distinction between capital expenses, implementation labour, on-going management and support, and operations and contracts. Such distinctions in capital- and operational expenses are typical for a TCO analysis, since both acquisition and implementation costs and operational (usage) costs should be considered. Such distinctions considering the timing of costs along the ERP life cycle are typical for a TCO analysis, since all cost should be considered.

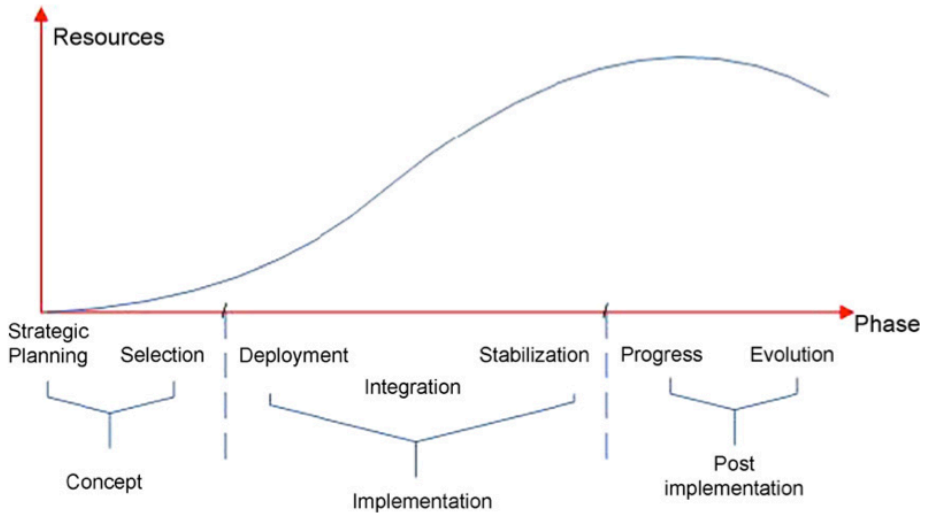

Figure 1: ERP life cycle. Source: Aloini, Dulmin and Mininno (2007)

However, the division in costs applied by Evestes et al. (2001) is more applicable to most TCO calculations: acquisition-, implementation-, usage and maintenance-, evolution-, and retirement costs. This division show all costs in chronological order. Considering the above ERP life cycle, the described concept phase matches the acquisition phase, the implementation phase stays intact, and the post-implementation phase matches the usage and maintenance costs as described by Evestes et al. (2001). The graph shows the distribution in the amount of resources needed throughout the ERP life cycle, which reach their peak during the 'usage and maintenance-costs' (post-implementation) phase, which is caused by the ERP solution actually being used at that moment. This shows the significance of the usage costs of the TCO of ERP, and the possible consequences on decision-making if these costs or resources are not properly included in the estimated costs of ERP. Usage costs also return each year, unlike acquisition- and implementation costs

1.4 Costs of an ERP solution

Not all IT costs are necessarily ERP costs (Wagle, 1998; Wolfsen & Lobry, 1998). This is an important remark, since many IT costs are also unavoidable without the use of an ERP solution. Including al IT costs therefore bias the TCO of an ERP solution, making an ERP solution seem more expensive than it actually is. This bias might influence the decision-making regarding an ERP implementation on for example the choice of the solution. However, not all ERP costs are IT costs too, since the implementation of ERP usually also involves for example change management, which is an act of human resources, both internal and external.

The described phases of the ERP life cycle, operationalized in cost-phases of the TCO of ERP, were explained in section 1.3. The distinction of Evestes et al. (2001) in acquisition-, implementation-, and usage costs will be used because it establishes a chronological distinction, with cut-off points. Acquisition costs include all costs before the implementation of the ERP solution is started. Implementation costs include all costs before the ERP solution goes live. Finally, usage costs include all costs between the implementation of the ERP solution and its retirement. This can be a simplified view of an ERP implementation, since some implementations go live throughout a series of phases. This is dependent on the implementation approach. It is therefore possible than in such a situation, implementation and usage costs occur simultaneously for a period of time. The actual costs within these categories however do not change.

Several costs that belong to each of the cost categories are extensively described in literature and can be distinguished (Aloini et al, 2012; Evestes et al., 2001; Monczka et al., 2010; Pisello & Strassman, 2001; Wu et al., 2008). Such costs are for example hardware-, software and licensing-, consultancy-, and maintenance costs. There are also many partially hidden and more uncertain costs of ERP, such as Business Processes Redesign (BPR) costs, which are aimed at adapting certain organizational processes to the selected ERP solution. BPR costs usually also involve change management costs, which are often both internal- and external costs. Aberdeen Group (2007) found that the TCO of ERP in midsize companies is among others influenced by: company size, number of ERP users, the deployed functionality, and the business benefits that are gained from ERP.

Table 1: Costs along the ERP life cycle

Phase	Tangible Costs	Intangible Costs
Adoption		Decision making costs
Acquisition	Consultancy Hardware Software licenses	Decision making costs Opportunity costs
Implementation	Consultancy Training Human resources System specification	Customization, conversion and da Time dedicated by staff Business process re.engineering
Usage and Maintenance	System Reconfiguration System adaptation Cost of system failure	Indirect costs of system failure Lost of competitiviness
Evolution	Cost of new applications	
Retirement		Opportunity costs Decision making costs

Source: Evestes et al. (2001)

Evestes et al. (2001) defined the many indirect costs and indirect losses of benefits of the TCO of ERP as intangible costs. Regarding the context of this research, which ignores the benefits and therefore losses of benefits of ERP, this approach might be confusing since costs and losses of benefits are used simultaneously. Most costs can however be included in the TCO of ERP, both tangible and intangible costs.

Gartner (2006) provides a 10-step process to produce a reliable estimate of the costs and the duration of ERP implementation projects. They include:

- *Process design*
- *Core and supplemental staffing needs*
- *Data conversion*
- *Customization and interface development*
- *User training*
- *Project management*
- *Organizational change management*
- *Pilot deployment and rollout to remote sites*

Based on the existing literature and input of KPMG ERP advisory employees of all the costs of an ERP solution, the following costs were identified and categorized in acquisition-, implementation-, and usage costs. The references were included in the most right column of tables two and three. Tables that show each individual type of costs linked to their specific reference are added under appendices A and B.

Table 2: Costs of ERP during the acquisition and implementation phases

	Cost category	*Costs specification*	*References*
Acquisition costs	Consultancy	Business Integrator, sourcing	Monczka et al. (2010), Evestes et al. (2001), Wagle (1998)
	Other costs	Internal resources required	Evestes et al. (2001)
Implementation costs	Consultancy	Business Integrator, System Integrator, sourcing, support staff	Gartner (2006), Monczka et al. (2010), Evestes et al. (2001) , Wagle (1998)
	Software & Licenses	Operating system licenses, server licenses, supporting software, system specification, customization, migration	Computable (2006), ERP softwareblog (2010), Evestes et al. (2001), Pisello & Strassman (2001), Wagle (1998)
	Hardware	Computers, servers, network	Computable (2006), Evestes et al. (2001), Pisello & Strassman (2001), Wagle (1998)
	Business Process Redesign (BPR)	Business Process Redesign costs, internal resources	Gartner (2006), Heemstra & Kusters (2005), Evestes et al. (2001)
	Training	Costs of training and education, technology training	Agilent Technologies, Computable (2006), Evestes et al. (2001), Pisello & Strassman (2001)
	Other costs	Internal resources, testing costs, opportunity costs	Evestes et al. (2001), Pisello & Strassman (2001), Wagle (1998)

Table 3: Costs of ERP during the usage phase

	Cost category	*Costs specification*	*References*
Usage costs	Software & Licenses	Operating system licenses, server licenses, supporting software, system specification, customization, system reconfiguration, system adaption, costs of new applications, security	Evestes et al. (2001), ERP softwareblog (2010), Pisello & Strassman (2001), Wagle (1998)
	Hardware	Hosting costs, new hardware purchases, leasing costs	Monczka et al. (2010), Evestes et al. (2001), Pisello & Strassman (2001), Wagle (1998)
	Training	Continuous training and learning	Evestes et al. (2001), Pisello & Strassman (2001)
	Usage	Costs of facilities	Agilent Technologies, Pisello & Strassman (2001)
	Maintenance	Costs of (preventive) maintenance, technical support, costs of repairs, costs of technology refresh, new applications, upgrades, continued development, testing costs downtime, backup/recovery process	Agilent Technologies, Evestes et al. (2001), Computable (2006), ERP softwareblog (2010), Pisello & Strassman (2001)
	Support	Technical support, support costs, support contracts	ERP softwareblog (2010), Pisello & Strassman (2001), SAP project KPMG
	Personnel	IT personnel, diminished performance	Computable (2006), Evestes et al. (2001)

Verhoef (2005) explains that many companies have a low maturity of IT cost management and controlling. These companies therefore do not gather data on the costs of IT and ERP, which is an important reason why benchmarks of ERP costs are very rare and often inaccurate due to low sample sizes. De Koning (2004) confirmed this by concluding that all cases within his research did not budget any internal human resources costs, even though they account for a significant proportion of the TCO of ERP. Rosa et al. (2013) found that the Vendor's implementation team costs account for 38% of the total implementation costs at the cases within their sample, as is shown in table 4. This amount however also includes for example change management, which can also be partly an internal activity. Nevertheless, this shows the significant impact of other costs than only software and hardware costs. Furthermore, it is likely that these costs are far more difficult to estimate than future software- and hardware expenses, since they are dependent on the current state of an organization, whereas other costs are expected to have a more fixed character due to less context dependencies and therefore lent themselves for a higher degree of generalization across multiple companies.

Table 4: investment cost contribution as function of category

Category	Contribution
Software engineering	17%
Systems engineering, program management, change management, development test & evaluation, traning development	21%
Site activation, user training, data migration	18%
ERP customer oversight	9%
Computer hardware and software licenses	7%
Interim Sustainment (up to go-live)	28%

Source: Rosa et al. (2013)

Considering the magnitude of the impact of the System Integrator's (SI) costs (both software engineering and system engineering), Rosa et al. (2013) state that the most common size measure for predicting the costs of the implementation team is the number of RICE objects. RICE stands for the number of Reports, Interfaces, Conversions, and Extensions. The complexity or the size of an ERP implementation is often operationalized as the number of modules to be implemented but this is seen to be a very rough estimate, which leaves little room for nuances (Heemstra & Kusters, 2005). The number of RICE objects is an indicator of the complexity of the ERP implementation, which is found to correlate with the System Integrator's required effort to implement the ERP solution. Hence, these four criteria are essentially partially the cost drivers of the System Integrator's costs, which also means they can be controlled to reduce the estimation risk of these costs. The customization of the ERP solution, which is also one of the tasks of the System Integrator, is not explicitly mentioned. These activities are included in the 'extensions' category of the RICE criteria, since the customization of an ERP solution is essentially the extension of the standard 'out-of-the-box' solution.

Regarding the actual calculation of the TCO of ERP, Wagle (1998) applies a few assumptions of which the most important assumption for this research is that taxes are ignored. As explained, taxes have a significant impact on the TCO of ERP, since they create a tax shield on both the depreciation of investments and the costs of debt financing of ERP, and therefore reduce the cash outflow per year. Pisello and Strassman (2001) also state that tax implications should not be ignored in such a cash flow analysis, as a result of their huge impact. Ignoring taxes might influence decision making quite severely due to the height and therefore impact of tax rates and is therefore neither wise nor desirable. An argument for ignoring taxes might lie in the fact that many countries use different tax standards, which results in research findings that are not necessarily generalizable throughout a large number of countries. Including taxes, but stating that the amount might differ per country would probably have been better a better solution, if this were the argument. Generalization of the TCO of ERP is also difficult for many others reasons, so the counterargument does not entirely hold.

After summing up all costs that are related to the implementation and usage of ERP, it is immediately shown that not all costs related to ERP are IT costs. The distinction between ERP and IT costs was already made in the respect of not all IT costs automatically being ERP costs. However, many costs that result from for example internal resources for business process redesign and change management are also not IT costs. This distinction is very important, since it is expected that ERP costs are much more than only IT or IT-related costs. ERP forces the standardization of an entire organization, which, depending on the existing degree of standardization, often causes disruptive change for a firm.

SaaS (Software as a Service) is becoming increasingly popular. SaaS is a form of Application Service Provider (ASP) services. This development evolves simultaneously with arising cloud solutions, which make internal hosting services unnecessary. This is also referred to as ERP on premise versus ERP in a cloud. The leasing of hardware equipment is also a related example. Since these services are usually contract-based and have a fixed fee, they decrease cost-misestimation risks in both software and licenses and hardware costs. Although the usage of these services does not indicate a level of maturity on this aspect, it is an example of what actions that an organization might take to be better able to manage and control future costs. However, as will be shown in the next section and table 5, these costs occur in categories that contain a relative low amount of both costs as well as estimation risks and do therefore certainly not solve the budget overruns of ERP costs.

1.5 Risks of an ERP implementation and usage

The proportion of ERP projects that go over budget or time, or are abandoned or modified, is high. For example, Phelan (2006) found that 40% of the ERP projects exceeded time and budget with at least 50%. This is an indicator of the high risk that is involved in ERP projects. Kulk et al. (2009) focus on the risk of falsely estimating the costs of IT investments, stating that this is one of the most critical Key Performance Indicators (KPI) in an investment project. This however is a very broad KPI, and therefore not suitable for effective cost management of ERP. It is likely that this risk is an important cause for the high failure rate of ERP implementations. Aloini et al. (2012) state that an explanation for this high failure rate is that "*managers do not take prudent measures to assess and manage the risks involved in these projects*" (Aloini et al., 2012, p.183).

Abid and Guermazi (2009) identify four sources of uncertainty in IT projects: uncertainty in future cash flows, uncertainty in investment costs, technical uncertainty and the risk of catastrophic failure. The authors also state that "*within IT risk management, risk is regarded as the combination of an undesirable event occurring and the magnitude of the loss associated with the event*" (Abid & Guermazi, 2009, p.77). Hence, the mere identification of a risk is insufficient, since some risks should have a higher weight than others. This weight

depends on both the probability of this risk occurring and the magnitude at the occurrence of this event. Cost categories that only represent a small proportion of the TCO of ERP could contain very high estimation risks, but the associated loss when this event occurs is quite small. Monczka et al. (2010) state that focusing on the smallest cost only delays decision-making and is therefore undesirable and unnecessary. This statement seems to represent a trade-off, since the TCO of ERP could rise significantly if high estimation-risks are involved in a high number of small costs. Aloini et al. (2012) provide a description of 19 risk factors of the implementation of ERP software and their interdependence during the different phases in implementation. Especially poor project team skills, low top management involvement and poor managerial conduct have a wide-ranging influence on other project risk factors. The occurrence of these three risk factors might trigger a snowball effect for other risk factors. Therefore, the risk level associated with these factors is very high.

De Koning (2004) found that four out of his five cases, contained budget overruns in consultancy costs, and three out of five in customization. He found that the budget overruns in his sample of five cases were especially caused by a too low level of detail in the budgets (four out of five cases), the knowledge-level of consultants (three out of five cases), and unexpected customization (also three out of five cases). The extent of customization of ERP software is often found in literature, which should be reduced to a minimum (e.g. Heemstra & Kusters, 2005; Ram, Corkindale, Wu, 2013; Rosa, Packard, Krupanand, Bilbro, Hodal, 2013) to avoid significant customization costs. According to Wijkstra (1999) many budget overruns are realized in this category, which accordingly is expected to contain both a high risk and potential impact due to its magnitude. Shanks, Seddon and Willcocks (2003) state that "*in order to minimize the risk associated with a lack of alignment of the [Enterprise Solution] and business processes, organizations should engage in business process reengineering, develop detailed requirements specifications, and conduct system testing prior to the ES implementation*" (Shanks, et al., 2003). Bothof and Götte (1998) found that the major cost overruns were realized at the usage of internal employees (54,7%) and external advisors/consultants (49,6%), indicating a high misestimation risk of these cost categories. This is in line with the conclusions of Francalanci (2001), who states that budget overruns were in particular realized at these same cost categories: the usage of both internal and external human resources. Considering these numbers, a high risk for massive budget overruns is potentially identified when referring back to De Koning (2004), who found that all cases within his research did not budget any costs that result from human resources. Wijkstra (1999) found that budget overruns were in particular realized at the execution of customizations to the standard ERP solution. These large budget overruns might all be signs of low organization maturity on this matter.

Implementing an ERP system involves adapting organizational processes to fit the industries standard, since "*ERP systems are built on best practices that are followed in the industry*" (Bingi et al., 2013, p.10). Reducing the amount of customization of an ERP solution is in line with the CSFs as described by Rosa et al. (2013), and is therefore seen as a best practice in

reducing the cost-estimation of the System Integrators consultancy costs. However, Bingi et al. (2013) found that at best, an application can fit 70% of the organizational needs in its standard form. The remaining 30% of customization might therefore still contain high estimation risks.

Sumner (2000) concluded that the following risks of ERP implementations can be identified:

- A mismatch between the organization and the ERP solution: a lack of adaption of organizational processes and the lack of an organization-wide approach to integrate data.
- A lack of experience of the implementation-team: a lack of knowledge of both the system and the context, not being able to combine internal and external knowledge.
- A lack of adaption to the ERP solution: no adjustments to the standardized work-processes of the organization.
- Problems related to planning and integration of technological solutions

Table 5: ERP risk factors

ERP risk factors

Risk factors	Category	Subclass item(s)	Uncertainty to be resolved
Exogenous factors	Technical subsystem	Hardware costs	Uncertain costs of further hardware purchase
		Software costs	Uncertain costs of adding modules for new ERP functionality
		Telecommunications costs	Uncertain costs of further infrastructure purchases
		System reconfiguration costs	The need to reconfigure ERP systems for optimal use
		Specification changing costs	Misunderstanding of requirement and/or changing requirement due to complexity
	Outside Training/ consulting	Consulting costs	Uncertain costs of further ERP introduction costs
		Ongoing user training costs	Unresolved learning curve makes this major expenditure uncertain
Endogenous factors	Socio-subsystem	Employee resistance	User involvement/resistance to using the system, and/or lack of user commitment
		Escalation	Continuing to invest in an unviable project and failure to decide when to abandon it
		Personnel costs	Costs of ERP system professionals turnover, recruitment and retention
		Maintenance costs	Ongoing maintenance costs
		Forgone project cost (Insufficient organization resources)	The need to decide when/whether to give up the project
		Competence	Do we have the managerial and technical competence in the IT department?

Source: Wu et al. (2008)

Wu et al. (2008) distinguish exogenous risks (that are connected with the uncertain environment) and endogenous risks (that arise within the organization). Exogenous factors are divided in a technical subsystem (e.g. hardware costs, software costs) and outside training/consulting (consulting costs and on-going user training costs). These risks therefore provide a link with the table of all the costs within the TCO of ERP as shown in the previous section. Endogenous risk factors all fall in the socio-subsystem category (employee resistance, escalation, personnel costs, maintenance costs, etc.).

Rosa et al. (2013) describe critical success factors (CSFs) of ERP implementation, based on an extensive literature review. The CSFs that were applicable as a cost estimation CSF to an ERP implementation were translated into cost-misestimation risks of an ERP implementation. The full list of CSFs of ERP implementation by Ram et al. (2013) is added to this research under appendix C. It is uncertain whether all success factors that are explained by Ram et al. (2013) can in fact be seen as critical, since this would mean each and every success factors must be met in an ERP implementation, otherwise it would fail. This point will be discussed later in this research, but it is important to determine the degree to which these factors can be seen as critical.

All risks from literature that were identified as cost-misestimation risks of ERP are linked to the cost categories as established in the previous section, and are added in the tables below. The references of these risks were included in the most right column of tables six and seven.

Table 6: cost-misestimation risks of ERP during the acquisition and implementation phases

	Cost category	*Cost-misestimation risks*	*References*
Acquisition costs	Consultancy	Ineffective consulting service, business processes not adequately identified and described, insufficient quality, no use of consultants at all, lack of a business plan, no formal project plan/schedule, unclear project scope	Aloini et al. (2012), Ehie & Madsen (2005), Rosa et al. (2013), Wu et al. (2008)
	Other costs	Inadequate selection, mis-match between organization and ERP solution, competence, poor project team skills, low top-management involvement	Aloini et al. (2012), Rosa et al. (2013), Sumner (2000), Wu et al. (2008)
Implementation costs	Consultancy	Ineffective consulting service, inadequate financial management, poor communication between BI and SI, poor project team skills, too much customization, need to reconfigure the ERP system, competence, lack of experience in the implementation team, lack of a business plan, no formal project plan/schedule, wrong/inadequate implementation approach, inadequate change management	Aloini et al. (2012), Gürbüz, Alptekin & Alpetekin (2012), Rosa et al. (2013), Sumner (2000), Wu et al. (2008)
	Software & Licenses	Licensing policies of ERP providers, technological dependence	Abid & Guermazi (2009), Computable (2006)
	Hardware	System quality, uncertain hardware purchases, uncertain infrastructure purchases	Rosa et al. (2013), Wu et al. (2008)
	Business Process Redesign (BPR)	Inadequate BPR, inadequate analysis of business of processes, no structural readiness, a high amount of	Aloini et al. (2012), Bingi et al. (2013), Ehie & Madsen (2005), Rosa et al. (2013),

		customization, lack of adaption to the ERP solution,	Sumner (2000)
	Training	Insufficient training, unresolved learning curve	Aloini et al. (2012), Rosa et al. (2013), Wu et al. (2008)
	Other costs	Poor project team skills, low top-management involvement, lack of experience in the implementation team, wrong implementation approach, ineffective monitoring of the project	Aloini et al. (2012), Rosa et al. (2013), Sumner (2000)

Table 7: cost-misestimation risks of ERP during the usage phase

	Cost category	*Cost-misestimation risks*	*References*
Usage costs	Software & Licenses	Future licensing policies of ERP providers, technological dependence, uncertain costs of further ERP development, inadequate IT supplier stability and performance	Abid & Guermazi (2009), Aloini et al. (2012) Computable (2006), Wu et al. (2008)
	Hardware	Further hardware purchases, modules for new ERP functionality, further infrastructure purchases	Wu et al. (2008)
	Training	Unresolved learning curve, continuity-rate of personnel	Wu et al. (2008)
	Usage	Uncertain costs of ERP facility	
	Maintenance	Unreliable system, availability of upgrades, uncertain testing costs, on-going maintenance costs	Agilent Technologies, Computable (2006), Gürbüz et al. (2012), Wu et al. (2008)
	Support		
	Personnel	Resistance to the system, lack of user commitment	Wu et al. (2008)

1.6 The influence of the implementation strategy

ERP of solutions can be implemented at organizations in a variety of approaches. The magnitude of organizational change that ERP often causes is of a major influence on the appropriate implementation strategy For example; an organization can choose to implement ERP globally across all entities according to a fixed template. This requires for all subsidiaries to work according to a standardized template, which is supported by the ERP solution. The complete opposite is a 'greenfield' approach.

A second type of implementation strategy is determined by the timing of the implementation. Software Advice (2010) describes three implementation approaches:

- **Big bang -** Implementation happens in a single instance. All users move to the new system on a given date.

- **Phased rollout -** Changeover occurs in phases over an extended period of time. Users move onto new system in a series of steps.
- **Parallel adoption -** Both the legacy and new ERP system run at the same time. Users learn the new system while working on the old.

Considering the organizational impact of the implementation of an ERP system, the implementation approach also has large consequences for the organization. The implementation approach is often described to be a critical success factor of an ERP implementation (e.g. Heemstra & Kusters, 2005; Ram et al., 2013; Rosa et al., 2013).

1.7 Concluding remarks on the theoretical framework

Based on literature, the appropriate valuation model was established. The life cycle phases that will be used throughout this research are the acquisition-, implementation-, and usage phase. In section all costs that are related to the TCO of ERP are explained on the basis of this distinction in life cycle phases. The same was done with the risks that concern the TCO of ERP in section 1.6, which were also divided on the basis of these three life cycle phases.

Sub questions one till four were adequately answered using the existing theory on the life cycle phases and the costs and risks of ERP. Since this research is design-oriented, the setup allows for new insights to arise during the process of designing a solution for a problem, which is what also occurred during this research. These development and therefore new sub questions will be explained after the methodological explanation of the proceedings of this research in the next section.

Key for the understanding of the factors determine the TCO of ERP within this research, is that the reliability of the estimation of TCO of ERP will always increase during the project. This is caused by many costs already being realized and therefore known, which decreases uncertainty. This does not mean that the budgeted TCO of ERP does not change during the project, but the extent to which it is unreliable is expected to decrease. Since most usage costs are expected to contain only small risks, the TCO of ERP is the most reliable at the end of the implementation phase. This is an argument that might be made by critics, but this only indicates the importance of this research, since it is desirable for organizations to possess a reliable estimate of the TCO of ERP before the project starts, or perhaps during or at the end of the acquisition phase. A reliable estimate of the TCO of ERP at the end of the implementation phase is nothing more than an overview of all costs that have been made, with the low-risk usage costs added.

2. Methodology

As stated in the introduction, the main research question is formulated as follows:

- *Which factors determine and control the Total Cost of Ownership of an ERP solution?*

The factors that control the TCO of ERP were added to the research question later and are based on the amounts of risk involved within the TCO of ERP. Due to the magnitude of an ERP project, it is expected that it is desirable to identify factors that control the TCO of ERP, since this could lead to the description of a set of organizational characteristics that are expected to lead to a better control of the TCO of ERP. It is expected that these characteristics are more dependent for a reliable estimation of the TCO of ERP, than the actual calculation itself. The calculation itself should for example, as explained in the theoretical framework, consider Present Values of cash flows and taxes.

The scope of this research is limited to factors that only determine the costs that are associated with an ERP implementation, and the extent to which these costs can reliably be estimated and controlled. The benefits of ERP, which are for an organization the primary reason to implement ERP in the first place, are outside the scope of this research. The importance of research on the benefits of an ERP solution is unquestionable, but requires a different approach and can therefore not effectively be combined with research on the costs of ERP in this setup. The benefits of ERP are for example heavily influenced by factors like market conditions and operational considerations. The goal of this research is also not a calculation of the TCO of an ERP solution since this is too dependent on the solution itself and the context it is implemented in. An important remark must be made regarding taxes, which are ignored by Wagle (1998). Due to the absence of a calculation, the scope of this research does not allow for taxes to be included properly, even though the very big influences of a tax shield through the depreciation of an investment in an ERP solution, and the resulting operational costs, which also decrease profits and therefore taxes, are acknowledged. This also holds for costs of financing, which are of a significant influence considering the magnitude of investment of an ERP system. The implementation approach, which influences the factors that determine the TCO of ERP, is also kept outside the scope of this research. It is expected that the described factors are of importance in any implementation approach, but the eventual weights of these factors may differ per implementation strategy.

The four sub research questions as stated in the introduction were satisfactory answered in the theoretical framework. To answer sub research question three, a table of all costs associated with ERP was comprised, based on an extensive literature review. Based on this framework and a second literature review, the risks that lead to cost-misestimation of ERP were added to a new table, answering sub research question four.

2.1 Deliverable

Considering the main research question of this research, we could state that this research question is relevant, since it is apparently unclear to KPMG ERP Advisory and others which factors should be included to calculate a reliable estimation of the future Total Cost of Ownership of an ERP solution. This is confirmed by the relevant literature on the matter. Large misestimations, which are occur regularly as we have seen, often have huge consequences for organizations due to the large financial impact of a total ERP implementation. A budget overrun of 50% in some cases means additional costs of millions of euros on top of the already substantial budget. It is needless to say that such consequences are significant to any organization. If such consequences could be avoided with a model that enables organizations to more reliably estimate their TCO of ERP, this is a relevant deliverable that also holds commercial value for KPMG ERP Advisory. The risks of ERP, as summarized in the theoretical framework in section 1.6, do not only include financial risks. For example, the actions of the management and employees, the existing business processes, and the influence of consultants all potentially cause risks for an ERP implementation that could increase of decrease estimation risks of the TCO of ERP. A cost-misestimation is within this research seen as a significant disparity between the budgeted TCO of ERP and the realized TCO of ERP.

The aimed deliverable of this research will be a model that is able to assess the maturity of an organization on the aspect of being able to reliably estimate the TCO of ERP on a number of perspectives. Such a model or a similar tool that describes actions to improve reliable ERP cost management does not exist yet and therefore fills an important gap between IT costs and ERP cost management and its huge budget exceeding. These perspectives need to be carefully chosen, to be able to include all cost-misestimation risks as found in tables six and seven. A company that is better able to control the cost drivers and the cost-misestimation risks of ERP will be indicated with a higher maturity of ERP cost-estimation. Referring back, a high maturity does not mean that costs of ERP are reduced, but only that the TCO of ERP can be estimated with more reliability. This improves for example decision-making and capital budgeting. When maturity is from here on described in this research, this always concerns the ERP cost-estimation maturity of an organization: the degree of maturity that influences the maximum possible amount with which the realized TCO of ERP could deviate from the pre-determined budget of the TCO of ERP.

Figure two provides a graphical representation of the consequences of a high maturity compared to a low maturity. Because an organization with a low maturity is less able to reliably estimate the TCO of ERP, the bandwidth with which the realized TCO of ERP could deviate from the budget is much larger than at an organization with a high maturity. Unfortunately, in an organization with a low EPP cost-estimation maturity this is nearly always in the negative direction, which means that budgets are far exceeded. Figure two

might give the impression that it implies that costs could decrease more at a low maturity organization, but it merely indicates a lack of precise determination of the TCO of ERP.

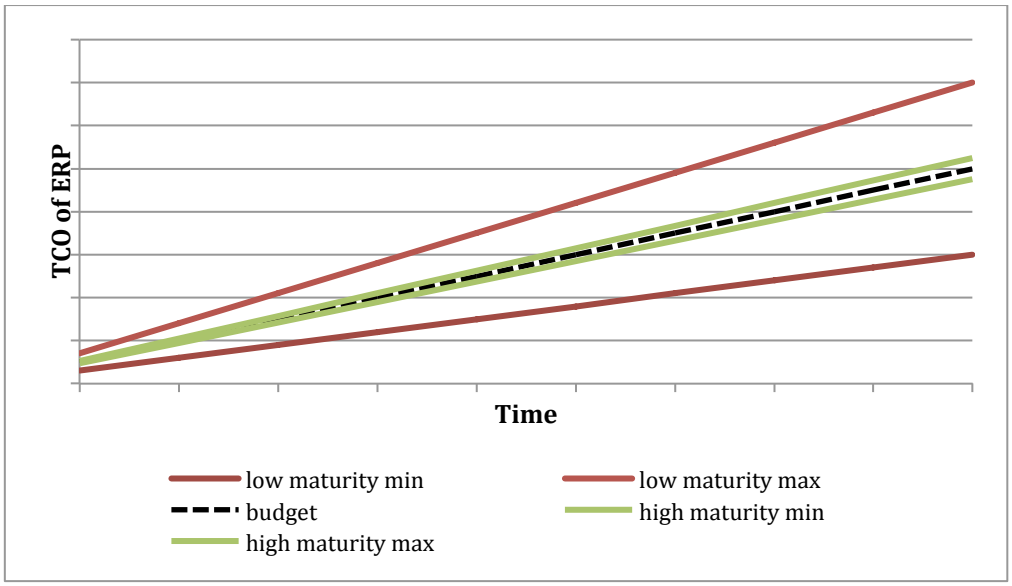

Figure 2: A graphic representation of the consequences of cost-estimation maturity

The first set of sub research questions was derived from the main research question in the introduction and the sub research questions were satisfactory answered based on the theoretical framework. Based on these findings and due the iterative design-oriented nature of this research, this follow-up set of sub research questions was derived:

5. *Which perspectives should be applied in a maturity model that describes an organization's ERP cost-estimation maturity?*

6. *What cost drivers and related risks need to be controlled to provide organizations with a more reliable estimation of the TCO of ERP, which improves the cost-estimation maturity of ERP of an organization?*

7. *What can be seen as success factors for reducing estimation risks of the TCO of ERP, indicating the maximum level of maturity of ERP cost-estimation?*

Since the deliverable of this research will be a maturity framework with a set of perspectives that all contain factors that determine and influence the TCO of ERP, the focus will be on the combination between the cost-misestimation risks and the cost drivers that cause the costs of ERP. When the cost drivers underlying all costs are known, actions to be taken to provide a more reliable estimation of the TCO of ERP can be given. The extent to which these actions are taken and the cost-misestimation risks of the TCO of ERP are controlled, determines the level of maturity in this field of an organization.

- *It is expected that the extent to which the cost drivers and the related cost-misestimation risks are controlled, controls the extent to which the TCO of ERP can reliably be estimated. The degree of control is operationalized as a degree of maturity and therefore controls the TCO of ERP.*

Therefore, the first step will be to identify all the relevant cost drivers of the TCO of ERP, based on the existing tables two and three that contain all life cycle costs of ERP. These cost drivers will be identified through a literature review and through a series of interviews at KPMG. The success factors for reducing the estimation risks within the TCO of ERP will be identified in a literature review.

2.2 Data

During this research, several attempts to gather data on a large scale were made. This was to be added with a series of about 20-25 interviews of clients of KPMG that implemented ERP in the past and were therefore useful to identify success factors and important risks of ERP cost estimations. To realize the collection of such data sets, several networks at KPMG, and ERP vendors Oracle and SAP were approached and contact with these potential data sources was maintained actively. Due to time limitations and confidentiality, which is always a major and just issue for KPMG as an audit firm, this proved to be impossible to realize within this research. However, it is possible that some questions would have been answered more thoroughly if this setup would have been applicable. Since this research lacks these amounts of data, it is expected that a few theory-based assumptions must be made regarding linking costs and risks to maturity levels of ERP cost estimation. Such assumptions provide future researchers with useful input for testing these assumptions.

3. Combining costs, risks and cost drivers of the TCO of ERP

In the proceedings of this research, the chronological distinction between the acquisition-, implementation-, and usage phases will be maintained. To be able to effectively combine the costs and risks of ERP, cost drivers will be determined. The cost drivers are the underlying drivers or processes that 'drive' the set of costs within the TCO of ERP. By defining why certain costs occur, the underlying activities or processes can be controlled, which in its turn more effectively and proactively controls the costs of ERP. It is expected that the extent to which the cost drivers and the related cost-misestimation risks are controlled, controls the extent to which the TCO of ERP can reliably be estimated. A higher degree of control in this matter reduces the possible bandwidth with which the budgeted TCO of ERP might deviate from the realized TCO of ERP and therefore indicates a higher degree of organizational maturity.

Before determining the cost drivers, the perspectives of the maturity model will be established and defined, to answer sub question five. All cost drivers can be linked to these perspectives. Each perspective then contains a set of cost drivers and related risks. The extent to which these cost drivers and risks are controlled determines the maturity of an organization in this perspective. The overall maturity of ERP cost estimation of an organization is dependent on the sum of these perspectives, which is a simplified but less detailed result.

3.1 Maturity perspectives of ERP cost estimation

By now, it is known that the risks of cost-misestimations of ERP implementations are dependent on more perspectives than just IT-related and –determined matters. For example, the Business Process Redesign (BPR) costs can be very extensive since they often involve the change management of an entire organization to adapt business processes to ERP and often require extensive consultancy costs.

To effectively guide the cost management of both the acquisition-, and implementation-, but also the usage costs of ERP, an organization is required to have a high maturity on a set of perspectives. A set of perspectives gives an organization a sense of their own maturity in each perspective. An overall maturity of ERP cost estimation is possible and easier to operationalize, but does not show an organizations maturity on each perspective. From a management perspective, a division of maturity on a set of relevant perspectives opens the possibility to more accurately control ERP cost management. Underdevelopment on one or more perspectives can also be easily identified and appropriate actions to increase maturity on the underdeveloped perspectives can be taken.

Davern and Wilkin (2010) propose measures related to the value and therefore also the costs of an ERP system across four levels of analysis: individual, process, organization and market. The market measures are of influence on the benefits of an ERP solution, which is outside the scope of this research. Furthermore, IT related cost management is not explicitly mentioned, and should be included in the maturity model. We could however argue that 'organization' refers to the organization of the implementation and usage of ERP, which corresponds with the management and therefore cost management of ERP implementation and usage. The remaining three perspectives as discussed by Davern and Wilkin (2010) provide a relevant distinction between the areas an organization should cover for effective ERP cost management. Several remarks of economic reality are included in each level. Within this research, the individual will be operationalized as People. As explained, IT must also be included. 'Organization' (Davern & Wilkin, 2010) is left out as a separate perspective, since all perspectives of the model added together should form an indication of ERP cost-estimation maturity of the entire organization. The described cost-misestimation risks of ERP show the influence of the management of the ERP implementation and usage process. Management is therefore also added as a perspective. Since the consultants influence the management of ERP, these important categories are also included under the Management perspective. This results in the following four areas that influence the quality and maturity of ERP cost estimation. The four colours of these perspectives will be maintained throughout this entire research for easy identification.

Table 8: four perspectives of ERP cost-estimation maturity

1. Management	**2. IT**
3. Process	**4. People**

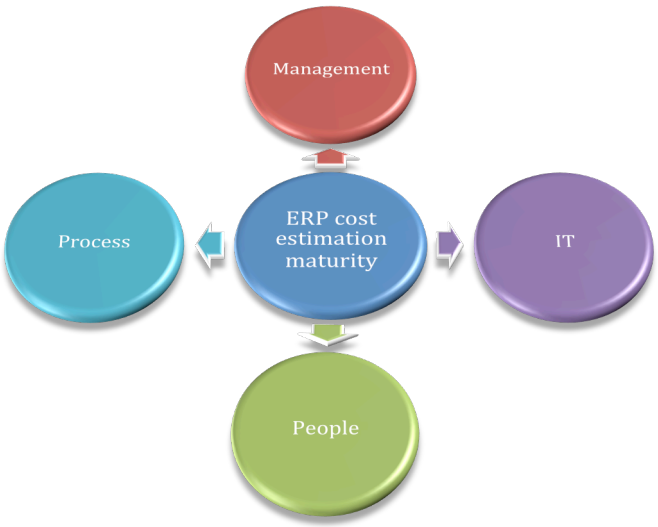

Figure 3: four perspectives of organization-wide ERP cost-estimation maturity

Furthermore, this distinction is often applied in various models, such as change models, used by KPMG, which has the benefit that it is applied, tested and confirmed in practice. This set of perspectives also holds the benefit that the model can directly be applied by KPMG to rate, or possibly benchmark in the future, the cost-estimation maturity of a new organization. A main thought within KPMG is the balance that should be present on these perspectives in order to change or evolve to a higher level of sophistication or maturity of the organization. Considering the potential commercial value the model holds for KPMG, the threshold that the findings of this research must be translated into a proposition and work standards is reduced.

3.2 Rating maturity using a best-practices framework

Benchmarking can help to achieve a sustainable competitive advantage through improved business performance by identifying gaps between by identifying gaps between organization practice and competition (Kahn, Barczak, Moss, 2006). Kahn et al (2006) state that a best-practices framework is an invaluable tool for satisfying performance benchmarks and process proficiency. Kahn et al. (2006) comprised a new product development best-practices framework that is comparable to the deliverable this research. Six perspectives of new product development across four levels of sophistication were explained, based on existing literature. A shortcoming of this specific research is the absence of empirical tests to test the content of the framework. However, the framework itself is highly comparable to the goal of this research. A best-practices framework provides a set of descriptions and characterizations and a basis of evaluation for complex function processes (Camp, 1998). Such a framework "*also provides understanding because it evaluates performance, identifies keen challenges and suggests directions for process improvement*" (Kahn et al, 2006, p.108). The latter statement is important, because a best-practices framework in this sense suggests guidance for a company that intends to raise a certain area of interest a maturity level upwards from their current state. However, achieving the highest level of maturity, or best-practice, often comes with high investments. It is possible for an organization to take the choice of accepting a certain amount of risk while avoiding certain (high) investments.

A necessity for benchmarking is a sufficient amount of data, especially for reliable benchmarking. Since the maturity level of organizations on the area of IT metrics is quite low, not much data is generated on this aspect (Verhoef, 2005). This makes benchmarking the maturity level of ERP cost estimation difficult or even impossible. However, the deliverable of this research offers a first step to benchmark the maturity level of ERP cost estimation in a quite simple way. When a large number of organizations uses such a tool and publish their information in a dataset, possibly anonymous, organizations could be able to benchmark their own cost estimation maturity and organizational readiness for ERP within for example their industry. This might also show that in some industries, it might not be necessary to score the highest level on each perspective. An organization might also strive for

the industry average. An industry average could well be 3232, based on the four perspectives in the explained order. An organization is then more able to establish what their goal level of maturity should be on each perspective, since a lower maturity requires a lower amount of investments but comes with a higher degree of risk.

The goal of the projected deliverable of this research is the rating of the cost-estimation maturity of ERP of an organization. An often seen critical success factor and cost driver of ERP is organizational readiness for ERP (Heemstra & Kusters, 2005). Based on the four perspectives that are selected to build this research on, it is expected that organizational readiness can be found throughout these four perspectives. A higher level of maturity on each perspective indicates a higher organizational readiness for ERP, and therefore indirectly reduces ERP cost-misestimation risks. Since this is such a critical factor for ERP, and is seen as a factor that overlaps all perspectives, it is not used separately in the questionnaire. We might therefore also be able to rate the organization readiness for ERP on four perspectives, using the exact same model we will use for establishing maturity of the cost-misestimation of the TCO of ERP.

Due to the conceptual nature of the model, the choice was made not to describe the maturity levels further than only on a scale from one till four, which already features a logical order. The possibility exists to describe level four as for example best practice, but this is a risky statement. The term 'best practice' implies that all possible risk is controlled. Since ERP is context dependent, the controls are expected to differ in each organization and each implementation. A possibility is referring to level four as a 'centre of excellence', which is often used within KPMG, but the scientific advantage for this research of such powerful expressions is doubtful.

3.3 ERP Project management

Not all IT project management literature is applicable to the management of ERP projects, since the frequency of occurrence is much lower and there often is 'only' one ERP project running simultaneously, even though this is often an extensive project. Portfolio management is therefore not directly applicable. However, it is possible and even likely that companies with a highly developed overall IT project management are also more able to effectively manage an ERP implementation project, due to their experience and expertise in the field.

Project justification according to Wolfsen and Lobry (1998) happens in both the business domain as well as the technology domain which both distinguish the following criteria:

- *Business domain:* Efficiency, accordance with strategy, competitive advantage, management information, competitive reaction, organizational risk.
- *Technology domain:* connection with IT-strategy, clearly defined demands, technological risk, infrastructural risk.

Rosa et al (2013), only five out of twenty companies had detailed schedule information available, indicating a low average maturity of project management within their sample of only twenty companies.

Wijnen, Renes, and Storm (1988) distinguish five controlling aspects in their project management concept: Time, Money, Quality, Information and Organization. Krooshof, Swinkels and van der Wal (1991) describe the ISES-Promise method, which is intended for the project management of IT projects specifically. Krooshof et al. (1991) distinguish six controlling aspects: Money, Organization, Safety, Quality, Information, Time and resources (MOSQUITO). Both models show many resemblances, with the exception of the aspect 'safety' that is decribed by Krooshof et al. (1991). This aspect is aimed at risk management, which is as explained highly important for managing an ERP project.

Wijnen et al. (1988) describe the following controlling objects to manage the five explained controlling aspects of a project:

Table 13: controlling aspects of a project

Controlling aspect	**Controlling objects**
Time	Relations between activities Time frames of activities Capacity loss due to the project
Money	Costs Revenues
Quality	Quality demands Results
Information	Decision information KPIs
Organization	Relation of project organization and context Organizational structures

Source: Wijnen et al. (1988)

We could argue that this research is aimed at identifying factors to manage the 'money' aspect (Wijnen et al., 1988; Krooshof et al., 1991). However, the goal of this research remains to identify all factors that determine the TCO of ERP, which is why four perspectives of maturity are involved. Wolfsen and Lobry (1998) explain that key in the aspect of 'money' is a well built cost management system. Although the importance of such a system in this domain cannot be denied, since it is an indicator of the maturity of the cost management of an organization, we are also interested in the quality of the input of this cost management system.

This input is comprised of the underlying factors that actually determine the TCO of ERP, whereas the cost management of ERP is intended to only calculate and monitor the TCO of

ERP. Furthermore, an ERP system based on cost management can only be appropriately managed if the input of the cost management system is correct. Cost management that is based on incomplete or wrong information is likely to cause ineffective or incorrect decision-making. This might result in a highly ineffective overall management of ERP, leading to judgemental problems because it is often trusted by key decision makers. Regarding the financial impact of an ERP solution, leaving out certain costs often highly influences the (budgeted) TCO of ERP.

A concern that is critical with the management of ERP implementation and usage, and therefore this research, is that organizations are dealing with a high complexity process, that is likely to be non-recurrent within the next few years. Almost all project organization literature is aimed at recurrent processes, with a certain frequency. For example IT project management, which might lie closest to ERP project management, therefore tends to have a limited usability within this research. For example, some critical success factors of ERP, such as a key decision maker (Ram et al., 2013), contain the risk that during the next

3.4 ERP cost drivers

Since an ERP project is often described as being an IT project, even though many often non-IT factors have been distinguished, determining IT cost drivers is a logical first step for determining the cost drivers of ERP acquisition, implementation and usage. An advantage of this approach is that parts of this perspective are well described in literature. Heemstra and Kusters (2005) describe the most important cost drivers of ERP implementation costs. Their operationalization of implementation costs is similar to both the acquisition-, and implementation costs of this research, and therefore applicable. Many cost drivers of the usage costs are similar to cost drivers within the implementation phase, but they are expected to contain fewer cost-misestimation risks since many decisions that influence usage costs are made in the acquisition- and implementation phases. Only the most important cost drivers should be identified. When drawing the comparison to software development costs, more than 1200 cost drivers can be identified, which is from a management perspective far too much to effectively (cost)manage an ERP implementation (Heemstra & Kusters, 2005). Furthermore, as discussed in the theoretical framework, ERP implementations do not only concern software development or IT costs, but also for example significant Business Process Redesign (BPR) and change management costs.

Theory on ERP cost drivers largely draws on ERP implementation critical success factors (Heemstra & Kusters, 2005; Ram et al., 2013; Rosa et al., 2013) and is also often aimed at software size estimations. Theory on this matter lacks the inclusion of for example Business Process Redesign, which is a large and expected to be highly uncertain proportion of the TCO of ERP. Cost drivers for estimating the development costs of ERP are highly immature (Heemstra & Kusters, 2005). After a literature review, it was concluded that not that much

has changed since 2005 in this aspect, and that literature on critical success factors remains the biggest input for determining cost drivers of ERP acquisition-, implementation- and usage costs.

Heemstra and Kusters (2005) distinguish cost drivers on the basis of 'size', 'what', 'for who', 'how' and 'with what'. Their cost drivers were based on literature and case studies at TPG Post and Interpolis. They found that:

- Size is an important cost driver of ERP implementation, and can be explained by the findings on three perspectives by Francalanci (2001) and von Arb (1997), which are stated below: organization size, configuration magnitude and implementation magnitude.
- The number of modules of an ERP solution is a very rough estimate, which leaves little room for nuances and should therefore be complemented with other cost drivers.
- The correlation between different cost drivers is interesting, since cost drivers are expected to correlate: like the organization size and the implementation magnitude.

As briefly touched, Francalanci (2001) and von Arb (1997) explain three measures of size of an ERP application:

- *Organization size:* describes the extent to which an organization is able to adapt. When an organization is larger, it is less likely to change or adapt fast due to the rigidness or an organization.
- *Configuration magnitude:* the nr of modules to be implemented, and the extent to which they require customization. The more modules are to be implemented, the more expensive an implementation will be.
- *Implementation magnitude:* the nr of users, the more users the more people need training.

This division in cost drivers of size is applicable to ERP implementations and this research, because it draws on both the organization and the software, which need to fit together. The fit between the ERP solution and the organization is an often-described critical success factor and cost driver of ERP implementations (e.g. Heemstra & Kusters, 2005; Ram et al., 2013; Rosa et al., 2013).

The intermediate COCOMO (Constructive Cost Model) distinguishes cost drivers on four perspectives: product drivers, computer drivers, employee drivers and project drivers (Wolfsen & Lobry, 1998). The COCOMO is aimed at the cost management of any IT project, and is therefore not necessarily directly applicable to the cost management of the implementation and usage an ERP solution for the same reasons as any other IT cost estimation model. As explained, an ERP project typically also has for example change management costs. The cost drivers of the COCOMO might be too technical for the goal of this research, but it interfaces the cost management of an ERP solution at many levels. The model therefore provides important input for this research on all perspectives.

Table 9: cost drivers of COCOMO

Category	*Cost drivers*
Product drivers	Demanded reliability of the program
	Size of databank
	Complexity of product
Computer drivers	Limitations on execution time
	Memory limitations
	Frequency of change of hardware
	Speed of job processing
Employee drivers	Capacity of analysts
	Experience with the application
	Capacity of the programmers
	Experience with underlying hard-/software
	Experience with the to be used programming language
Project drivers	Usage of advanced programming techniques
	Usage of helping devices
	Demands of project duration

Source: Wolfsen and Lobry (1998)

Especially the employee cost drivers as explained by Wolfsen and Lobry (1998) need to be extended to suit them for application on the TCO of ERP, since the influence of consultants (both the Business Integrator as well as the System Integrator) is not explicitly discussed. Both types of consultancy costs are expected to have a significant influence on the (mis)estimation of the TCO of ERP. Furthermore, the 'experience with the application' cost drivers as an employee driver means in the case of an ERP implementation at an organization that was previously not running ERP, the recruitment of new employees. Wolfsen and Lobry (1998) also describe a well-built cost management system as a success factor, which concerns the Management perspective.

The complexity of the product, which is a product cost driver, is also expected to be of much impact on the TCO of ERP. Rosa et al. (2013) explain how the complexity of an ERP solution, which is context-dependent, correlates with the dependent variables 'software engineering effort' and 'total integration effort'. Especially the total integration effort is a typical ERP implementation variable. Both variables result in both consultancy costs and costs related to internal activities. The complexity of an ERP application was operationalized as the number of RICE objects, as explained in section 1.5. The number of RICE objects, indicating complexity, is highly correlated ($r = 0.9$) to software engineering effort (Rosa et al., 2013). Complexity therefore increases the costs of an ERP system, because the software engineering effort increases. The number of users, another measure of size, is however only weakly correlated to both software engineering effort and total integration effort. This seems unexpected, since the complexity in terms of the number of RICE objects often increases as the number of users increases, since this increases the size of the entire ERP system. This

finding also contradicts Heemstra and Kusters (2005), who found that the number of users is one of the cost drivers, or determinants, of the size of an ERP system.

COCOTS is a further development of the COCOMO, and groups cost drivers into three distinct groups (Agarwal, Manish, Yogesh, Mallick, Bharadja, Anantwar, 2001):

- Cost drivers related to the experience, quality and availability of the involved people during the implementation.
- Cost drivers related to COTS (Commercial Of The Shelf) components such as maturity, complexity, update frequency of the project, support, and training.
- Cost drivers related to the application, such as reliability of the application.

Literature often lacks the precise determination of cost drivers of costs such as software, licenses, and hardware costs. However, the cost drivers underlying these costs are fairly straightforward and do not require empirical research the way more risky costs do. These costs are also expected to contain only small estimation risks, since they are known before an ERP implementation phase start. Some costs, like software and licensing costs, are contract-based, which further decreases any cost-misestimation risks, since all future costs are determined and therefore known before the implementation of the ERP system. Some costs occur during both the implementation- and usage costs phases. The underlying cost drivers sometimes slightly vary, which is for example the case with hardware costs since the implementation phase sets other requirements than the usage phase, but they match quite regularly.

Heemstra and Kusters (2005) found the key cost drivers of ERP implementation to be:

- *Software size and complexity*
- *The implementation approach and execution*
- *Contracts and relationship with vendor*
- *Quality and availability of Consultants*
- *Management commitment*
- *Project management and control*
- *Number of users*
- *Users participation*
- *IT experience and knowledge (maturity)*
- *Organizational characteristics*

Contract, a cost driver under which responsibilities and tasks are defined, was found to be an important cost driver from theory. This cost driver was however not specifically made relevant at the case studies at TPG Post and Interpolis. Heemstra and Kusters (2005) expect such organizations to find such a cost driver to be self-evident for their organization in any project. This then holds across all projects and is therefore not specifically mentioned as a cost driver or critical success factors, even though it likely is.

The existing literature on the critical success factors of ERP usually concerns the success factors of ERP implementation (e.g. Ram et al, 2013; Rosa et al., 2013). Many success factors are expected to have an effect on the TCO of ERP, but are not always directly controllable. Ram et al. (2013) provide a table of a literature review on the critical success factors (CSFs) of ERP. The CSFs that are expected to be of a direct influence on the estimation of the TCO of ERP were picked from this list. The full literature review by Ram et al. (2013) is added under appendix C. The list of CSF's is quite extensive and various. It is therefore doubtful whether each and every success factor is in fact critical. For now, the success factors will still be referred to as CSF, and this important point will be treated further in chapter four. The applicable CSFs were divided into the four perspectives of ERP cost estimation as described in section 3.1.

Table 10: critical success factors of ERP implementation

Perspective	*Critical Success Factor*
Management	Project management and evaluation/project management capabilities
	Business plan and vision / build a business case
	Project champion/sponsor
	Project team composition
	Quality of ERP consultants
	Sustained (top) management support
	Steering committee
	Charismatic leadership
	Implementation strategy/approach
	Formal project plan / schedule
Process	Integration of business processes
	Fit between ERP and organization
	Organizational transformation
	Structural readiness
People	Employee/user training and education
	User involvement, participation and support
	Management of expectations
IT	Minimum customisation
	System quality
	ERP Vendor support
	Careful package selection
	Data analysis, conversion and integrity

Source: Ram et al. (2013)

Since these are success factors of ERP implementation, they are applicable to higher maturity levels of ERP cost estimation. They however also provide input for lower levels of ERP cost estimation, such as a partially met level of this CSF. An example is an ERP project plan. In a high level of cost estimation, this project plan is often updated, while this is not the case in a lower level of cost estimation. Many other CSFs can be used in a similar way. The CSFs that

were described by Ram et al. (2013) were transformed into cost drivers when possible, following the approach of Heemstra and Kusters (2005).

All cost drivers were added with the appropriate perspective of the eventual maturity model, as explained in section 3.1. This creates the possibility of adding or averaging the weights of all cost drivers in one perspective, as an indicator for the total weight of the perspective. The weights of the cost drivers, as identified in the survey at KPMG and explained in section 2.2, will also be added. In the exceptional case of a cost driver being applicable to more than one perspective, the perspective that it was most applicable to was selected. Multiple cost drivers are expected to correlate, but the sufficient data to test such a correlation is unfortunately not available. Some cost drivers, such as consultancy cost drive, also have an influence on other costs and cost drivers, such as BPR efforts. Since most consultancy cost drivers belong to the Management perspective, and most BPR cost drivers belong to the process perspective, this would mean multiple perspectives are also expected to correlate.

Even though a large proportion of the costs of an ERP system are attributable to external factors, such as consultancy costs and software licenses, this all remains the responsibility of the management. The cost drivers and success factors that for example influence consultancy costs, such as the availability, experience, and quality of consultants (cost drivers one and two), are the responsibility of the management and therefore added under the Management perspective. A second example is the availability of training. Even though this could be added under the People perspective, this concerns a management responsibility.

It can be noted that some cost drivers are added more than once. In most cases they are added twice, but process standardization and harmonization is added three times. Since these cost drivers or CSFs are expected to be highly important on more than one cost category, they are added to the relevant categories. Different weights per category may possibly be found.

Table 11: Cost drivers during the acquisition and implementation phase of ERP

	Cost category	*Nr*	*Cost drivers*	*References*	*Perspective*
Acquisition phase	Consultancy	1	Availability of consultants	Heemstra & Kusters (2005)	Management
		2	Experience and quality of consultants	Heemstra & Kusters (2005), Wolfsen & Lobry (1998)	Management
		3	Process standardization and harmonization	Heemstra & Kusters (2005), Ram et al. (2013), Rosa et al. (2013) KPMG	Process
		4	Pressure due to cutting project duration	Wolfsen & Lobry (1998), KPMG	Management
		5	Sound ERP project plan	Ram et al. (2013), KPMG	Management
	Other acquisition costs	6	Project organization with key decision maker / champion	Heemstra & Kusters (2005), Ram et al. (2013), KPMG	Management
		7	Project organization with key subject matter expert	KPMG	Management

		8	Management commitment	Heemstra & Kusters (2005), Ram et al. (2013), Rosa et al. (2013)	Management
Implementation phase	Consultancy	9	Availability of consultants	Heemstra & Kusters (2005), Vathanophas (2007)	Management
		10	Experience and quality of consultants	Heemstra & Kusters (2005), Wolfsen & Lobry (1998)	Management
		11	Process standardization and harmonization	Heemstra & Kusters (2005), Ram et al. (2013), Rosa et al. (2013) KPMG	Process
		12	Configuration-, and customization magnitude, number of RICE objects	Francalanci (2001), Von Arb (1997), Heemstra & Kusters (2005), Rosa et al. (2013), KPMG	IT
		13	Pressure due to cutting project duration	Wolfsen & Lobry (1998), KPMG	Management
		14	Implementation approach	Heemstra & Kusters (2005)	Management
		15	Complexity of data conversion	Heemstra & Kusters (2005), KPMG	IT
		16	Coherence between implemented modules	Heemstra & Kusters (2005)	IT
		17	Management commitment	Heemstra & Kusters (2005), Ram et al. (2013), Rosa et al. (2013)	Management
		18	Monitoring and performance management	KPMG	Management
	Software & Licenses	19	Number of users	Heemstra & Kusters (2005), KPMG, Ram et al. (2013)	People
		20	Breadth and depth of ERP solution	KPMG	IT
		21	Number of user groups	Heemstra & Kusters (2005), KPMG	IT
		22	Number of modules	Heemstra & Kusters (2005)	IT
	Hardware	23	Required hardware		IT
		24	Required data storage		IT
	Business Process Redesign (BPR)	25	Required degree of BPR	Heemstra & Kusters (2005), KPMG	Process
		26	Nr and complexity of involved processes	Heemstra & Kusters (2005), Rosa et al. (2013).	IT
		27	Process standardization and harmonization	KPMG	Process
		28	Nr and complexity of interfaces	Heemstra & Kusters (2005)	IT
		29	Nr and complexity of transactions	Heemstra & Kusters (2005), KPMG	IT
		30	Fit between organization and ERP system	Heemstra & Kusters (2005), KPMG	Process
	Training	31	Required effort of employee/user training	Heemstra & Kusters (2005), KPMG	People
		32	Training effort realized in practice	KPMG	Management
		33	Current quality of employees	Heemstra & Kusters (2005)	People

		34	Availability of training	Rosa et al. (2013)	Management
		35	Availability of users	KPMG	People
	Other impl. costs	36	Maturity of project organization (e.g. contracts)	Heemstra & Kusters (2005), KPMG	Management
		37	Sound testing plan and execution	Heemstra & Kusters (2005), KPMG	IT

Note: Cost drivers that were determined in interviews with KPMG are marked 'KPMG' as a reference.

Table 12: Cost drivers during the usage phase of ERP

	Cost category	*Nr*	*Cost drivers*	*References*	
Usage phase	Software & Licenses	38	SaaS contracts	KPMG	IT
		39	Future licensing policies	Heemstra & Kusters (2005)	IT
		40	Introduction of new information flows and processes	KPMG	Process
	Hardware	41	Frequency of change of hardware	Wolfsen & Lobry (1998)	IT
		42	Fixed price trough service agreement	KPMG	IT
		43	Hosting	Monczka et al. (2010), Evestes et al. (2001), KPMG	IT
	Training	44	Continuity of the employees	Heemstra & Kusters (2005), KPMG	People
		45	Technological changes in ERP software	KPMG	IT
	Usage	46	Costs of facilitating ERP	Pisello & Strassman (2001)	IT
	Maintenance	47	Technological changes in ERP software	KPMG	IT
		48	Frequency in change of demands	KPMG	Process
		49	Availability of upgrades / new applications	KPMG	IT
	Support	50	Support contracts	Pisello & Strassman (2001)	IT
		51	Availability of upgrades / new applications	KPMG	IT
	Personnel	52	IT personnel	KPMG	People

Note: Cost drivers that were determined in interviews with KPMG are marked 'KPMG' as a reference.

Many of the cost drivers that are indicated as belonging to the People perspective are expected to be of a limited direct influence on the misestimation of the TCO of ERP, compared to the three other perspectives. However, the importance and influence of the People components is undeniable. Leaving out individual cost drivers due to their low expected influence on estimating the TCO of ERP is uncertain. For this reason, these specific cost drivers, especially the cost drivers that are related to training, are left in. The questionnaire will point out their weights, and a better advised choice can then be made.

After classifying all cost drivers on the four perspectives, Management was discovered to have no cost drivers at all throughout the usage phase. The Process perspective was represented with only two cost drivers, and People with only one cost driver in the entire usage phase. Since most decisions that influence the usage phase are taken in the acquisition- and implementation phase, this finding is regarded as not that surprising. As long as the TCO of ERP is seen and used as a complete ERP life cycle calculation, and not to estimate the TCO of separate life cycle stages, this is expected to pose no threats to this research.

As briefly explained, it can be argued that not all critical success factors as explained by Ram et al. (2013) are in fact critical. In reality, it is likely that not all critical success factors are met in a very successful ERP implementation. However, the importance of these factors is undeniable, but it is likely they are in fact success factors. The extent to which these success factors are critical might be context dependent and could therefore differ per ERP implementation.

Discussion

Limitations

A major issue within this research is the absence of data and the inferences, or rather their limitations, which can be made on the basis of literature that was not intended for his specific goal. A similar research or model that describes the factors that determine the TCO of ERP, and describes four perspectives of organizational maturity that control the TCO of ERP, is non-existent so far. From a criticism point of view the absence of data and the possible limitations of inferences that can be made using this model is a valid argument, but like other 'pioneering' researches, this is the first major step to a very valuable framework for determined organizational characteristics that are able to significantly reduce the quite frequent budget overruns of the predetermined TCO of ERP. This maturity model has a level managerial relevance, since organizations can potentially start using the model tomorrow. Besides reducing misestimations of the TCO of ERP, the model leads to a better rating of the organizational readiness of ERP on more levels than only IT, and it is suitable to be used as a change management tool to increase the maturity and readiness of an organization for ERP.

A second potential point of critique, which is mainly an entrepreneurial issue, is based on whether or not a company always wants to be rated at the highest level of maturity on each perspective. It must be emphasize that this has never been argued throughout this research. The construct of 'best-practice' was deliberately avoided during this research, since it is uncertain whether 'best-practice' exists at all. Especially considering the fast-moving developments around IT and ERP, the characteristics of a 'best-practice' maturity constantly change. Furthermore, it can be argued that best-practice implies that no better practice exists, and therefore reduces any risk to a minimum. However, returning to the discussion whether an organization should always score the highest level on all perspectives, the answer is probably 'no'. However, the awareness of all risks within estimating the TCO of ERP, and therefore being able to take the rational decision to accept a certain degree of risk to avoid a certain investment, already indicates a high level of maturity. This could mean that an organization therefore scores on average a level two or three maturity, while it in potential could be a level four since some characteristics, containing certain risks, are rated level four.

Concerning the data collection method, the simplified representation of the required investment, the probability of occurrence, and the potential impact, all being measured at a three-point scale, was a conscious decision. The abstract description of the cost drivers and the low sample size within KPMG did not allow for a high variety of answers being properly included. This would also lead to more threats of misinterpretation. Such data was also not expected to lead to more information considering the scope and goal of this research. As explained, the delivered maturity model is a first step to a very valuable management tool for

ERP projects, in particular their cost management. A larger dataset is required to test this framework on its validity.

Future research on the TCO of ERP

Referring back to section 4.3, developing a larger dataset is also partly the responsibility of the ERP-using organizations. A higher maturity and therefore the usage of more sophisticated cost management systems, leads to more data, which is in its turn of a higher quality. Due to this data, more input is available for a better and more accurate description of maturity levels, which in its turn again leads to a more thorough data collection. This evolution essentially represents an upward spiral. Additional data would also point out the differences in weights between probability and potential impact of a cost driver and could determine which success factors are in fact critical in any ERP implementation, and which are not. This could also lead to more theory on the implementation strategy, which is highly important factor but largely unknown terrain when referring to its effect on the TCO of ERP. Future research could proceed here, since it is expected that the importance of some factors differ per implementation approach. A larger dataset is also expected to shed more light on the importance of the Management perspective. Factors within Management were indicated as of high importance in the questionnaire, but not as important as literature describes. This could be due to the data sample, which exists fully of consultants within KPMG IT Advisory. The collection of a larger dataset that includes organizations of all kinds is expected to highlight the importance of the Management perspective, which essentially determines all other perspectives. Management might therefore in the future possibly be seen as an overarching perspective within the model.

Another advantage for organizations to take part in such a research, especially when it is on a large scale, is that it allows to set benchmarks of maturity within for example a certain industry or country. The industry average, or the top-performers, could then become the benchmark, instead of a level-four maturity on each perspective. Better availability of data would also likely mean that research agencies such as Gartner, who already produce IT-benchmarks, could start producing ERP-specific benchmarks.

A second field of desired research within ERP is the benefits that organizations aim to achieve through ERP, which are the main reasons for an organization to start using ERP in the first place. Even though this area is far more developed than research on the costs of ERP, such research would make the full calculation of an NPV possible, which in its turn leads to a better cost management of ERP systems, and therefore to a higher maturity in terms of estimating the TCO of ERP. The model that has been developed in this research could also be used for estimating and realising the benefits of ERP. The model could set certain conditions, in which the intended goals are more likely to be realized, which represents a similar setup as compared to this research.

Conclusion

This research will be concluded in the same manner as the structure that has been present throughout this research: based on the order of the research questions. The answers to the nine sub research questions as were identified in this research will therefore first be discussed followed by an overall conclusion of this research. The first four research questions were answered in the theoretical framework of this research, which led to a second set of five sub research questions. The steps that have been taken during this design-oriented process allow for new insights to arise during the process of doing research on the desired deliverable due to the iterative character of this research. Some questions that are related are discussed simultaneously.

Sub research questions

1. *What is according to the literature the appropriate, or least problematic, valuation model for valuating all cash flows out, related to an ERP investment over its entire life cycle?*

This research has shown that the TCO of ERP is highly context-dependent, and is not only dependent on size. A generalizable calculation of the TCO of ERP based on for example the number of users therefore proved to be impossible. However, the way the TCO of ERP is calculated is highly important, and influences the Management perspective later on in this research. The PV-TCO was proposed, which is the Present Value of the Total Cost of Ownership. An ERP solution is a long-term investment, which means that when calculating future cash flows the time-value of these cash flows must be considered. The PV-TCO does this, since it adjusts cash flows to their present value by discounting. The discount rate is dependent on the risk that is present in the ERP implementation, and is often higher than only the cost of capital of an organization. Furthermore, tax considerations should be included since they significantly influence future cash flows as a result of ERP implementation, due to depreciations. The valuation model is only included slightly in the eventual maturity model, but it does represent a very important aspect of an ERP cost management.

2. *What is the duration of the entire life cycle of an ERP solution, and from what stages does it exist?*

Research by Gartner (2006) has shown that the life cycle of an ERP solution has an average duration of seven to ten years. The phases of the ERP life cycle have been discussed and determined in section 1.3 based on research by Aloini et al. (2007), which are the acquisition-, the implementation-, and the usage phase. This distinction in phases has been kept throughout this research, mainly due to their chronological distinction. Aloini et al. (2007) have shown the amount of resources required per phase (figure one), which is at its maximum during the usage phase. This shows the importance of including the usage phase in the TCO of ERP, since leaving out the significant usage costs of ERP highly biases the TCO of ERP and is therefore very likely to lead to wrong decision-making.

3. *Which are the different types and categories of costs over the entire life cycle of an ERP solution, both direct and indirect, and internal and external?*

To answer this sub question, the chronological distinction in the life-cycle phases of ERP has been applied. The different categories and types of costs have therefore been distinguished on the basis of the acquisition-, the implementation- and the usage phase. The complete tables two and three that describe all costs along the ERP life-cycle with references can be found on pages seventeen and eighteen, and in a more elaborate form in appendices A and B. This overview also shows the significance of the usage phase, which consists of many cost categories.

Table 25: summary of all costs of ERP along the entire ERP life cycle

Acquisition costs	Consultancy
	Other costs
Implementation costs	Consultancy
	Software & Licenses
	Hardware
	Business Process Redesign (BPR)
	Training
	Other costs
Usage costs	Software & Licenses
	Hardware
	Training
	Usage
	Maintenance
	Support
	Personnel

Rosa et al. (2013) have comprised an overview of the distribution of all costs within the TCO of ERP, which shows that the costs of the vendor's implementation team account for 38% of all costs. Such overviews show the significance of other costs than internal costs. Other research (e.g. De Koning, 2004) has shown that many organizations lack the inclusion of human resources costs within the ERP budget. This indicates a very low maturity of cost-estimation of ERP, considering the impact of for example the implementation team costs.

4. *What is the influence of the risks involved in controlling the costs of implementing and using an ERP solution on the calculation of the TCO of ERP and on the weighing factor of the different cost factors?*

The risks in ERP implementation are considered high. Phelan (Gartner, 2006) for example found that 40% of the ERP projects exceeded time and budget with at least 50%. Considering the magnitude of ERP investments, such budget overruns could have dramatic consequences for organizations. A certain, but likely not full, explanation for such budget overruns are the

low maturity of ERP cost estimation. Many organizations do not budget all costs associated with ERP (e.g. Heemstra & Kusters, 2005; De Koning, 2004; Wijkstra, 1999; Wu et al., 2008). An important success factor in ERP, and a risk if not applied properly, is a minimum amount of customization of ERP (Rosa et al., 2013). This mainly influences System Integrator (SI) and Business Process Redesign costs. All risks that were identified can be seen as cost-misestimation risks. Many risks influence the extent to which the aimed benefits of ERP can be achieved. The importance of such risks is undeniable, but their direct influence on the extent to which the TCO of ERP can reliably be estimated is uncertain.

Other important risks that influence cost-misestimation of the TCO of ERP (e.g. Heemstra & Kusters, 2005; Rosa et al., 2013; Sumner, 2000) are a mismatch between the organization and the ERP system, a lack of experience of the implementation team, a lack of adaption to the ERP solution, and planning and integrating problems. All risks have been linked to the cost categories that have been identified to answer sub question three, and the full tables six and seven which link all risks to their relevant cost categories can be found on pages 24 - 25.

5. *Which perspectives should be applied in a maturity model that describes an organization's ERP cost-estimation maturity?*

The tables that distinguish all costs and risks associated with ERP along the entire ERP life cycle, show that ERP cannot be considered to be an IT project only. Many other factors, such as management and processes within ERP also influence the extent to which the TCO of ERP can be reliably estimated. To develop a model that describes the maturity of ERP cost estimation, four perspectives have been identified, that all have a specific influence on the reliability of the estimation of the TCO of ERP. A higher maturity on each aspect indicates that the estimate of the TCO of ERP is more reliable than at a lower maturity. The four perspectives that have been chosen are Management, IT, Process, and People.

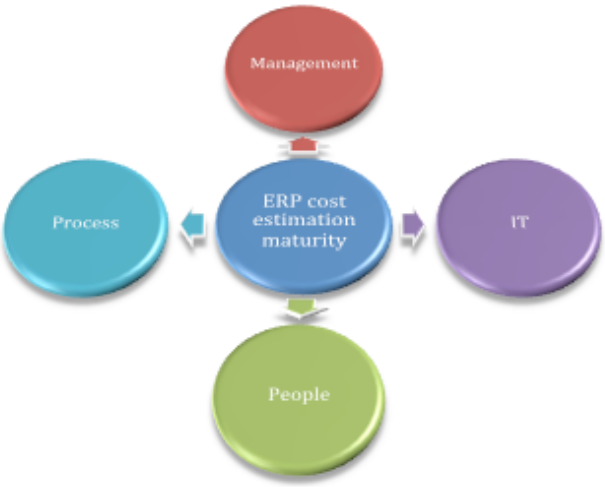

Figure 8: four perspectives of organization-wide ERP cost-estimation maturity

6. *What cost drivers and related risks need to be controlled to provide organizations with a more reliable estimation of the TCO of ERP, which improves the cost-estimation maturity of ERP of an organization?*

7. *What can be seen as success factors for reducing estimation risks of the TCO of ERP, indicating the maximum level of maturity of ERP cost-estimation?*

Many cost drivers that are discussed at ERP projects are cost drivers that are related to the size of the solution, such as the number of users, the configuration magnitude and the implementation magnitude (Francalanci, 2001; Von Arb, 1997). Such measures however do not fully explain the TCO of ERP (Heemstra & Kustes, 2005). To make sure all cost categories of ERP of this research as shown in table 25, this same table has been used as a basis for describing all cost drivers found in literature. Literature on the cost drivers of IT projects is often used as a basis, because ERP is not largely available. This is why some researchers use critical success factors instead (e.g. Heemstra & Kusters, 2005). Rosa et al. (2013) provide a literature review of all critical success factors of ERP, which is added under appendix C. It is uncertain whether all success factors that are explained can actually be considered critical, because it is well possible that ERP implementations could be very successful even though certain success factors are not fully covered. All cost drivers what were identified in literature after an extensive literature review and identified in interviews with KPMG have been added in tables eleven and twelve on pages 42 - 44. The four perspectives that will be used to describe the maturity model are also added to identify which cost drivers influence which perspective.

Main research question

- *Which factors determine and control the Total Cost of Ownership of an ERP solution?*

The factors that determine and control the TCO of ERP, are all costs, risks and related cost drivers within the TCO of ERP. These factors were divided over four perspectives, which together form a maturity model that describes the organizational readiness for ERP. Such a maturity that describes actions which lead to a more reliable cost-management of ERP has until not been inexistent. A higher maturity of organizational readiness of ERP makes for an organization to be able to produce a more reliable estimate of the TCO of ERP since the costs, risks and cost drivers that determine the TCO of ERP are controlled to higher extent. This maturity model enables organizations to rate their maturity. It is also able to help organizations increase their maturity, to minimize the large misestimations of the TCO of ERP, based on a set of organizational characteristics. A remarkable finding was that the Management perspective was found to contain no risks of the highest category, even though this is an often seen critical success factor in literature. This finding can possibly be explained by the sample in which the data was collected, which consisted of KPMG ERP Consultants only. These consultants can already be seen as a highly mature, given the context

of this model, and might consider certain factors as self-evident. Management can likely be seen as a highly important perspective that determines many, or all, of the factors in the other perspectives and might therefore actually be seen as an overarching perspective.

The results of this research also shed light on a very important other finding: that ERP implementations are definitely not only IT projects. Based on the indicated required investments of all perspectives, the IT perspective as a total scored an average required investment, which leaves three other highly important aspects that also determine and control the TCO of ERP, and therefore control the readiness of an organization to implement and use ERP. This is expected to be an important eye-opener for many organizations, and especially their management.

The next step for academics is the addition of extensive data to test this model, since it is based on the logical interpretation of extensive literature reviews and a small questionnaire within a group of highly experienced ERP-consultants at KPMG. This process essentially represents and upward spiral, since a higher maturity of organizations is described to lead to more data of a higher quality (Verhoef, 2005), which in its turn increases maturity. The delivered maturity model holds a significant commercial value for KPMG, and is potentially very valuable for practitioners, because it allows organizations to be rated on their organizational readiness for ERP, and therefore the extent to which the TCO of ERP could possibly deviate from the pre-estimated budget. The magnitude of an ERP investment causes significant problems for organizations in the case of a major budget overrun due to for example financing consequences, which could be prevented using this maturity model.

Recommendations

The model that has been developed in this research is aimed for the internal use by KPMG, which now allows KPMG to rate organization on their maturity and organizational readiness for ERP based on a fixed set of characteristics. KPMG can therefore rate the likeliness of the TCO of ERP deviating significantly from the budget. An important recommendation for KPMG is to initiate efforts to gather data on this aspect, for example based on existing customers. This is important for any research that concerns the costs of ERP, since the amount data on this aspect, especially outside IT-specific costs, is highly inadequate. In the future, this model can then be tested, and inferences can be made on the maximum deviation of the budget, when rating a certain maturity at a client. The model is also suitable for guiding a trajectory of change management, to increase a client's maturity.

Future academics will for now not be able to use the developed model, since it is confidential, but can build on the bridges that have been made between the costs, risks, cost drivers and 'critical' success factors of ERP. Future research is necessary, and the development of a database based on tables six and seven on pages 24 and 25 is an excellent start.

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Appendices - table of contents

Appendix A: Acquisition- and implementation costs of ERP

Category	Costs	References
Acquisition		
Consultancy	Consultancy costs: business integrator	Nah (2002), Wagle (1998)
	Sourcing	Moncka et al (2010)
Other acquisition costs	Decision making costs	Nah (2002)
Implementation		
Consultancy	Consultancy costs: business integrator	Nah (2002), Wagle (1998)
	Consultancy costs: system integrator	Nah (2002), Wagle (1998)
	Sourcing	Moncka et al (2010)
	Support staff	KPMG
Software & Licenses	Operating system licenses	Nah (2002), ERP softwareblog (2010), Pisello & Strassman (2001), Wagle (1998)
	Server licenses	Pisello & Strassman (2001)
	Supporting software	ERP softwareblog (2010)
	System specification	Nah (2002)
	Customization (intangible)	Nah (2002)
	Migration	Computable (2006)
Hardware	Servers	Computable (2006), Pisello & Strassman (2001), Wagle (1998)
	Computers (workstations etc)	Computable (2006), Pisello & Strassman (2001)
	Network	Computable (2006), Pisello & Strassman (2001)
Business process redesign	BPR costs	Nah (2002), Heemstra & Kusters (2005)
	Internal resources	
Training	Costs of training and education	Agilent Tech, Pisello & Strassman (2001)
	Technology training	Computable (2006)
Other implementation costs	Time spent by staff (intangible)	Nah (2002), Wagle (1998)
	Testing costs	Pisello & Strassman (2001)
	Opportunity costs (intangible)	Nah (2002)

Appendix B: Usage costs of ERP

Category	Costs	References
Usage costs		
Software & Licenses	Operating system licenses	Nah (2002), ERP softwareblog (2010), Pisello & Strassman (2001), Wagle (1998)
	Server licenses	Pisello & Strassman (2001)
	Supporting software	ERP softwareblog (2010)
	System specification	Nah (2002)
	System adaptation	Nah (2002)
	Costs of new applications	Nah (2002)
Hardware	Hosting costs	Monczka et al. (2010), Wagle (1998)
	Purchases of new hardware	Wagle (1998)
	Equiment leasing	Pisello & Strassman (2001)
Training	Continuous training and learning	Pisello & Strassman (2001)
Usage costs	Costs of facilities (electricity etc)	Agilent Tech, Pisello & Strassman (2001)
Maintenance	Costs of (preventive) maintenance / technical support	Agilent Tech, ERP softwareblog (2010), Pisello & Strassman (2001)
	Costs of repairs (repair frequency?)	Agilent Tech, ERP softwareblog (2010)
	Costs of technology refresh / new applications / Upgrades / continued development / Testing costs	Agilent, Nah (2002), Computable (2006), ERP softwareblog (2010), Pisello & Strassman (2001)
	Downtime	Computable (2006)
	Backup/recovery process	Computable (2006)
	Security	Computable (2006)
Support	Support costs, several lines/tiers (support contracts?)	Pisello & Strassman (2001), SAP project KPMG, Wagle (1998)
	Technical support	ERP softwareblog (2010)
Personnel costs	IT personnel	Computable (2006)
	Diminished performance	Computable (2006)
	New employees: shortage of qualified personel	KPMGs

Appendix C: CSFs of ERP implementation Ram et al. (2013)

Identified as a CSF to ERP implementation stage	*References of studies that have identified the CSF*
Cultural and structural changes/readiness/ organisational culture	Dezdar and Sulaiman (2009); Motwani et al. (2002), (2005)
Project management and evaluation/project management capabilities	Dezdar and Sulaiman (2009), Finney and Corbett (2007), Snider et al. (2009), Somers and Nelson (2004), Motwani et al. (2002)
Business plan and vision	Al-Mashari et al. (2003), Dezdar and Sulaiman (2009), Finney and Corbett (2007), Nah and Delgado (2006)
Enterprise wide communication/strong communication inwards and outwards	Dezdar and Sulaiman (2009), Finney and Corbett (2007)
Project champion/sponsor	Dezdar and Sulaiman (2009), Finney and Corbett (2007)
BPR and minimum customisation/software configuration/integration of business processes	Al-Mashari et al. (2003), Bingi et al. (1999), Dezdar and Sulaiman (2009), Finney and Corbett (2007), Motwani et al. (2005), Nah and Delgado (2006); Somers and Nelson (2004), Vathanophas (2007)
Training employees/user training and education/ job redesign	Dezdar and Sulaiman (2009), Finney and Corbett (2007), Snider et al. (2009), Vathanophas (2007)
Teamwork and project team composition, competence and compensation/selecting the right employees/balanced team/small internal teams	Bingi et al. (1999), Dezdar and Sulaiman (2009), Finney and Corbett (2007), Plant and Willcocks (2007), Snider et al. (2009), Somers and Nelson (2004)
System quality	Dezdar and Sulaiman (2009), Ram et al., (2013b)
ERP vendor support	Bingi et al. (1999), Dezdar and Sulaiman (2009), Somers and Nelson (2004)
ERP consultants/consultant quality/use of consultants/qualified consultants	Finney and Corbett (2007), Somers and Nelson (2004), Snider et al. (2009)
System integration	Al-Mashari et al. (2003), Bingi et al. (1999)
User involvement, participation and support	Dezdar and Sulaiman (2009)
Sustained (top) management support/commitment	Dezdar and Sulaiman (2009), Finney and Corbett (2007), Nah and Delgado (2006), Plant and Willcocks (2007), Snider et al. (2009)
Interdepartmental (enterprise-wide) cooperation/ communication	Dezdar and Sulaiman (2009), Plant and Willcocks (2007), Somers and Nelson (2004)
Steering committee	Somers and Nelson (2004)
Management of expectations	Somers and Nelson (2004)
Careful package selection	Dezdar and Sulaiman (2009), Finney and Corbett (2007), Somers and Nelson (2004), Vathanophas (2007)
Data analysis, conversion and integrity	Finney and Corbett (2007), Somers and Nelson (2004)
Charismatic leadership	Wang et al. (2005)
Fit between ERP and organization	Baki and Cakar (2005)
Implementation strategy & time frame	Finney and Corbett (2007)
Vanilla ERP	Finney and Corbett (2007)
Build a business case	Finney and Corbett (2007)
Implementation approach	Vathanophas (2007)
Organisational transformation and software migration	Vathanophas (2007)
Formal project plan/schedule	Bingi et al. (1999)