Quantifying usability
A research on quantifying usability activities in a software development process

Master thesis
Barneveld / Amsterdam
January 2002 – August 2002

Supervision
prof. dr. R. de Hoog
Department of Social Science Informatics
University of Amsterdam

Michael Bosch
Kelvin Geerlings
ir. H. Vons
Usability Consultancy
Baan Development
Abstract

This master thesis describes the results of a literature study and a case study conducted at Usability Consultancy of Baan.
“Usability” was a so-called buzzword in the 90’s and gained the attention of many companies. Is performing usability activities profitable within a software development life cycle? This is the question that we try to answer with this research.
This needs to be done because the cost savings from better usability are not always directly visible to a development organization.

During the literature study we investigated what kind of cost benefit calculation methods can be used to quantify usability activities in a software development process. After this a case study is being performed within Baan, using the most suitable calculation methods found during the literature study. In doing this a quantification of usability activities within the Baan development process can be presented.

The methods that are used by us are all taken from Bias and Mayhew (1994), however we had to adjust these methods to make them applicable for the situation within Baan.

The goals that we fulfilled during this research are both scientific as well as Baan specific.
The first scientific goal was to find out which methods are suitable to measure costs and benefits in the field of usability engineering.
The second scientific goal was to make an abstract term like usability “suitable” for a concrete quantification in dollars. This way one can find out if usability activities are beneficial to perform on a software product.
The first Baan goal was find out which of the cost benefit calculation methods can best be used to quantify their usability activities.
The second Baan goal was to quantify the usability activities of the Baan usability consultants in terms of costs and benefits.
The third Baan goal was to give advise for the improvement of the usability activities within Baan when taking our cost benefit analysis in consideration.
A goal for Baan, as well as for the university, was to give a description of how appropriate the used model was for this research.

Keywords: Cost-benefit calculation methods; Cost justification of usability; Usability
General Introduction

This report describes the added value of usability design within a development process, the abstract term usability is being quantified in dollars. This is done because the cost savings in dollars from better usability are not always directly visible to a development organization.

It is also our master thesis performed for the Department of Social Science Informatics (SWI) at the University of Amsterdam. The contractor for this research is Baan, located at Barneveld. The research is being conducted at Usability Consultancy, which is part of Baan Development.

In Chapter 1 the details about this research will be described. The problem statement, problem space and research methods and model will be described. Chapter 2 is the literature review. We will explain what usability is, what benefits usability has for an organization and what a cost-benefit calculation is. The most important parts of this chapter are the parts where the different calculation methods will be described and compared with each other. In Chapter 3 an overview is given of Baan and the Baan usability department. The usability activities, which the usability consultants perform, will be explained. Chapter 4 will explain different research options. A decision will be made which will be used in the research. This decision will be based on available data, available product and on the advise of the usability consultants. Also there will be decided which product is chosen to be used as a subject in this research. Chapter 5 will describe which cost-benefit calculation method should be used for this research. This decision is based on decision variables like which data is available at Baan, etc. In Chapter 6 an overview will be given of the product that was chosen. Chapter 7 will describe the costs that are made for ThinBaan. It will give an overview for costs per activity and per product. In Chapter 8 the benefits of ThinBaan will be described. This will be done via two different scenarios a conservative one and an average one. In Chapter 9 an overview will be given of the costs and benefits. The result will be distributed over the different activities by two different models. Chapter 10 describes the applicability of the method which has been used and its limitations.

The numerical data shown in this report is fictitious and shows no relation to Baan figures. The product names that are used are fictitious and show no relation to Baan products.
Index

Abstract ........................................................................................................................................ i

General Introduction .................................................................................................................. ii

Index ........................................................................................................................................ iii

Chapter 1

1.1 Introduction........................................................................................................................... 7

1.2 Problem Statement ................................................................................................................. 7

1.3 Overview of the problem space .............................................................................................. 7

1.4 Research method and model ................................................................................................. 10

1.5 Research limitations............................................................................................................... 12

Chapter 2

2.1 Introduction........................................................................................................................... 13

2.2 Usability explained ............................................................................................................... 13

2.3 The problem of measuring ................................................................................................ 15

2.4 Cost-benefit analysis ........................................................................................................... 16

2.5 Cost-benefit calculation methodologies .............................................................................. 24

2.6 General cost-benefit calculation methods ....................................................................... 28

2.6.1 Cost calculation methods ............................................................................................... 28

2.6.2 Benefit calculation methods .......................................................................................... 33

2.7 Information system calculation methods ........................................................................... 37

2.7.1 Cost calculation methods .............................................................................................. 37

2.7.2 Benefit calculation methods .......................................................................................... 37

2.8 Usability calculation methods ........................................................................................... 43

2.8.1 Cost calculation method ............................................................................................... 43

2.8.2 Benefit calculation method ........................................................................................... 44

2.9 Summary of cost-benefit calculation methods ................................................................. 46

2.10 Conclusions ....................................................................................................................... 52

Chapter 3

3.1 Introduction........................................................................................................................... 54

3.2 Overview Baan organization .............................................................................................. 54

3.3 Baan development process ................................................................................................. 56

3.3.1 Introduction.................................................................................................................... 56

3.3.2 Baan development methodology: DMethod ................................................................. 56

3.3.3 Stages in the development process: ............................................................................ 57

3.4 Baan usability activities within the development process ................................................. 59

3.4.1 Usability techniques used .............................................................................................. 60

3.4.2 Conceptual Solution ....................................................................................................... 60

3.4.3 Task Analysis ................................................................................................................. 60

3.4.4 Task Design ................................................................................................................... 60

3.4.5 Conceptual Usability Design ......................................................................................... 61

3.4.6 Prototyping .................................................................................................................... 61

3.4.7 Usability Walkthrough ................................................................................................ 61

3.4.8 Other Usability Activities ............................................................................................ 62

3.4.9 Promoting Usability in General .................................................................................. 62

3.4.10 Further Embedding of Usability in DMethod ............................................................ 63

3.4.11 Usability Reviews and Audits ..................................................................................... 63

3.4.12 Style Guides and Usability Checklists ........................................................................ 64

3.4.13 Assisting in Realization ............................................................................................... 64

3.5 Focus on usability activities ............................................................................................... 64

3.5.1 Questionnaire focus on usability activities ..................................................................... 68

3.6 Positioning of usability activities within Baan ................................................................. 72

3.6.1 Questionnaire positioning of usability activities within Baan ..................................... 73

3.7 Conclusions from questionnaires regarding our cost benefit analysis .............................. 73
Chapter 4  
Research options................................................................. 75
  4.1  Introduction........................................................................ 75
  4.2  Research options............................................................ 75
  4.2.1  Research option 1: Product with no usability activities...... 75
  4.2.2  Research option 2: Two versions of a product with and without usability design...... 75
  4.2.3  Research option 3: A product with usability design............ 76
  4.2.4  Research option 4: A product with no comparison of different versions.............. 76
  4.2.5  Research option 5: A combination of the different research options................. 77
  4.2.6  Visualization of what is known for the first tree different research options........ 77
  4.3  Choice of which research option and products will be taken.......... 78
  4.3.1  Theoretical.................................................................... 78
  4.3.2  Practical....................................................................... 79
  4.4  Conclusion....................................................................... 81

Chapter 5  
Decision on Cost-Benefit Calculation Methods................. 82
  5.1  Introduction....................................................................... 82
  5.2  Decision variables .......................................................... 82
  5.3  Data sources .................................................................... 86
  5.4  The methods that will be used.......................................... 92
  5.5  Conclusion....................................................................... 94

Chapter 6  
Case: ThinBaan................................................................. 95
  6.1  Introduction....................................................................... 95
  6.2  Context ThinBaan within Baan........................................ 95
  6.3  Usability consultancy in relation to ThinBaan.................... 95
  6.4  Usability consultant’s effort on ThinBaan.......................... 95
  6.5  Conclusion....................................................................... 96

Chapter 7  
Costs of usability.............................................................. 97
  7.1  Introduction....................................................................... 97
  7.2  Activities performed on ThinBaan.................................... 97
  7.3  Distributing hours over activities..................................... 98
  7.4  Costs by activity............................................................... 100
  7.5  Costs by product.............................................................. 101
  7.6  Conclusion....................................................................... 102

Chapter 8  
Benefits of usability ....................................................... 104
  8.1  Introduction....................................................................... 104
  8.2  Frequently used numbers and definitions....................... 104
  8.3  Inventory Customer Service & Support............................ 105
  8.3.1  The Support Group Process........................................ 105
  8.3.2  The PEG Process........................................................ 106
  8.4  Savings gained from making changes early in the development cycle............. 106
  8.4.1  Context........................................................................ 106
  8.4.2  Processing the data....................................................... 106
  8.4.3  Results after processing the data................................... 107
  8.4.4  Calculation................................................................. 108
  8.4.5  Web Defect Tracker...................................................... 108
  8.4.6  Context........................................................................ 108
  8.4.7  Acquiring the data....................................................... 108
  8.4.8  Processing the data....................................................... 108
  8.4.9  Results after processing the data................................. 110
  8.4.10 Calculation................................................................. 111
  8.5  Decreased amount of customer support...................... 112
  8.5.1  Context........................................................................ 112
  8.5.2  Acquiring the data....................................................... 112
  8.5.3  Processing the data....................................................... 112
  8.5.4  Calculations................................................................. 113
  8.6  Decreased cost of training............................................... 114
<table>
<thead>
<tr>
<th>Section</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.6.1</td>
<td>Context</td>
<td>114</td>
</tr>
<tr>
<td>8.6.2</td>
<td>Acquiring the data</td>
<td>114</td>
</tr>
<tr>
<td>8.6.3</td>
<td>Processing the data</td>
<td>114</td>
</tr>
<tr>
<td>8.6.4</td>
<td>Calculation</td>
<td>115</td>
</tr>
<tr>
<td>8.7</td>
<td>Summary</td>
<td>119</td>
</tr>
<tr>
<td>8.8</td>
<td>Conclusion</td>
<td>120</td>
</tr>
</tbody>
</table>

**Chapter 9**

Revenues of usability ................................................. 121

9.1     Introduction ......................................................... 121
9.2     Payback period and return of investment .................... 121
9.2.1   Overview of costs and benefits .................................. 121
9.2.2   Payback Period ..................................................... 122
9.2.3   Return of investment .............................................. 123
9.3     Distributing benefits by percentage of total worked hours for an activity on ThinBaan .................................................. 123
9.4     Distributing benefits via the framework of Kabel ......... 125
9.5     Discussion results .................................................. 128
9.6     Conclusion ............................................................ 128

**Chapter 10**

Discussion and Conclusions .............................................. 129

10.1    Introduction .......................................................... 129
10.2    Usability activities .................................................. 129
10.3    Methods ............................................................... 129
10.4    Results ................................................................. 129
10.5    Applicability of the model ....................................... 130
10.6    Limitations ............................................................ 131
10.7    Improvement suggestions ........................................ 132
10.8    Conclusion ............................................................ 132
10.9    Further research ..................................................... 133

Appendices A: References ............................................... 134

A1: Literature .............................................................. 134
A2: Internet and Intranet sites ......................................... 136

Appendices B: Abbreviations .............................................. 137

B1: Abbreviations in text ............................................... 137
B2: Abbreviations in equations ....................................... 138

Appendices C: Cost-benefit calculation examples .................. 141

Appendices D: Collecting product data and data sources ......... 146

Appendices E: Questionnaire Focus on Usability Activities ...... 151

Appendices F: Questionnaire Positioning of Usability Activities .. 155

Appendices G: Activity Based Costing .................................. 158
Chapter 1 Research description

1.1 Introduction

In this chapter an overview of our research at Baan Usability Consultancy will be given. The assignment that was given to the authors was to write a report that clearly describes the added value of usability design within the development process, possibly including recommendations on how to optimize the added value. This needs to be done, because the cost savings from better usability are not always directly visible to the development organization.

First in section 1.2 the motivation of our research will be further dealt with and the goals will be explained. After this the problem statement itself will be explained, as well as the research questions. Then, in section 1.3, the problem space will be dealt with on a high abstraction level, as a kind of high level “mental model” for this research. How we will conduct the research is described in section 1.4, which includes the research model. Finally we will discuss the limitations of this research.

1.2 Problem Statement

Motivation:
Currently very little is known about the research area: cost-benefit calculation methods for usability. There is limited knowledge about the quantification of usability activities. At the moment of writing this only one literature reference is available that contains cost-benefit calculation methods for usability. At Baan there is limited or no data available to prove that their usability consultants are beneficial to the final software products. It would be of great value for the usability consultants if these costs and benefits of the usability activities could be made explicit in a clear and structured way. If the results are positive, it will show that usability is beneficial within the Baan development process.

Goals:
The goals will be split up in Baan specific goals and scientific goals, some goals may overlap while others are distinct.

The first scientific goal of this document is to find out which methods are suitable to measure costs and benefits in the field of usability engineering. This will be done by means of a literature study about “cost calculation methods” and “benefit calculation method”. The methods that we find will be reviewed in terms of theoretical advantages and disadvantages. Most of the methods will not be used within Baan but from a scientific point of view it is interesting to see which cost benefit methods are suitable to quantify usability activities.

The second scientific goal is to make an abstract term like usability “suitable” for a concrete quantification in dollars. In this way one can find out if usability activities are beneficial to perform on a software product.

The first Baan goal is to find out which of the cost benefit calculation methods can best be used to quantify their usability activities.
The second Baan goal is to quantify the usability activities of the Baan usability consultants in terms of costs and benefits. Also the indirect costs and benefits of departments, which do not perform direct usability tasks but do generate costs and benefits regarding usability, need to be made explicit. This quantification will be performed on one or two versions of the same software product of Baan development in order to make a comparison (for more details see Chapter 4).

The third Baan goal is to give advise for improvement of the usability activities within Baan when taking our cost benefit analysis in consideration.

A goal for Baan as well as for the university is to give a description of how appropriate the used model was for this research.

**Problem statement:**
- How to quantify the costs and benefits of usability activities performed on a software product?

**Research questions and sub questions:**
- Which methods are available to measure the costs of usability engineering?
- Which methods are available to measure the benefits of usability engineering?
- How difficult are these methods to use?
- Are there any cost calculation methods in use by the usability consultants of Baan?
- What method could be applied best to quantify the usability activities that are being performed in terms of costs and benefits?
- By what methods are the usability activities applied within the Baan development process?
- What are the usability engineering activities of the Baan usability consultants performed in the development process of Baan?
- What are the extra costs of possible usability problems in Baan products?
- If we consider cost and benefits together, what are the revenues of the usability activities that were performed?

**Research questions for other departments of Baan:**
- What costs are being made by activities performed in relation to usability?
- What costs should have not been made if usability engineering was being performed more adequately within the Baan development process?

**Suggestions for further improvement:**
- How can costs be minimized and benefits (by sales) maximized?

**Applicability of the model:**
- How applicable was the model for Baan?
- Can it be used for different products?
- Can it be used by different organizations?
1.3 Overview of the problem space

Figure 1 represents an overview of the problem space. The Baan usability consultants are performing usability activities, which are based on (several) methods within the development process of Baan and which are carried out at different moments in the development process. DMethod is a methodology that consists of methods and activities that should (can) be performed in a development process of a product. The usability activities are performed on some Baan products (e.g. ThinBaan and Product Q) in this development process. These activities generate costs in terms of resources such as time and money. Both costs and benefits need to be made quantifiable and justifiable. The quantification will be done in such a way that the benefits are calculated and, where possible, linked to usability activities. In this way it will be made explicit if the activities of the Baan usability consultants are beneficial, and thus justifiable.

There are also indirect costs that a product generates, the so called after sales (e.g. customer support, training etc) and pre-sales (e.g. sales). Here are also “hidden” usability activities with indirect usability costs, which are done by people other than the usability consultants such as, pre- and after sales (e.g. sales people who are trying to hide poor usability for their clients). These indirect costs should also be calculated to get the larger picture of all usability costs within a company. We will calculate these indirect costs, while the indirect benefits that are made here will be linked to (possible) usability activities (which could have been) performed by the Baan usability consultants. Possible benefits are minimizing costs in the development process and the increased sales of the software products.

Figure 1: Problem space of the research
1.4 Research method and model

Below we will describe our research method and our research model that we will use during this research.

Research method:
The research method is divisible in two parts. First there will be a literature review of cost and benefit calculation methods (for usability). The second part of the research will be a case study within Baan where we will apply some of these cost and benefit calculation methods. A case study has the following features according to Swanborn (1996);

- The social phenomenon can be observed with one or more “carriers” of this social phenomenon (such as people or groups)
- In a natural surrounding
- During a certain period in time, where you can measure at different times or measure a period in time afterwards
- Multiple data sources are being used
- A detailed description on stability and changes on a range of variables, by these means you can find accounts for processes

The usability activities of the usability consultants at Baan will be “cost justified” by means of this case study. This will be done for either one or two versions of a software product. The data that will be used is qualitative data (e.g. interviews) and quantitative data (e.g. worked hours, results of a satisfaction survey etc.).

Description research model:
The literature about cost-benefit calculation methods (for usability) will deliver a specification of the possible cost-benefit calculation methods for usability (see Figure 2). The specification of Baan usability activities and calculation methods consist of the following components:

1. Research on Baan usability activities
2. Research on Baan cost-benefit calculation methods for usability

The specification of the cost-benefit calculation method for usability, which will be applied during the research, results from:

1. The selection criteria for the calculation methods.
2. The specification of usability activities and cost-benefit calculation method applied at Baan.
3. The possible cost-benefit calculation methods.

There will be a specification made by means of the research options, because one research option may be better to execute than the other, also a combination of research options is possible. The research options will be compared with the cost-benefit calculation methods for usability and the selection criteria for the research options to see which best fits. The best research option(s) for a product will be carried out in the second part of the research. Because a choice is made in a later phase all the research options are elaborated.
The descriptions for the first 3 research options (see Chapter 4) are all the same; for each option a comparison is made of two versions of a software product. The difference lies in what is known about a version of a software product and what is unknown (and thus needs to be estimated).

The descriptions for the fourth research option (see subsection 4.2.4) is a bit different, hence a different research model (Figure 3) is applicable. The most striking difference with the first three research options is that there will be no comparison between two versions of one product. Instead we concentrate on the (estimated) cost reduction in the development life cycle due to usability activities. This is done on a single version of a software product.

For a more detailed description of the research options see Chapter 4.
1.5 Research limitations

The research will be focused on the position of usability within the Baan development process and the obtained benefits in terms of time and money for Baan. The research will not look at the benefits for the customer generated from usability engineering on a software product. Specific usability issues are outside the scope of this research.
Chapter 2 Literature review of cost-benefit calculation methods

2.1 Introduction

This chapter is based on a literature review, which is performed during the traineeship at Baan. In this chapter usability and cost-benefit calculation methods will be explained. A differentiation will be made between the different cost-benefit calculation methods. They will be subdivided in general methods, information system methods and usability specific methods. General methods are methods that can be used for every company branch. Information system cost-benefit calculation methods are methods that can only be applied for information systems. Usability specific methods are methods that can only be applied for usability. The costs are most of the time straightforward and easy to calculate but the benefits are much harder to calculate.

An analysis will be made of the problems with the methods: how easy or hard it is to use these methods and to gather the needed information. But first there will be a short introduction to the field of usability.

2.2 Usability explained

*What is usability?*

Usability can be defined in different ways. According to the ISO 9241 standard usability can be defined as the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use ([http://www.usability.serco.com/trump/resources/standards.htm#9241-11](http://www.usability.serco.com/trump/resources/standards.htm#9241-11)). Baan uses an almost similar definition: the extent to what the product support the user by the execution of his or her task (Hinssen and Vons 2001). Donahue et al. (1999) defines usability as follows: a description for the processes and techniques intended to make systems easy to learn, easy to remember, efficient, error-preventive and satisfying such as user and task analysis, interface prototyping and usability testing. Easy to learn and easy to remember are difficult concepts because the ease of use, ease of learning and ease of remembering something is different for everybody. Therefore Baan’s definition of usability is used in this research.

Usability is not the same as quality assurance. Quality assurance focuses on elements that users do not interact directly with (e.g. code integration). Usability on the other hand focuses on the elements that end users interact directly with, e.g. navigation (Donahue et al. 1999).

*Where do you need it for?*

In the literature the benefits of usability are very often well explained. So this section gives a few examples. Donahue et al. (1999) describes that for every dollar spent on implementing usability techniques, the organization will realize a benefit of ten to hundred dollars. Usability has significant direct and indirect positive effects for an organization, according to Karat (1997). An organization can achieve significant cost avoidance for their help desk, training, support service, personnel and maintenance. For more examples of benefits from usability design: a good overview is given by Donahue et al. (1999).
Introducing usability into an organization

To introduce usability into an organization three different aspects of an organization have to be taken into account (Bevan 2000):

- **Cultural**: all those involved in the development of a system or product must be aware of the issues and activities involved in user-centered design to effect the best design decisions at a micro- and macro-level.

- **Technical**: development processes and procedures must include the user-centered methods and activities, which are appropriate for the organization and whose purpose and benefit can be clearly demonstrated to the developers.

- **Strategic**: the organization and its management must set quality in use as a principal objective for systems development, but until recently there has been no way to accurately specify quality in use requirements prior to design.

If one aspect of the organization does not accept the changes, it will be very difficult to get usability accepted into the organization.

Usability engineering lifecycle

Usability engineering is a discipline that provides structured methods for achieving usability in user interface design during product development (Mayhew 1999). Its roots lie in different disciplines like cognitive psychology and software engineering. The usability-engineering life cycle described by Mayhew (1999) consists of several types of tasks:

- **Structured usability requirements analysis tasks**
- **An explicit usability goal setting task**, driven directly from requirement analysis data
- **Tasks (e.g. work reengineering and conceptual model design)** for supporting a structured, top-down approach to user interface design driven directly from usability goals and other requirements data.
- **Objective usability evaluation tasks** for iterating design towards usability goals.

Mayhew describes three phases where different usability tasks play a role. The most important tasks will be described below. The first phase that Mayhew describes is requirements analysis. This consists of user profile and contextual task analysis. User profiling is making a description of the characteristics of the different users (relevant to the user interface). Contextual task analysis results in a description of current tasks and workflow, and an understanding and specification of underlying user goals.

Phase two is design, testing and development. Important tasks are here conceptual model design, screen design standards prototyping and detailed user interface design. Conceptual model design identifies navigational pathways and major displays and establishes rules for the consistent presentation of work products, processes and actions. Screen design standards and prototyping can be applied at the design of the detailed user interface for selected subsets of product functionality. During the detailed user interface design the detailed design of the complete user interface is carried out based on the refined and validated conceptual model and screen design standards.

Phase three is the installation of the product phase. User feedback is gathered to enhance design of the products or design new releases of products. For more information see Mayhew (1999).
Usability inspection methods

Nielsen and Mack (1994) describe in their book different kinds of usability inspection methods. Usability inspection methods are defined by Nielsen and Mack (1994) as the generic name for a set of methods based on having evaluators inspect or examine usability related aspects of a user interface. Most of the time these methods are used to evaluate the user interface. The most common methods are:

- Heuristic evaluation: having usability specialists judge whether each dialogue element conforms to established usability principles.
- Guideline reviews: inspections where an interface is checked for conformance with a list of usability guidelines.
- Pluralistic walkthroughs: developers, usability consultants and users step through a scenario, discussing usability issues associated with dialogue elements involved in the dialogue steps.
- Consistency inspections: are aimed at evaluating consistency across the family of products that has been evaluated by an inspection team.
- Cognitive walkthroughs: is a more explicitly detailed procedure to stimulate a user’s problem solving process at each step in the human-computer dialogue, checking to see if the stimulated user’s goals and memory for actions can be assumed to lead to the next correct action.

There are more evaluation methods but they are not further described here, see Nielsen and Mack (1994) for more information.

Usability is defined as the extent to which the product supports the user by the execution of his or her task (Hinssen and Vons 2001). Usability has many benefits for an organization, one of them is cost avoidance, according to Karat (1997). There exist structured methods which can be used during software development to improve usability. Usability inspection methods can be used to evaluate the software for usability aspects.

2.3 The problem of measuring

A method consists of concepts, calculus definitions and operationalizations. Calculus is the way a method is calculated. The concepts in a method need to be defined, operationalized and measured. Operationalization is the translation of a not observable characteristic in an observable phenomenon, which seems to represent the mentioned characteristic as good as possible for the examined system or phenomenon at that place and that time (Swanborn 1987). The operationalizations have to be commensurable, because otherwise it is difficult to compare two different outcomes with each other for example dollars, lines of code, etc.

Example: Cost of an activity $a$

The method is calculating the cost of activity $a$. The calculus to do this is:
\[ CA_a = \sum (W_1 \cdot t_1 + W_2 \cdot t_2 + \ldots + W_n \cdot t_n) + OTC \]

Where:
- \( CA_a \) = Cost of activity \( a \)
- \( W_n \) = Fully loaded wage for personnel type \( n \) in hours
- \( t_n \) = time in hours worked by personnel type \( n \)
- \( OTC \) = One-time cost

A concept in this method is one-time cost. The definition of this concept is: one-time costs that are made during activity \( a \). This all is measured in dollars and this is the operationalization of the variable.

When something is measured, it must be free of errors by chance and systematic errors. It must be possible for other researchers to use the same measures and reach the same conclusions. Errors by chance originate from accidental oddities of the researcher, the situation and the moment of research, and by what means the measuring instruments are used. Errors by chance are recognized when two (of the same) measures have two different outcomes. This can be prevented by using standardization and repetition (Swanborn 1997). The reliability of a measure is to what extent a measure is stable, when used by other researchers, at other points in time, measured by other measuring instruments and other unforeseen circumstances. Systematic errors are defined as unintended variables that cause an irregularity of some importance. This would generate, by variables of the same kind, by other researcher or repetitions over time the same outcome (Swanborn 1987). Systematic errors can’t be cancelled by repetition, like errors by chance.

There are different kind of validity, in this section only construct validity will be discussed. This is because other validities do not play a role in this research. Construct validity is concerned with the question: do we measure what we want to measure (Swanborn 1997)? A method should be valid and reliable otherwise the outcome does not have a meaning. A measure is more valid when the values reflect the intended differences (Swanborn 1987).

The problems that can arise with measuring must be prevented, otherwise the conclusions that are made from the results are not valid. Errors by change or systematic errors must be prevented, this can be done by standardization and repetition.

### 2.4 Cost-benefit analysis

What is a cost-benefit analysis?

A cost-benefit analysis is a method for analyzing projects investment purposes (Burill and Ellsworth 1980 as cited by Bias and Mayhew 1994). A cost-benefit analysis consist of the following phases:

1. Identify the financial value of expected project cost and benefit variables.
2. Analyze the relationship between expected costs and benefits.
3. Make the investment decision.
Lobry and Wolfsen (2001) add to this that this financial value (i.e. return rate, revenues and cash flows) of an investment can be calculated for different scenarios. The following four scenarios are given:

- Worst case scenario
- Pessimistic scenario
- Realistic scenario
- Optimistic scenario

It is said that it is of great importance to give arguments for these scenarios and that per scenario applicable techniques have to be used to calculate the revenues, rate of return and cash flows.

Although Lobry and Wolfsen (2001) do not say anything about specific techniques for specific scenarios they do give important points for a costs benefit analysis. They state that it is very important to select the right people who have to do the estimations. Next the question is, if the people who did the estimations use the same techniques (Lobry and Wolfsen 2001).

How do cost-benefit analysis relate to business cases?

Business cases are a mechanism for proposing projects, tracking projects, and communicating with the organization at large. A business case includes:

- A project description
- A market analysis regarding the proposed project
- Analyses of expected benefits and costs for ‘business as usual’ compared with ‘business as proposed’
- Staffing and equipment requirements for the proposed project
- A project timetable
- An analysis of project dependencies
- A risk analysis for the project

A business case provides an objective and explicit basis for investment decisions, such as allocating resources to projects that will accomplish organizational goals, for example, financial, social or legal milestones. In the case of investment in usability engineering, cost-benefit judgments have been made largely in the absence of formal cost-benefit analysis and business cases. So the data on which decisions are based are all very judgmental. Due to this, usability engineering at the project management level has been competing for resources against other groups who do have objective cost benefit data available for management review (Karat, Chapter 3 from Bias and Mayhew 1994).

Problems with a cost-benefit analysis

According to Lobry and Wolfsen (2001), companies in the IT sector do not spend a much time on conducting a cost-benefit analysis. The main problems in conducting this are:

- Budgeting of costs and benefits are difficult
- Fast technological changes which are hard to take into account
- The value of money changes during time, and cost and benefits do not appear at the same time
There is a much uncertainty involved in IT projects and the risks are hard to quantify. To conduct a cost-benefit analysis is often experienced by companies as being dangerous.

**Benefits of a cost-benefit analysis**

Companies who do cost-benefit analyses can have the following advantages of this quantification:

- Norm for revenue control
- More commitment from people on the project, because they know what the project they work on will yield
- More confidence in revenue comparisons between investment possibilities
- Better to prioritize, because of measurement in terms of money
- Univocal communication due to measuring in terms of money, which anybody can understand
- More support to execute the project due to the fact that results are clearly stated in numbers

**Classification of costs and benefits in an analysis:**

The question with costs and benefits on investments is if this investment really generates more than that it will cost. In other words, what are the benefits of this investment compared to the situation in which this investment would not have been done? The answer to this question can include:

- Reduction of costs
- Increase of sales
  - But also:
    - Avoiding costs
    - Stability of sales

Specifically for IT projects, benefits are defined as follows by Lobry and Wolfsen: All benefits that are generated by doing the IT project compared to the situation in which this investment was not done in this project.

Lobry and Wolfsen (2001) give the following classification of costs and benefits:

1. **Visible versus hidden costs and benefits**

   The hidden costs and benefits outnumber the visible costs. This means that an accurate and careful inventory has to be made of the costs and benefits, because this has a large effect on the controllability and realization of the project.

2. **Influenceable versus non-influenceable costs and benefits**

   Who can influence what costs and benefits. In this way the right people can be held responsible for the realization of the costs and benefits. The costs of the project should be fully controllable by the project manager.

3. **Already made versus future costs and benefits**

   There are costs and benefits that one has already made within a project, but there are also costs and benefits that one can see in the future.
4. Direct versus indirect costs and benefits
With direct costs a cause and effect relation of the costs can clearly be observed. Who made the costs is very clear here, so these kinds of costs are reasonably manageable. Indirect costs do not have such a cause and effect relation and should therefore be allocated to activities that generate costs, this is done via “activity based costing”. In this way one can see what activities are the causes of what costs. This will increase the controllability of the costs.

5. Internal versus external costs
Internal costs are the costs for the people and resources of the own organization, such as personnel, buildings and PC’s. Return control in companies is mostly emphasized on external costs, because these lead to real bills. This can lead to an uncontrollable and unmanageable cost side.

6. Fixed versus variable costs
Fixed costs cannot be influenced in a short or middle time range, this can lead to inflexibility.

7. Project costs and project benefits versus exploitation costs and exploitation benefits
The project costs relate to activities that are needed for the project result. The benefits of the project during the project are mostly learning effects and training people. After the project is finished it is being handed over to those responsible for the use and maintenance of it. The exploitation costs are dependent on the quality of the project result. The exploitation is responsible for the exploitation costs. The employer is carrying responsibility for the exploitation benefits.

Problems with budgeting benefits and costs
The traceability and the measurability of benefits can be very difficult, one has to take care not to quantify certain benefits in multiple benefit calculations. If the benefits are not quantified at all, than it will be hard to find out if a department adds value to the company. On the other hand, the quantification of benefits, in terms of money, should not suggest too much certainty. One can best work with margins here. For example the benefits can be approximately $1 million plus and minus $200,000.

(Lobry and Wolfsen 2001)
There are many factors, which can influence benefit calculations:

- Time span between budgeting and realization of the benefits
- Projects have influences on each others benefits
- The realization of the benefits as stated in the project result are for the present situation and may change over time
- Absence of experience in stimulating the budgeting of benefits
- Not enough methods and techniques which can be used in practice
- Difficult to get support and commitment for the budgeting of benefits
- Companies do not have experience in dealing with margins regarding budgeting of benefits

Although costs are easier to quantify than benefits, there remain some difficulties:

- Hidden costs outnumber the visible costs (see “classification of costs and benefits”)
- Internal costs are not seen as costs
• User costs are not calculated (not valid for a vendor organizations such as Baan)
• No experience with calculating costs
• Companies do not have experience in dealing with margins
• Absence of heuristics and relevant data from projects in the past

Hidden costs are for example, maintenance, administration, end user support, and use of computer servers, databases (Lobry and Wolfsen 2001).

Apart from Lobry and Wolfsen, also Giaglis et al. (1999) notes some good aspects of budgeting benefits, and gives a clear overview on the several benefits that exists for information systems (IS). Giaglis et al. (1999) says that one of the main problems when trying to apply any of the financial techniques for assessing a particular information system investment, seems to be the difficulty of identifying and measuring the expected benefits of a proposed information system. Estimates for the expected benefits of a given information system on business performance are far from easy to obtain, especially in the case of complex, sophisticated IT applications with intangible, indirect, or strategic impacts on business performance.

For this Brown (1994, p. 187) as cited by Giaglis et al. (1999) distinguishes between hard and soft benefits. Hard benefits are a direct result of the introduction of the information system and are easily measured. According to Brown, soft benefits include at least intangible, indirect and strategic benefits. Figure 4 builds upon this classification to highlight the importance of both the extent to which benefits are directly attributable to the introduction of the information system and the extent to which they can be readily quantified. The horizontal axis distinguishes between quantifiable and non-quantifiable benefits, while the vertical axis distinguishes between those benefits that are realized solely as a result of the introduction of the information system, from those that depend, to a greater or lesser extent on other organizational factors as well.

Giaglis et al. (1999) says that hard benefits are usually related to cost reduction, such as the reduction in data-entry staff made possible by the introduction of an electronic ordering system or to revenue generation, such as the increased throughput as a result of a new production control system. Such measurable benefits are relatively easy to incorporate in traditional investment appraisal techniques.

The problem of measurement, as discussed above, is mainly related to the remaining three categories of the so-called “soft” IS benefits as defined by Brown. Intangible benefits can be attributed to particular applications but they cannot be easily expressed in quantitative terms. An example is the introduction of a Decision Support System. Giaglis et al. (1999) says that such systems are primarily expected to improve the quality of decision-making as well as the job structure of their users. However he says that it is difficult to define ‘quality of decision making’ and ‘job structure’. Secondly, even if this is achieved, it may still be difficult to assign a quantitative (and, preferably, monetary) measure of improvement in advance.

Indirect benefits are potentially easy to measure, but cannot be wholly attributed to the proposed investment and can only be realized as a result of further investments, enabled by the new system. For example, the implementation of a Local Area Network (LAN) across an organization provides the infrastructure on which valuable shared applications can later be implemented. Although this is a potential benefit made possible by the LAN, it cannot be realized unless these shared applications are also successfully introduced. Such complementary investments may be in IT or in any other organizational resource, such as a change in business processes enabled by the introduction of IT. Although in the broader sense of the term, many indirect benefits may not be directly measurable, in this quadrant Strategic benefits Giaglis et al. (1999)
emphasize those indirect benefits that can be quantified. For ease of reference, Giaglis et al. (1999) places all indirect benefits that are not easily quantifiable at the ‘strategic benefits’ quadrant.

Strategic benefits are said to refer to positive impacts that are realized in the long run and usually come as a result of the synergistic interaction among a number of contributing factors. They are the outcome of, for example, a new business strategy or a better market positioning of the organization, which can only be partially attributed to a given IS. Such benefits are notoriously difficult to quantify in advance due to their very nature and to the risk associated with their realization.

At this point, Giaglis et al. (1999) note that rarely one information system does yield one type of benefit. Any given information system can be expected to deliver a range of various types of benefits. Moreover, different kinds of systems can produce different combinations of types of benefits, with more sophisticated systems usually moving towards soft and difficult to measure benefits.

![Figure 4: Different types of information systems benefits](image)

*Quantifying in money*

According to Lobry and Wolfsen (2001) managers often say that some benefits should be quantified and that the other can be qualitatively weighed. Most of the time the manager only quantifies benefits that are easy to quantify, however it is better to quantify all benefits. Only if there is no other possibility than qualification, it is permitted to qualify benefits (Lobry and Wolfsen 2001). If it is not possible by means of quantified benefits to prove that the project is profitable, then the question is whether to invest in this project or not. This will be a very risky investment.

Advantages of quantifying in money:
- Calculation of profitability is possible
- Straightforward communication and measuring in a well known unit
- Commensurability amongst different types of variables that can now be quantified in one type of variable
- Makes benefits measurable, controllable and ready for evaluation
- Management is used to work in terms of money
- Increases the chance of realization of potential benefits, because it can be clearly seen what amount of money is involved as a potential benefit
- Has a learning effect, one can see what projects have done well and what projects have done not so well.

However there will always be benefits that need to be made qualifiable, these qualitative benefits are called “imponderables”. These can be handled in three different ways: A first possibility is to let the manager note down a subjective amount of money for the qualitative benefit. Often this will not be one amount of money for all qualitative benefits. Secondly are weighing the qualitative benefits by means of a score model. A third possibility is to let the qualitative benefits only count when the quantifiable benefits are the same in both investment options.

**Cost-benefit analysis for usability**

Most of the time in a cost-benefit analysis the costs and benefits of a product with usability and a product without usability are compared. The goal of such an analysis is to determine the cash value of the positive difference in a product due to usability engineering. The following “guidelines” (which in the view of the authors of this report are more like warnings subdivided in steps) are given by Karat (Karat, Chapter 3 from Bias and Mayhew 1994) for quantifying human factor costs and benefits:

1. The variables that are relevant for the analysis will vary depending on the focus of the product and the context of its use
2. There will be differences in the key benefits and cost variables for products for internal and external use
3. Initial analyses often overlook benefits and costs, so distribute a draft analysis of the benefit and cost variables to project team members and people with different backgrounds in your organization to gain wisdom of their different perspectives and expertise

If the variables have been identified, they have to be separated in tangible and intangible variables. Tangible variables can be quantified financially. Intangible variables are for example organization images and cannot easily be measured. A list of intangible variables should be kept and referred to periodically, as methods for quantifying those variables may surface at a later time. The final step is to determine the value of the tangible benefits and costs.

**Cost-benefit analysis for different organizations and organizational groups**

The focus in an usability cost-benefit analysis should be on the benefits that are the most relevant to the group for which the analysis is conducted (Donahue et al. 1999). These can be different organizations but also different groups in organizations. The organizations can have different costs and benefits. Groups can have different interests. Mayhew & Mantei describe two different organizations: internal development organizations and vendor companies. Internal development organizations develop software for in-house use, vendor organizations sell software to customers. Possible relevant benefits are described in Table 1 (Mayhew & Mantei, Chapter 2 from Bias and Mayhew 1994). This is a, by no means, complete list of the different benefits for the two different companies.
1. Increased user productivity
2. Decreased number of user errors
3. Decreased training costs
4. Savings gained from making changes earlier in the design life cycle
5. Decreased user support

Table 1: Comparison of benefits for different organizations.

Usability is often difficult to get accepted in an organization. According to Bloomer (1997), most of the time we try to convince managers with words instead of that we try to sell usability. For each group in an organization the way the message of usability is delivered must be different. A first step is to identify those groups. Table 2 shows the most relevant groups in an organization and what their interests are.

<table>
<thead>
<tr>
<th>Groups:</th>
<th>Needs to be convinced of:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Senior Managers</td>
<td>- Usability does not threaten time and budget schedule</td>
</tr>
<tr>
<td></td>
<td>- Usability decreases time and budget schedule</td>
</tr>
<tr>
<td>Possible Allies</td>
<td>- Usability helps them to reach their goals (for each ally are that different goals)</td>
</tr>
<tr>
<td>Developers</td>
<td>- Usability makes their work easier</td>
</tr>
<tr>
<td></td>
<td>- Usability does not increase their budget or their time schedule</td>
</tr>
<tr>
<td>Client and Users</td>
<td>- Users are not difficult to convince</td>
</tr>
<tr>
<td></td>
<td>- Clients need to be convinced that the investment is worth it</td>
</tr>
<tr>
<td>Other Groups</td>
<td>- Usability does not threaten other groups their work</td>
</tr>
</tbody>
</table>

Table 2: Important points of usability where of groups need to be convinced.

To identify groups, who can be your ally, the overall objective of such group has to be identified. Once that is done, a proposal can be made that demonstrates how usability can help them achieve that objective (Bloomer 1997).

Why use a cost-benefit analysis for usability?
There are several reasons why a cost-benefit analysis for usability can be made (Karat 1997):

- To educate others in the organization about the value of usability as it relates to their business goals and concerns
- To build business cases and provide management with better data on which to make decisions about which projects to allocate usability resources to and the number of usability engineers necessary to support the organization’s work
- To learn about how to make better tradeoffs in the use of usability methods in different situations

It is now clear that there are several kinds of costs and benefits involved in a cost benefit analysis, and that it is very valuable for a company to conduct such an analysis. This can be done on a project level, but it is also of great value for usability as an activity.
The main problems arise at the benefit side of the story, while the cost side most of times is pretty straightforward to calculate.

2.5 Cost-benefit calculation methodologies

There are several methodologies for cost-benefit calculation methods. Sassone (1988) describes 8 different methodologies, which will be reviewed briefly. The advantages and disadvantages described in this section come out Sassone (1988). After this different cost-benefits calculation methods will be coupled to the different methodologies. Each of these methodologies uses some calculation model to come to a decision. The kind of calculation method can differ between methodologies. The best cost-benefit calculation methods, which can be used by the different methodologies, will be coupled and explained. These calculation methods are further described in sections: 2.6, 2.7 and 2.8. Firstly, the difference between methodology and method will be described.

Methodology versus method

Originally a methodology refers to knowledge about methods. Methodological knowledge is understood as “know what”, “know-how” and “know when”. They are normative or prescriptive: they don’t describe a state of the world, but prescribe how a sensible agent should act to achieve a certain goal. The methodological pyramid is a convenient way to characterize what is involved in a methodology (De Hoog 1997).

The top layer refers to the principles and assumptions that underlie the methodology. They often include the goal(s) that is being served. The theory layer elaborates these principles and assumptions and forms the core of the knowledge in the domain of the methodology. Methods and techniques operationalize the content of the theories, the main “how” part of it. Tools are computerized instances of methods and techniques in the previous layer. Being computerized often requires additional use knowledge attached to them. The use layer represents the touchstone of a methodology. It will reveal shortcomings in the prescriptions provided by the layers above, which will lead to revisions in the different components of the methodology (De Hoog 1997).

Sassone (1988) describes 8 different methodologies; one of them is decision analysis. It uses different methods like “Payback Period” and “Net Present Value” to achieve the goal of making a comparison between different options. Below the different...
methodologies will be described with their views and methods, which can be used to achieve the goal of the methodology.

1. **Decision Analysis**

Decision analysis is a structured approach to make a decision between of several options. It usually involves the specification of objectives, a set of feasible choices, a set of possible states, and probabilities of states occurring and a set of possible outcomes.

**Advantages:**
- Flexible approach for making decisions under risk and decisions under certainty
- It allows projected benefits to be audited through tracking the pre- and post implementation success ratio’s

**Disadvantages:**
- Difficulty of determining the values of the probability-state matrices
- Relative few implementations of information systems fit neatly into a decision analysis.

Decision analysis can use cost-benefit calculation methods to find the best possible option among different available options. The option with the least costs or the option with the most revenues is the best option to choose. The following cost-benefit calculation methods could be used:

- “Payback Period”: to calculate the time that is needed for the return to equal the investment
- “Net Present Value”: to calculate the present value cash flows and costs
- “Profitability Index”: to calculate the highest return among different projects
- “Return On Investment”: to calculate the return on investment

2. **Structural Models**

A structural model analytically represents a line of business or business function, and the impact of an information system on the costs and revenues of that function.

**Advantage:**
- The performance of the information system can be directly linked to the organization’s bottom line, and can explicitly identify the intervening relationships, parameters and assumptions.

**Disadvantages:**
- Difficult to use because the links between the information system and the bottom line are often tenuous and poorly understood.
- The models are unique; each one must be developed from scratch.
- The data that is needed extends the data that is available.
- The details of the models tend to be complex and difficult to communicate to management.

Structural models use cost-benefit methods to analyze the impact of an information system on the costs and revenues of a business function. The calculation methods that can be used are:

- “Information Economics”: to calculate the company’s contribution to a project
- “IT Balanced Scorecard”: to guide business oriented IT decisions
3. **Breakeven Analysis**
The breakeven point is calculated. That is the point where the cost and the benefit are equal. The technique is used when the benefits are not tangible or uncertain and the costs are easy to calculate.

**Advantage:**
- Quick and easy to perform

Breakeven analysis is used to calculate the point where the costs equal the benefits, this can be calculated with the following calculation method:
- “Payback Period”
- “Return On Investment”

4. **Subjective Analysis**
Decision makers are asked to subjectively determine whether the prospective benefits of a system are worth the projected costs. This technique is used when benefits are not tangible, speculative or uncertain.

**Disadvantage:**
- The quality of the analysis depends on the knowledge and judgement of the managers polled.

Subjective analysis use calculation methods whereby decision makers estimate the costs and benefits. The following calculation methods can be used for this:
- “Balanced Scorecard”
- “IT Balanced Scorecard”
- “Information Economics”

5. **Cost Displacement /Avoidance**
A comparison is made of the costs to the total of the current costs they will displace plus the projected costs they will avoid. This approach is only usable if the proposed system will replace an existing system. It assumes that the benefits of the proposed information system are equal to or greater than the benefits of the current system.

**Advantages:**
- Data and information on which to base the analysis are usually available.
- The analysis is conceptually straightforward, auditable and easily conveyed to top management.

**Disadvantage:**
- Information systems do not always replace knowledge workers, so they do not displace costs, but provide added value. The costs displacement/avoidance methodology is increasingly inapplicable to today’s cost justification problems.

Cost displacement avoidance use calculation methods whereby the costs of an old system are compared with the costs of a new information system. It is almost solely focused on costs savings. The following calculation methods can be used for this:
- “Activity costs”: to calculate the cost of activities
- “Activity Based Costing”: to calculate the costs of resources, products and activities
- “Increased Productivity”: to calculate increase of productivity
- “Decreased cost of training users”: to calculate the decrease of training costs
- “Decreased user error”: to calculate the decrease in user errors
• “Decreased amount of customer support”: to calculate the decrease of customer support (helpdesk)
• “Decreased turnover rate”: to calculate the decrease of the turnover rate

6. Cost Effectiveness Analysis (CEA)
This approach is used to choose from similar information systems or system components.
CEA is most useful when the benefits of a system are largely incommensurable, that is, when they are quantifiable in non-monetary dimensions.
Advantage:
• Is a traceable approach to identify the best option among a set of similar alternatives.

Disadvantages:
• It does not provide a general cost justification of an investment.
• It frequently relies on subjective assessments.

Cost effectiveness analysis uses calculation methods to choose between similar information systems or system components the best options. It is mostly quantified in non-monetary dimensions. The following calculation methods can be used for this:
• “Balanced Scorecard”
• “IT Balanced Scorecard”
• “Information Economics”

7. The Time Savings Times Salary (TSTS) approach
Estimates the percentage of workers’ time the system will save, and then to multiply that percentage by the workers’ loaded salaries of wages.
Advantages:
• Intuitively plausible
• Easy to perform

Disadvantages:
• It assumes that the person’s value equal is to his or her cost to the organization.
• It takes not into account of how the saved time is used.

The TSTS approach use calculation methods to calculate decreases in costs. The following calculation methods can be used for that:
• “Activity costs”
• “Activity Based Costing”
• “Increased Productivity”
• “Decreased cost of training users”
• “Decreased user error”
• “Decreased amount of customer support”
• “Savings from making changes earlier in de design life cycle”: this are savings gained because of making repairs in software earlier in the design life cycle.
• “Decreased turnover rate”
• “Planned usability engineering program”: to calculate the cost of usability activities
8. The Work Value Model

This model helps to overcome the shortcomings of the TSTS approach. This approach takes into account that white collar workers routinely perform activities of different intrinsic value to the organization and that one of the major benefits of information systems is their capacity to restructure work patterns. So it is not only increased efficiency, but also increased effectiveness. The work profile matrix characterizes an organization’s allocation of its time, by leveling the job hierarchy and by major type of activity.

Advantages:
- The approach explicitly recognizes the restructuring of work patterns
- By estimating pre and post-implementation work profile matrices, the projected benefits can be audited.

Disadvantage:
- The extensive amount of information required about the organizations work patterns, this can be time consuming and expensive.

The Work value model is a supplement on TSTS approach. This methodology takes also into account how the people spent the saved time. The same calculation methods can be used as in TSTS:
- “Activity costs”
- “Activity Based Costing”
- “Increased Productivity”
- “Decreased cost of training users”
- “Decreased user error”
- “Decreased amount of customer support”
- “Savings from making changes earlier in the design life cycle”: these are savings gained because of making repairs in software earlier in the design life cycle.
- “Decreased turnover rate”
- “Planned usability engineering program”

Some calculation methods, which are explained in 2.6, 2.7 and 2.8, could not be coupled. The properties of the methodologies were not the same as those of the type for calculation methods.

2.6 General cost-benefit calculation methods

In this section the cost-benefit calculation methods are reviewed which are general economic calculation methods. This means that they can be applied at almost every industrial enterprise.

2.6.1 Cost calculation methods

The most general method in economics is to calculate the costs of the activities that are performed during a project. This can be calculated in two different ways.

Activity costs
Most activities can be calculated by the product of the time spent on the particular activity and the fully loaded hourly wage. Fully loaded hourly wage can be calculated by
adding the costs of salary, benefits (bonuses, etc.) office space, equipment and other
facilities for a particular type of personnel and dividing this by the number of hours
worked each year by that particular type of personnel (Mayhew & Mantei, Chapter 2 by
Bias and Mayhew 1994) For in-house personnel the fully loaded hourly wage is taken.
For outside personnel their hourly wage plus travel expenses should be taken into
account.

\[ CA_a = W_n \cdot t_n \]

Where:
\[ CA_a = \text{Cost of activity } a \]
\[ W_n = \text{Fully loaded wage for personnel type } n \text{ in hours} \]
\[ t_n = \text{time in hours worked by personnel type } n \]

There also exist activities, which use different wages because of different personnel. The
formula is then:

\[ CA_a = \sum ( W_1 \cdot t_1 + W_2 \cdot t_2 + \ldots + W_n \cdot t_n ) \]

Sometimes there are costs that are only made one time during an activity, such as using
special equipment, e.g. videotapes (see Appendices C: for examples). The formula would
than be:

\[ CA_a = \sum ( W_1 \cdot t_1 + W_2 \cdot t_2 + \ldots + W_n \cdot t_n ) + OTC \]

Where:
\[ OTC = \text{One-time cost} \]

Total cost of all the activities can be calculated by adding up all activities that are
performed for a project:

\[ TCA = \sum ( CA_1 + CA_2 + CA_3 + \ldots CA_n ) \]

Where:
\[ TCA = \text{total cost of performed activities} \]

Most organizations collect information about which activities are performed, how long
people spent time to perform the activity and wage costs. It should not be too hard to
find this data in an organization. If it is not possible to find these data, then an
estimation should be made. An average should be taken of the estimation from the
people that were involved in the activity/project.

**Activity Based Costing**

“Activity Based Costing” (ABC) is an accounting methodology that allows “indirect and
support expenses to be driven, first to activities and processes, and then to products,
services and customers”. In this way managers get a clearer picture of the economics
and their operations instead of looking at labor and machines the way they were used to.
According to Kaplan and Cooper (1997) “ABC” is extending this traditional view by “linking resource expenses to the variety and complexity of products produced, not just the physical volumes produced”. How this can be done is discussed below.

Below the reader will find the terminology and formulae that are used for this method, and more important what each of them will really measure. This is being done following Van Wegen (1996), which is based upon Kaplan and Norton.

Relevant elements in “ABC” are resources, resource drivers, activity drivers and products. For each activity the cost of the resources consumed should be assigned to the activity with a resource driver measure. These costs should then be assigned to each product with an activity driver measure. So a resource driver is “a variable that indicates how the volume of the cost of resources must be assigned to the various activities that consume them”. An activity driver is “a variable that indicates how the volume of cost of an activity must be assigned to the various products produced by the activity” (Dekker and De Hoog, 2000). This should look like Figure 6.

![Figure 6: “Activity Based Costing” applied at Baan](image)

Before the formulae are being presented some terminology must be defined, this is as follows:
Set of resources: \( R = \{ r_1, \ldots, r_n \} \)
Set of activities: \( A = \{ a_1, \ldots, a_j, \ldots, a_m \} \)
Set of products: \( P = \{ p_1, \ldots, p_k, \ldots, p_o \} \)
A resource can be used by several different activities; therefore the resource driver measure \( RDM_{i,j} \) is introduced. It represents consumption of resource \( r_i \) by activity \( a_j \). The cost per unit of consumption is needed to calculate the cost of consumption per activity. When the consumption \( RDM_{i,j} \) of its resource has been determined for all activities \( a_j \) the total consumption \( RTV_i \) of \( i \) the resource can be calculated as follows:

\[
RTV_i = \sum_{j=1}^{m} RDM_{i,j}
\]

Given the total cost \( RTC_i \) of resource \( r_i \) the cost per unit of consumption \( RDC_i \) can be determined as follows:

\[
RDC_i = \frac{RTC_i}{RTV_i}
\]

For example the \( RTC_i \) is the total cost in a year of the resource usability consultant: $70,000. The \( RTV_i \) is the total hours a usability consultant (resource) works: 2,000.

\[
RDC_i = \frac{RTC_i}{RTV_i} = \frac{70,000}{2,000} = $35.00.
\]

The total cost of an activity \( TCA_j \) is the accumulation of the cost of resources \( r_i \) consumed \(( \sum_{i=1}^{n} (RDC_i \times RDM_{i,j}) )\), this must be multiplied with the percentage of the occurrence \( Fa_j \) of the activity \( a_j \). The equation will then be:

\[
TCA_j = Fa_j \times \sum_{i=1}^{n} (RDC_i \times RDM_{i,j}).
\]

For example \( Fa_j \) is 100%, so the activity is 100% used. The \( RDC_i \) is again the cost per hour of an usability consultant: $35.00. \( RDM_{i,j} \) is the time used by a usability consultant (resource) for a specific task: 64 hours. So the total cost of the activity task analysis would be:

\[
TCA_j = Fa_j \times \sum_{i=1}^{n} (RDC_i \times RDM_{i,j}) = 1 \times 35.00 \times 65 = $2,275.
\]

The final goal is to determine the costs of an activity per product. As activity effort can be demanded by various products \( p_k \). The cost \( ADC_j \) per unit of effort is required to calculate the cost \( ICP_{j,k} \) of activity \( a_j \) per product \( p_k \).

The cost rate of the activity driver measure \( ADC_j \) can be determined when the total demand \( ATV_j \) by products \( p_k \) on the activity \( a_j \) has been calculated:

\[
ATV_j = \sum_{k} ADM_{j,k}
\]
Then the cost per unit of demand $ADC_j$ is calculated by dividing the accumulation of the cost of resources $r_i$ consumed by the total demand $ATV_j$ on activity $a_j$.

$$ADC_j = \frac{TCA_j}{ATV_j}$$

In the example the activity total consumption is 100% and is divided over two products: ThinBaan 80% and help 20%, so $ATV_j = \sum_{k=1}^{n} ADM_{jk}$. The $ADC_j$ (cost per activity) are the same as $TCA_j$ for task analysis: $2,275$.

The incurred cost $ICP_{jk}$ of an activity $a_j$ per product $p_k$ is the product of the cost $ADC_j$ by unit of demand on the activity and the activity driver measure value $ADM_{jk}$ of the activity $a_j$ and the product $p_k$ and the direct cost $DC_{jk}$ is added to this cost.

The level of the activity is also relevant.

- At a unit level the activity is executed for each product. Then the cost of a product equals the direct cost plus the accumulated activity driver cost.
- A batch level activity is executed for a batch of products, and, consequently the cost should be discounted by the batch volume $BV_{jk}$.
- A product level activity is triggered by characteristics of the products, but is not sensitive to changes in output or batch volume. Therefore, to determine the cost per product the cost of the product level activities should be discounted by the product volume $PV_{jk}$.

Now the formula to determine the cost incurred per activity per product is given for unit level, batch level and product level.

$$ICP_{\text{unit},jk} = (ADC_j * ADM_{jk}) + DC_{jk}$$

$$ICP_{\text{batch},jk} = \frac{ADC_j * ADM_{jk}}{BV_{jk}} + DC_{jk}$$

$$ICP_{\text{product},jk} = \frac{ADC_j * ADM_{jk}}{PV_{jk}} + DC_{jk}$$

In the example $ADM_{j,Webtop}$ for the activity task analysis is 0.8. The incurred cost for the activity task analysis of the product help will be: $ICP_{j,Webtop} = 2,275 * 0.8 = 1,820$.

The total cost $ACP_{jk}$ for an activity $a_j$ for a given product $p_k$ is determined as follows:

$$ACP_{jk} = \sum_{l=1}^{m} OC_{l,j,k} + ICP_{jk}$$
where \( OC_{i,j,k} \) is the cost of \( a_i \) to an activity \( a_j \) for a given product \( p_k \), and \( ICP_{j,k} \) is the cost incurred by activity \( a_j \).

The activity cost \( ACP_{i,k} \) per product \( p_k \) will be apportioned to all activities \( a_j \) that have an input from this activity \( a_i \). The cost of an output \( OC_{i,j,k} \) from activity \( a_i \) to activity \( a_j \) for a given product \( p_k \) is determined as follows:

\[
OC_{i,j,k} = \frac{ACP_{i,k}}{ARV_{i,k}} \times ARM_{i,j,k}
\]

According to Nancy Maluso (http://www.prosci.com/abc1.htm) an “ABC” approach will account for:
- Activities / processes compared before and after the reengineered project
- The frequency and cost of the activity/process compared before and after the reengineered project
- The do-nothing scenario (what would happen if we do not do the project)
- Which processes provide value (i.e. are needed to attract and retain customers, result in operational savings) (Kaplan and Cooper 1997).

### 2.6.2 Benefit calculation methods

Most of the general economic calculation methods, are methods to see if a project should be undertaken or what the minimum benefits should be to equal the costs.

#### Payback Period

“Payback period” is an investment evaluation method to determine the amount of time (e.g. year units) that it will take to generate net cash flows (cash benefits) to recover the initial investment in the project (Burill and Ellsworth as cited by Bias and Mayhew 1994). According to Lobry and Wolfsen (2001) this is not a sufficient base for a decision. It can however be used in combination with other techniques that do not have the limitations as stated for the “payback period” technique.

\[
R_1 + R_2 + \ldots + R_k \geq C
\]

Where:
\( R_k \) = cash benefits in a year minus the costs in that year
\( C \) = initial development costs

According to Karat (Chapter 2 Bias and Mayhew 1994) it is a method, which can be easily computed.

According to research done by the Cambridge Information Network (CIN), cited by Lobry and Wolfsen (2001), the “payback period” is an important way for justifying an IT investment. 90% of the respondents (IT managers) said that this method has a significant influence on decisions for IT projects.

Limitations are:
- The magnitude of the investment is not taken into account, small investments can have the same payback period as much larger investments
• The spread of the income throughout the whole payback period is not taken into account
• Income after the payback period is not taken into account
• The returns of the investment is not taken into account (Lobry and Wolfsen 2001)

**Present value of future cash flow**

This method is about calculating the “present value of future cash inflows” from a project, including the acceptable rate of return, and specifying the time period on which the cash returns are received. In this way better investment decisions can be made (Gordon and Pinches 1984 as cited by Bias and Mayhew 1994). This concept focuses on the analysis of present and future costs and benefits for a project in terms of the present day value of all the money.

This is the formula for calculating the present value of one future cash flow:

\[ P = F_n \cdot \left( \frac{1}{1+i} \right)^n \]

Where:
- \( P \) = present value
- \( F_n \) = Future cash inflow in time period \( n \)
- \( i \) = discount rate, the minimum acceptable rate of return for investments
- \( n \) = number of time periods in years

The expression \( \left( \frac{1}{1+i} \right)^n \) is called the present value interest factor (PVIF). A value for this can be found in a PVIF chart. In order to find the right value, a discount rate and a period of time (years) have to be selected.

The next step is to calculate the present value of several cash inflows across time. The present value of projects benefits (cash inflows) across a number of years is calculated by summing the separate cash flows. The formula is:

\[ P = F_1 \cdot \left( \frac{1}{1+i} \right)^i + F_2 \cdot \left( \frac{1}{1+i} \right)^2 + \ldots + F_n \cdot \left( \frac{1}{1+i} \right)^n \]

**Net present value**

The “net present value” (NPV) is a sophisticated technique. “NPV” is the present value of the benefits (inflows) from a project minus the present value of the project cost (outflows). The formula of the “NPV” is as follows:
\[
NPV = F_1 \cdot \left( \frac{1}{1+i} \right)^1 + F_2 \cdot \left( \frac{1}{1+i} \right)^2 + \ldots + F_n \cdot \left( \frac{1}{1+i} \right)^n - C
\]

Where:
- \( F \) = future cash inflows in years 1-n
- \( i \) = discount rate
- \( n \) = number of years the project runs
- \( C \) = present value of present cost (outflows).

Benefits of the “NPV” are:
- The time value of money is taken into account
- Magnitude of the investment is taken into account, because the initial investment costs are parts of this calculation
- “NPV” of various projects can be compared

Limitation:
- Only the quantified costs and benefits are accounted with this calculation.

The expected return of a project can be calculated. However this should not only be done at the start of a project but also during the project. There are two applications for this method in projects, first one can base go/no go decisions made at a project milestone upon this and secondly one can draw comparisons between investment alternatives (Lobry and Wolfsen 2001). Only if the “NPV” is positive a project should be selected for investment.

**Profitability index**
The “profitability (PI) index” is a way to compare projects of unequal size. It is another way of stating the relationship between the present value of project inflows and outflows. “PI” is calculated as follows:

\[
PI = \frac{\text{Present value of project inflows}}{\text{Present value of project outflows}}
\]

**Internal rate of return**
The most popular technique is the “internal rate of return” (IRR). “IRR” is the actual rate of return that an investment in a project will bring if cash inflows and outflows are projected. Organizations set a minimum rate of return, if the “IRR” is greater or equal than the minimum return rate the project may be accepted.

A benefit of “IRR” is:
- The time value of money is taken into account here

Limitations:
- “IRR” of various projects cannot be compared because you cannot add these
- Internal interest percentage says nothing about the magnitude of the project
- If the cash flow switches from sign repeatedly, then you will get multiple internal interest percentages for one investment
- There are investments for which you can not calculate a cash flow, because the formula can not be calculated when there is a certain course in the cash flow
- The “IRR” method assumes that the generated cash flow is invested again with the same “IRR” percentage of that project (Lobry and Wolfsen 2001)
Return on investment

“Return on investment” (ROI) is a method to calculate the return for an investment.

\[ \text{ROI} = \frac{\text{average.net.profit}}{\text{InvestmentCosts}} \]

Benefits are:
- Technique is easy to use
- Well known and widely used

Limitations are:
- The magnitude of the investment is not taken into account
- The spread of the income and the value of money is not taken into account
- Sometimes a fixed period of time, i.e. 4 years, is being used
- Depreciation method is being influenced by “ROI”
- Managers should deal with the same criteria, that is the expected “ROI” for the projects they have initiated that year (Lobry and Wolfsen 2001)

According to research done by the Cambridge Information Network (CIN), cited by Lobry and Wolfsen (2001), the “ROI” is valued by 65% of the IT managers as a reliable method to calculate a possible investment.

Balanced scorecard

The “balanced scorecard” is a measure and performance system that translates strategy to concrete actions. There exists also an “IT Balanced scorecard” (see 2.7.2).

In order to translate strategic goals to appropriate actions, multiple perspectives have to be taken into account such as financial-, customer-, process- and innovation perspectives. In order to translate the strategic goals to concrete measurements, this method uses the “critical success factor method” (CSF method). A critical success factor is something the organization has to excel in, in order to achieve these strategic goals. Buytendijk and Brinkhuis-Slaghuis (2000) say that these CSF’s are necessary in order to achieve these strategic goals, but are by no means a guarantee for them.

CSF’s in their turn are being made measurable by “Critical Performance Indicators” (CPI).

To make CSF explicit it is important to take responsibility for results into account, managers are often responsible for part of a (end) result. All these “pre-results” have to be covered by some CPI’s that are being compared to the norm in order to check if the results are achieved. Furthermore there are explicit relations between CPI’s and tasks, responsibilities and authorizations.

Those who have the responsibility for a task must get feedback about it; this is done by means of the “balanced scorecard” results and thus creates a learning effect. In this way actions are taken to stick to the strategic goals that one has set. In this way the step from performance measurement to performance management is achieved.

Advantages and disadvantages of the balanced scorecard

Two disadvantages that are mentioned are:
- All this quantification leads to managing CPI’s instead of managing a company.
- Qualitative data (such as case studies) are forgotten and all one wants to do is to quantify.
The two advantages that are mentioned are:

- Quantification makes things explicit.
- It is stated that with quantification one can test objectively against the standard norm that is set.

In practice it is often easier for a manager to name 200 CPI’s then to name 20. The trick here is to let the CSF’s be the basis and that all CPI’s have relations with another, thus there are no stand alone CPI’s and there are also no two of the same CPI’s (Buytendijk and Brinkhuis-Slaghuis 2000).

2.7 Information system calculation methods

An overview will be given of cost and benefit calculation methods, which can be applied to information systems.

2.7.1 Cost calculation methods

No methods were found that could fit this category.

2.7.2 Benefit calculation methods

The benefit calculation methods for information systems are cost savings. So there are fewer costs because of some reduction (e.g. in training, telephone calls), which is the cause of a change in the environment. The formulae presented in this subsection are based on the examples from Bias and Mayhew (1994) except “IT balanced scorecard” and “information economics”.

Increased productivity

“Increased productivity” is a cost saving, because people work faster. This is not a one-time benefit, but a benefit that is realized each year. The formula would be:

\[
CSIP = D \cdot R \cdot W_n \cdot UP
\]

Where:

- \(CSIP\) = Cost savings of increased productivity per year
- \(D\) = Number of workdays in a year
- \(R\) = Reduction in hours per day per user
- \(W_n\) = Fully loaded wage for type personnel \(n\)
- \(UP\) = Size of User population

Different things can cause the reduction in time. People can process more screens or application jobs in one day. The reduction time of one task can be measured. First people work with the “old” application and do their task. The average time people spent on that task, is taken. Then the “new” application is taken and the average time is taken, which people spent on completing the task. These data can be found in documents if these tests are done, otherwise it can be done by researchers. Szafron and Schaeffer used, among other things, logfiles and lines of code to measure if productivity of programmers increased due to increased usability (Szafron and Schaeffer 1994). If the reduction in time is impossible (or takes too much time) to measure then estimations
have to be used, this can be rules of experience or estimations from experts. The extra
time people gain from the improvement is not fully used. People do not normally work
in an optimal way, so to get a better picture of the real savings the productivity ratio
should be taken into account. Productivity ratio is based on estimations. This method
can be used by internal development organizations to measure increased productivity of
their employees.

\[ CSIP = D \cdot R_t \cdot W_n \cdot UP \cdot PR \]

Where:
\( PR \) = Productivity ratio

Decreased cost of training users
The cost saving formula for training users is almost the same as the formula for
increased productivity. What must be known are the size of the user population, the
training reduction time and the wage of training personnel.

\[ CSTU = R_t \cdot W_n \cdot TP \]

Where:
\( CSTU \) = Cost saving training users per year
\( R_t \) = Reduction in hours per training per user
\( W_n \) = Fully loaded wage for training personnel per hour
\( TP \) = Size of training population

This is a one-time benefit, which is realized when the system was first introduced. The
reduction in training time can be calculated by measuring the training time before a
change is made and after the change is made. If these data are not available, an
estimation can be made on the basis of experience, or estimations by trainers can be
given. Because errors can be made with estimations it is wise to make a conservative
estimate (Bias and Mayhew 1994). This method can be used for vendor organizations
and internal development organizations. Vendor organizations can use this when
employees are trained or when they hire an external company that give training to users.
Internal development organization can use the method to calculate cost savings gained
from reduced training of their employees.

Decreased number of user errors
These are errors that can be eliminated by usability engineering techniques in the
development stage of a product. Error reduction because of training, practice and
experience are not considered here. This is not a one-time benefit, but a benefit that is
realized each year. What must be known to calculate the savings are: errors eliminated
per user per day, recovery time per error, workdays, fully loaded hourly wage and user
population. The formula would be:
\[ CSUE = UP \cdot E \cdot D \cdot RT \cdot W_n \]

Where:
- \( CSUE \) = Cost saving user errors per year
- \( UP \) = Size of user population
- \( E \) = Number of error eliminations per user per day
- \( D \) = Number of workdays in a year
- \( W_n \) = Fully loaded wage for personnel type \( n \) per hour
- \( RT \) = Recovery time in hours per day

Frequencies of errors can mostly be found in databases of development organizations or can be found by interviewing and observing users. By eliminating the errors, the recovery time is also eliminated, which saves money. Recovery time is the time that a user needs to recover from an error. This can be measured by logging the computer of the user, or by observations made by researchers. The average recovery time of the errors should be taken. If measuring takes too long, estimations can be used based on previous data or experience. Internal development organizations could use this method.

**Savings gained from making changes earlier in the design life cycle**

It is said that if usability testing is done in an early stage in the development life cycle, changes may be made to eliminate problems and to achieve benefits much more cheaply, because code has not been written, manuals have not been published, and users have not been trained. The resulting benefit is a one-time benefit. What must be known to calculate the difference are: number of changes, fully loaded hourly wage, time needed to make the change and the reduction of cost by making changes earlier in the life cycle.

\[ CSED = X \cdot (W_n \cdot Ch \cdot t_{ch}) - (W_n \cdot Ch \cdot t_{ch}) \]

Where:
- \( CSED \) = Total cost saving changes made earlier in the development cycle per year
- \( W_n \) = Fully loaded wage for personnel type \( n \) per hour
- \( Ch \) = Number of changes made per year
- \( t_{ch} \) = Time in hours spent per change
- \( X \) = Penalty factor for making changes late in the development life cycle

Costs made for changes early in the development life cycle, cost one-fourth compared with the costs when changes are made late in the development life cycle (Mantei & Teorey 1988 as cited by Mayhew and Mantei 1994). So cost reduction in percents are based on experience rules. The calculation should be made conservatively to make it plausible (Bias and Mayhew 1994). This method is typical used by vendor organizations.

**Decreased amount of customer support**

Another factor that should be looked at is decreased amount of customer support because of increased usability. This is a yearly benefit, as long as the product is in use. What must be known to calculate the cost savings of customer support are: size of user population, number of eliminated calls, time per call and fully loaded hourly wage of support personnel.
Where:

\[ CSCS = CP \cdot EC \cdot DC_n \cdot W_n \]

Most development companies have a database for support. In such a database data about the phone calls is saved. The calls for a particular problem that is solved should be counted. The average phone calls per month should be taken and the average time of such a call. It can be calculated what the cost savings are per month or year. Vendor companies gain benefits from decreased amount of customer support. Internal development organizations gain benefit form decreased user support, which is the same formulae.

**Decreased turnover costs**

Employee turnover cost companies extra money. Savings can be made by reducing turnover cost. What must be known are: the annual reduction in employee turnover, cost of the turnover (percentage of salary employee) and the average annual salary of employees.

\[ CSTC = R_e \cdot S_n \cdot CT \]

The Average annual salary of personnel can be found at the accounting (administration) department. It can also be estimated. Most companies have records of employee turnover. Is this not the case, than an estimation has to be made. Cost of turnover can be based on estimations from accounting personnel or can be found in accounting documents. This method is mostly used by internal development organizations.

**IT Balanced scorecard**

In recent years the “BSC” has been also applied to information technology (IT). It is shown by Van Grembergen (2000) how the “IT balanced scorecard” (IT BSC) can be linked to the business-balanced scorecard (BU BSC) and in this way support the IT/business governance and alignment processes. As cited by van Grembergen (2000), Pucciarelli et al. (1999) predict that “by 2003, 60 percent of large enterprises and 30 percent of midsize enterprises will adopt a balanced set of metrics to guide business-oriented IT decisions (0.7 probability).”

According to Van Grembergen, Figure 7 illustrates how a cascade of scorecards can be instrumental in the IT/business governance processes and how this hierarchy of scorecards can support the alignment of business and IT strategy. The IT Development
BSC and the IT Operational BSC are introduced as enablers for the Strategic BSC that in turn is the enabler of the Business BSC.

![Diagram of IT BSC]

**Figure 7: IT BSC**

The User Orientation perspective represents the user evaluation of IT. The Operational Excellence perspective represents the IT processes employed to develop and deliver the applications. The Future Orientation perspective represents the human and technology resources needed by IT to deliver its services. The Business Contribution perspective captures the business value of the IT investments.

Each of these perspectives has to be translated into corresponding metrics and measures that assess the current situation. These assessments have to be repeated periodically and have to be confronted with goals that have to be set beforehand and with benchmarking figures. Very essential is that within an “IT BSC” the cause-and-effect relationships are established and the connections between the two types of measures, outcome measures and performance drivers, are clarified. A well-built IT scorecard needs a good mix of these two types of measures. An example that is given an outcome measure like programmers’ productivity (e.g., number of function points per person per month), which without performance drivers such as IT staff education (e.g., number of educational days per person per year) does not communicate how the outcomes are to be achieved.

Performance drivers without outcome measures may lead to significant investment without a measurement whether this strategy is effective. Another example that is given by Van Grembergen is the outcome measure of an “index of customer satisfaction” with the performance driver “average response time helpdesk” (Van Grembergen 1998). These cause-and-effect relationships have to be defined throughout the whole scorecard: more and better education of IT staff (future perspective) is an enabler (performance driver) for a better quality of developed systems (operational excellence perspective) that in turn is an enabler for increased user satisfaction (user perspective) that eventually must lead to a higher business value of IT (business contribution perspective) (Van Grembergen 1998).
A final question that Van Grembergen (2000) is trying to answer is: how does the “IT balanced scorecard” satisfy IT governance? In other words, how does the “IT balanced scorecard” answer the three IT governance questions? The proposed cascade of balanced scorecards fuses business and IT and in this way supports the IT governance process. The example of Figure 8 illustrates that IT is fully involved in the (new) business processes of the bank. The Business BSC shows a marketing strategy of reaching more and new customers through alternative distribution channels. The alignment IT/business process and the IT governance process is shown in the IT Strategic BSC and the IT Development BSC: the web site technology is chosen and a rapid web site development approach is to be applied. The different balanced scorecards drive the business and IT strategies on measurement and follow-up. In this way, there is assurance (or no assurance) that the IT organization returns some business value and does not invest in bad projects, and about the adequacy of IT control mechanisms. The scorecards may also uncover major problems. It may be possible that the Board of Directors of a bank decides to go for web banking and that its IT organization is not at all acquainted with this technology as delineated by its IT Development BSC (Van Grembergen 2000).

The steps that are to be taken in order to develop a business specific “IT BSC” are already partly addressed above, however Van Grembergen (1998) states these explicitly in his book:

---

**Business Balanced Scorecard**

<table>
<thead>
<tr>
<th>Corporate perspective</th>
<th>* increase net income</th>
</tr>
</thead>
<tbody>
<tr>
<td>Customer perspective</td>
<td>* individual relationships</td>
</tr>
<tr>
<td></td>
<td>* new distribution channels</td>
</tr>
<tr>
<td>Internal perspective</td>
<td>* customer relationship management</td>
</tr>
<tr>
<td></td>
<td>* electronic distribution channels and call centers</td>
</tr>
<tr>
<td>Innovation perspective</td>
<td>* teach employees to use the new approaches</td>
</tr>
</tbody>
</table>

**IT Strategic Balanced Scorecard**

<table>
<thead>
<tr>
<th>Corporate contribution</th>
<th>* higher business value</th>
</tr>
</thead>
<tbody>
<tr>
<td>User perspective</td>
<td>* internal users</td>
</tr>
<tr>
<td></td>
<td>* external users (consumers and business)</td>
</tr>
<tr>
<td>Internal perspective</td>
<td>* business intelligence technology</td>
</tr>
<tr>
<td></td>
<td>* website technology</td>
</tr>
<tr>
<td>Innovation perspective</td>
<td>* teach IT professionals and business users to use the new approaches</td>
</tr>
<tr>
<td></td>
<td>* research into emerging technologies</td>
</tr>
</tbody>
</table>

**IT Development Balanced**

| Corporate perspective | * new, better and faster development processes |
|                       | * development with new technologies |
| User perspective      | * user interfaces for external users |
| Operational excellence| * rapid development |
|                       | * website development |
|                       | * data warehouse development |
|                       | * data mining development |
| Future Orientation    | * training and education of IT staff in emerging technologies |

---

Figure 8: Bank example of a cascade of scorecards
1. An introduction of the “IT BSC” to the top level management and IT management.
2. To collect information about the business strategy and IT strategy, plus the collection of the IT metrics that are in use.
3. To develop a strategic and business specific “BSC” based on the principles and the steps described in Kaplan and Norton (1996).

There are many potential problems given that one can have with the IT balanced scorecard, these can be found in every type of organization. The solutions for these problems however, are specifically applicable for a type of business. An example that is given is that the cause and effect relations are not clear in the “IT BSC”, which can result in measuring the wrong things. The solution is to involve a BSC expert when developing a “BSC”. One can check whether this worked by doing interviews with people who can make these cause and effect relations more clear (Van Grembergen 1998).

**Information economics**

“Information economics” of Parker and Benson (cited by Van Grembergen 1998) evaluates the intangible elements and the tangible elements. This method is only applicable for the evaluation of IT projects according to Van Grembergen (1998). The method of information economics is a scorings technique with value- and risk categories that can have values ranging from 0 to 5. Where 0 is a negative contribution and 5 is a positive contribution. With risk categories 0 means no risks and 5 means risky.

To give some examples: company value has categories like competitive advantage, service and quality etc. Company risks are for instance business strategy risks, IT risks are technical uncertainties. Lastly an example of IT value that is mentioned is strategic IT architecture.

The value- and risk categories have weights. When one adds the weighted scores of the different value categories and one subtracts this with the weighted scores from the risk categories the end score of an IT project is calculated.

Every company has to customize this list to its own context. This method is related to the customization of this list, since users of this method can state in this list their estimations about the company value and the IT value for this project. In this way the company contribution of the project can be determined and the intangible elements evaluated (Van Grembergen 1998). “Information economics” can be used by internal development organizations or by vendor companies.

### 2.8 Usability calculation methods

An overview will be given of the cost-benefit calculation methods, which can only be used for a cost-benefit analysis for usability.

#### 2.8.1 Cost calculation method

There are not many cost calculation only methods, because the costs of usability can easily be calculated with existing general calculation methods.

**Planned usability-engineering program**

All the usability activities that have been used by a company can be put in a planned usability-engineering program (see Table 3). In the program are the costs for the different usability activities/techniques located and the number of times they are used.
(Bias and Mayhew 1994). A total can be given of all the costs. The planned usability-engineering program could be adopted by other industrial enterprises and changed to a general cost calculation method.

<table>
<thead>
<tr>
<th>Life Cycle Stage</th>
<th>UI Task / Technique</th>
<th>Cost / Technique</th>
<th>Number / Technique</th>
<th>Total Cost ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Functional specification</td>
<td>Task Analysis</td>
<td>2,425</td>
<td>4</td>
<td>9,700</td>
</tr>
<tr>
<td></td>
<td>User interviews</td>
<td>6,000</td>
<td>1</td>
<td>6,000</td>
</tr>
<tr>
<td>Design</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td><strong>Total cost</strong></td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
</tbody>
</table>

*Table 3: Planned usability-engineering program (From Chapter 2 Bias and Mayhew 1994)*

2.8.2 Benefit calculation method

During the literature study not many benefit calculation methods for usability were found. We think that the cause of this may be that usability focuses more on cost saving, instead of obtaining benefits. The formula for the method “increased sales” is based on the examples given in Bias and Mayhew (1994).

*Increased sales*

When estimations are made about this category one should consider relevant market forces such as current market share, trends of the market, and strength and weaknesses of the competition. Only new sales that could be attributed to increased usability are here considered. What must be known for calculating increased sales are: number of extra systems sold due to usability and profit margin per product.

\[
IS_i = ES_i \cdot PM_i
\]

Where:

- \(IS_i\) = Increased sales of product \(i\)
- \(ES_i\) = Number of extra systems sold of product \(i\)
- \(PM_i\) = Profit margin of product \(i\)

The profit margin is a percentage of the selling price. This is known in companies and can be found. If companies are not too eager to give their profit margin away, than it can be based on an estimation. It is difficult to precisely say how much extra systems are sold due to improved usability. Usability does not have to be the only factor why there is an increase in sales of some product.

*Yearly earnings*

The following explanation is based on the situation of Lund’s company (Lund 1997). If someone has a new idea for a product he puts it in the database. The new idea should be screened for feasibility, its revenue potential and its strategic fit. If the idea passes the screening, a project manager prepares a formal business case. The number of ideas that become part of the database and the number of ideas for which business cases are prepared are tracked. Eventually the revenue stream resulting from these new ideas is tracked. As a measure of the value of the ideas emerging from the department all the earnings in approved business cases resulting from ideas that came from the department
are added. The NPV is used to represent earnings in the idea’s business case. Increasing the number of idea’s generated per person or by increasing the added value of each idea can increase the value of a department.

\[ IV = \sum_{i} NPVi \]

Where:
- \( IV \) = Idea’s Value
- \( NPVi \) = Net Present Value of idea \( i \)
- \( i \) = number of ideas

To demonstrate the value of usability improvements for the company, the value added for each project supported is summed for the usability department. The costs and benefits for each project are estimated, and the difference is used to calculate a NPV. For the remaining projects, for which there does not exist enough information to generate an analytical estimate, an estimate shaped by historical data is used. A catalog of case studies in which one records before and after productivity and revenue data is used. The total value of usability is the sum of the sum of values that have been added to projects through field measurements (\( NPVd \)), the sum of values that can be estimated for projects based on specific usability improvements (\( NPVe \)) and the sum of a 10 percent improvement in the NPV from the business cases of the remaining projects (\( NPVb \)).

\[ UV = (NPVd) + (NPVe) + (0.10 * NPVb) \]

Where:
- \( UV \) = Usability Value
- \( NPVd \) = values that have been added to projects through field measurements
- \( NPVe \) = values that can be estimated for projects based on specific usability improvements
- \( NPVb \) = 10% improvement in the NPV from the business cases of the remaining projects

The total value is:

\[ TV = UV + IV \]

Where:
- \( TV \) = Total Value
- \( UV \) = Usability Value
- \( IV \) = Ideas Value

The TV is deceptive because one way to increase the value is to simply increase the number of people in the department and thus the total work completed (Lund 1997). To have a metric that allows a determination of whether productivity is increased, the average year-to-year revenue added by each usability professional must be known.

One of the concerns was that dividing by the actual number of professionals in the department would mean that productivity could be improved by simply increasing the
number of employees. Thus instead of dividing by the number of professionals in the
department, it is divided by the number of virtual professionals. To calculate the number
of virtual professionals (VP), the average number of hours per week each person in the
department is working was calculated. The yearly earnings (YE) per person is calculated
by dividing the total value by the earnings period used in the NPV calculation (n), and
the number of virtual professionals in the department (Lund 1997).

\[
\text{YE} = \frac{TV}{n \times VP}
\]

Where:
YE = Yearly Earning
TV = Total Value
n = earnings period used in NPV calculation
VP = Number of Virtual Professionals

2.9 Summary of cost-benefit calculation methods

A brief summary of the different methods is made by listing the properties (variables) of
the methods. In Table 4 through Table 8 this is done. First a short characterization will
be given of the different description variables, then the description variables for each
method are described.

Description of the variables
The first description variable is the focus of the different cost-benefit calculation
methods. In other words, for what purpose can this method be used? The second
description variable is about the variables of the different methods. There are methods,
which use the same variables, for example, most of the cost-benefit calculation methods
use wage per hour. As the third description variable the combination rules that the
different methods apply are described. An important description variable is the unit of
measurement the different methods use. It is important that the same unit of
measurement is used when the results have to be added or subtracted from each other.
The kind of measure has to be dollars if a cost-benefit calculation for usability has to be
made. A cost-benefit calculation method has certain assumptions about the results. The
last three description variables are how to measure in practice; whether or not this
measurement is straightforward and how easy it is to measure. Cost-benefit calculation
methods can be calculated but sometimes it is not easy to get the information that is
needed to fill in the variables, then this must be estimated. Non-ambiguous and
straightforward depends on the estimations that have to be made and the kind of data
that has to be retrieved. How easy to measure the method is, depends on all criteria.
This consists of two components: how can a measuring system be installed in such a
way that it results in the data that is needed? How much effort has to be made to acquire
the data that is needed? This range from very easy to very difficult. Below will the
variables, which where described be applied at the different methods from the previous
sections.
Description of the methods

The variables which were described above, will be used to make a distinction between the different methods, which were described in sections 2.6, 2.7 and 2.8. The methods will be compared in order to arrive at set of methods, which could be used for the cost-benefit calculation at Baan.

In Table 4 the general cost calculation methods are summarized.

- The calculation method “activity costs” focuses on the performed activities. It does not have assumptions and is very easy to measure in practice, because the necessary data can be easily found or estimated.
- “Activity Based Costing” focuses on linking expenses of resources on the variety and complexity of products produced. The variables are costs of resources, activities and products. It is a difficult to use method, because it has many formulas, which have to be filled with data.

In Table 5 the general benefit calculation methods are summarized.

- “Payback period” focuses on the return of the investment. When the benefits and costs are known is it is a very easy method, but if they have to be calculated it becomes more difficult. Experts have to estimate the cost and benefits. The problem with estimation is that there is no guarantee that they are valid.
- “Present value of future cashflow” focuses on the present value of future cashflows. The assumption is that cashflows have different values over time. Future cashflows have to be estimated by experts. How valid these estimations are, is a problem for every method where estimation plays a (significant) role. The discount rate can be found in a table and are decided upon by the project management team. The method scores average on the question how easy it is to measure.
- The “net present value” focuses also on the present value of cashflows and the present value of costs. The comments are the same for this technique as the previous comments.
- “Profitability index” focuses on present value of inflows and outflows. The assumption here is that the project with the highest rate is the project with the most benefits and thus the best option to choose. Problem with this method is that it is a rate instead of dollars. The project inflow and outflow must be calculated or estimated by experts. When inflows and outflows can be calculated, the data could (would) be found by managers or by the accounting department. The ease of measuring is average.
- “Return of investment” is also a rate and the projects with the highest rate are the best to choose. The return of investment is most of the time based on estimations of experts. The ease of measuring is average.
- “Balanced scorecard” focuses on the strategic goals of a company and monitors if they are achieved. The variables are performance indicators. It can be used as an estimation technique. The ease of measuring is difficult, because if a company doesn’t have clear goals it is hard to measure them. There are many departments in a company that are contributing to a high level strategic goal.
In Table 6 the information system benefit calculation methods are summarized.

- “Increased productivity” focuses on higher productivity of the company’s personnel. Increased productivity saves money. When it is calculated, the time reduction of an activity must be measured in an experiment. Experts can also estimate it. This is difficult to measure, because productivity is a difficult concept. The time that is won by decreasing the duration of an activity is not fully used for other activities. Another problem is whether the increase solely can be attributed to improved usability. Environmental effects could cause the increase in productivity instead of the improvement of usability. This is a problem, which applies to every method in this table.

- “Decreased costs of training users” focuses on the training hours that a user receives. The assumption is that decreasing the number of training hours will decrease the costs (which is a benefit). The problem with this method is whether the decrease solely can be attributed by improvement of usability or not. The reduction can be measured or estimated by experts (trainers). The ease of measuring is average.

- The focus of “decreased user error” is on eliminating errors, which saves recovery time from these errors. Problem with this method is the definition of user errors. What is it and what has usability to do with these errors? Errors can be measured (observed) or estimated by experts. The ease of measuring is average.

- “Decreased amount of customer support” focuses on decreasing the number of calls and the call duration. These calls can be tracked in a support database. Experts can also estimate them. The ease of measuring is average.

- “Savings gained from making changes earlier in the design life cycle” focuses on eliminating errors early in the design cycle. The assumption is that repairing errors early in the design life cycle will cost less than repairing them later. It can be based on estimations, rules of experience or be calculated. The ease of measuring is average.

- “Decreased turnover rate” focuses on the turnover of employees. The assumption is that the lower the turnover of employees, the lower the extra costs of the turnover. The turnover rate can be estimated by experts or calculated from data, which the company has. The ease of measuring is average.

- “IT balanced scorecard” focuses on a balanced set of metrics to guide business-oriented IT decisions. Performance indicators are used as variables. A problem with this method is, if the estimations are valid. The unit of measurement is a rate. It can be used as an estimation technique. It is a difficult method, because if a company doesn’t have clear goals it is hard to measure them. Furthermore there are many departments in a company that are contributing to a high level strategic IT goal.

- “Information economics” focuses on scorings of risk and value categories. It is a performance indicator, the higher the rate is the better it is for the company. Problem with this method is how valid the estimations are. The ease of measuring is difficult.

In Table 7 the usability cost calculation methods are summarized.

- “Planned usability engineering program” focuses on the usability activities that are performed of will be performed in a project. This can be calculated by project plans and time sheet. The ease of measuring is easy.
In Table 8 the usability benefit calculation methods are summarized.

- “Increased sales” focuses on the extra products that are sold due to improved usability. The assumption is that an improvement of usability will help to sell more products. The problem with this is whether improved usability solely contributes to the extra products sold. This will likely be estimations because most companies will not give the figures or don’t have the figures that are needed. So the ease of measuring is very difficult.

- “Yearly earnings” focuses on the value of ideas and usability. Usability consultants can file ideas, if it are good ideas the company will make a business case of it. The costs and benefits for the ideas are recorded. If the value of ideas and usability increases and the total of virtual professional stays the same, the yearly earnings will increase. The ease of measuring is difficult, because it is hard to obtain all the data for this method.

**Comparison**

A short description will be given of striking points in the tables. Almost all the methods in the tables use multiplication as combination rules and use dollars as a unit of measurement. If the unit of measurement is not dollars, then a rate is used to compare the results. The methods, which are described, can all be calculated if data is available or can be generated. If this is not the case, different experts must estimate the data. This is less precise and is always a second best option. In Table 4, Table 6 and Table 7 the variable wage is always used with a certain activity. A problem, which comes to the fore in Table 6 and Table 8, is whether reduction or increase can only be attributed to usability improvement. Environmental effects can also have influences on the reduction or increase of factors. In Table 5 the methods use often the cashflow variable. These methods can be used to compare different projects to each other. The ease of measuring depends on the variables.
### Summary of general cost calculation methods

<table>
<thead>
<tr>
<th>Calculation Method</th>
<th>Focus on</th>
<th>Variables</th>
<th>Combination rules</th>
<th>Measurement type</th>
<th>Assumptions</th>
<th>How to measure in practice?</th>
<th>Non-ambiguous, straightforward?</th>
<th>How easy to measure?</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Activity costs</strong></td>
<td>Performed activities</td>
<td>Wage per hour</td>
<td>Multiplying and adding</td>
<td>Dollars</td>
<td>None</td>
<td>Time sheet of worked hours per activity or estimation.</td>
<td>Yes.</td>
<td>Very easy</td>
</tr>
<tr>
<td><strong>Activity Based Costing</strong></td>
<td>“linking resource expenses to the variety and complexity of products produced”</td>
<td>Costs of the resources, activities and products</td>
<td>Multiplying, adding, square and subtract</td>
<td>Dollars</td>
<td>None (although handy if this accounting methodology is already in use at the company).</td>
<td>Time spent on activity and demand of product.</td>
<td>Yes.</td>
<td>Difficult</td>
</tr>
</tbody>
</table>

**Table 4: Summary of general cost calculation methods**

### Summary of general benefit calculation methods

<table>
<thead>
<tr>
<th>Calculation Method</th>
<th>Focus on</th>
<th>Variables</th>
<th>Combination rules</th>
<th>Measurement type</th>
<th>Assumptions</th>
<th>How to measure in practice?</th>
<th>Non-ambiguous, straightforward?</th>
<th>How easy to measure?</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Payback period</strong></td>
<td>Number of years before the return equals the investment</td>
<td>Cash benefits minus costs in that year</td>
<td>Subtracting</td>
<td>Time in years and dollars</td>
<td>Shortest payback time is the best project.</td>
<td>Cash benefits minus costs in a year and investments have to be estimated if the projects are not done yet. Improvements and cash benefits minus costs in a year can be calculated if the project is done.</td>
<td>How do you estimate cash benefits and costs? How valid are these estimations?</td>
<td>Easy</td>
</tr>
<tr>
<td><strong>Present value of future cash flows</strong></td>
<td>Present value of future cashflows</td>
<td>Future Cashflow No. of time periods in years</td>
<td>Multiplying, adding and square</td>
<td>Dollars</td>
<td>Future cashflows have to be estimated by experts. The discount rate is decided by the project management team.</td>
<td>Future cashflows have to be estimated by experts. The discount rate is decided by the project management team.</td>
<td>How do you estimate cashflows? How valid are these estimations?</td>
<td>Average</td>
</tr>
<tr>
<td><strong>Net present value</strong></td>
<td>Present value of cashflows and costs</td>
<td>Future cashflow No. of time periods in years</td>
<td>Multiplying, adding, square and subtract</td>
<td>Dollars</td>
<td>Project with the highest NPV is the best project.</td>
<td>Project with the highest NPV is the best project.</td>
<td>How do you estimate cashflows? How valid are these estimations?</td>
<td>Average</td>
</tr>
<tr>
<td><strong>Profitability index</strong></td>
<td>Present value of inflows and outflows of different projects</td>
<td>Project inflow Project outflow</td>
<td>Division</td>
<td>Rate</td>
<td>Project with the highest rate is the project with most benefits.</td>
<td>Project inflow and outflow must be estimated by experts or calculated</td>
<td>How do you estimate project inflows and outflows? How valid are these estimations?</td>
<td>Average</td>
</tr>
<tr>
<td><strong>Return on investment</strong></td>
<td>Return on investment</td>
<td>Average net profit Investment costs</td>
<td>Division</td>
<td>Rate</td>
<td>Project with the highest rate has the most return.</td>
<td>Average net profit and investment costs have to be estimated by experts or calculated</td>
<td>How do you estimate average net profit and investment costs? How valid are these estimation?</td>
<td>Average</td>
</tr>
<tr>
<td><strong>Balanced scorecard</strong></td>
<td>Strategic goals and actions to achieve these goals</td>
<td>Performance indicators</td>
<td>None</td>
<td>Rate</td>
<td>When the indicators (and their relating activities) are achieved, then this means good business.</td>
<td>Find the indicators on the management level, else this can be used as an estimation method.</td>
<td>How to find these strategic goals when a company does not use the BSC method?</td>
<td>Difficult</td>
</tr>
</tbody>
</table>

**Table 5: Summary of general benefit calculation method**
### Summary of information system benefit calculation methods

<table>
<thead>
<tr>
<th>Calculating Method</th>
<th>Focus on Variables</th>
<th>Combination rules</th>
<th>Measurement type</th>
<th>Assumptions</th>
<th>How to measure in practice?</th>
<th>Non-ambiguous, straightforward?</th>
<th>How easy to measure?</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Increased productivity</strong></td>
<td>Increased productivity</td>
<td>Productivity ratio, Reduction in time, Wage per hour, Size of user population, Workdays</td>
<td>Multiplying</td>
<td>Dollars</td>
<td>Increased productivity saves money.</td>
<td>Productivity ratio and reduction in time are difficult to measure and are most of the time estimations. Can the increased productivity solely be attributed to usability improvement?</td>
<td>Difficult</td>
</tr>
<tr>
<td><strong>Decreased cost of training users</strong></td>
<td>Training hours, Reduction in time, Wage per hour, Size of user population</td>
<td>Multiplying</td>
<td>Dollars</td>
<td>Decreased training hours saves money.</td>
<td>Reducing time of training can be based on judgments of trainers, so most of the time there are estimations.</td>
<td>Can the reduction in time solely be attributed to usability improvement?</td>
<td>Average</td>
</tr>
<tr>
<td><strong>Decreased number of user errors</strong></td>
<td>Errors, Size of user population, Error elimination, Workdays, Wage per hour, Recovery time</td>
<td>Multiplying</td>
<td>Dollars</td>
<td>Decreased number of user errors save time and cost in recovering from an error. This saved time can be spent on other duties.</td>
<td>User errors can be observed during a (usability) test. The time it cost to recover from these errors can during these tests be measured. It is possible to estimate the errors and recovery time, this must be done by experts.</td>
<td>What is the definition of a user error? Can the eliminated errors solely be attributed to usability improvement?</td>
<td>Average</td>
</tr>
<tr>
<td><strong>Decreased amount of customer support</strong></td>
<td>Telephone calls of customers, Wage per hour, Call duration, Size of user population, Eliminated calls</td>
<td>Multiplying</td>
<td>Dollars</td>
<td>Decreased amount of customer support saves money.</td>
<td>Call duration and eliminated calls can be tracked in a support databases.</td>
<td>Can the eliminated telephone calls solely be attributed to usability improvement?</td>
<td>Average</td>
</tr>
<tr>
<td><strong>Savings from making changes earlier in design life cycle</strong></td>
<td>Costs made during the design life cycle of a product, Wage per hour, Changes made per year, Hours spent per change, Reduction factor</td>
<td>Multiplying and subtracting</td>
<td>Dollars</td>
<td>Errors earlier repaired in the design life cycle is cheaper than repairing them later</td>
<td>Eliminated errors can be tracked in a database. It can be calculated or estimated by rules of experience or expert.</td>
<td>Can the early elimination of errors solely be attributed to usability improvement?</td>
<td>Average</td>
</tr>
<tr>
<td><strong>Decreased turnover rate</strong></td>
<td>Turnover of employees, Reduction in employee turnover, Salary, Cost of turnover</td>
<td>Multiplying</td>
<td>Dollars</td>
<td>Decreased turnover rate saves money.</td>
<td>Salary of personnel should not be too difficult to find. Turnover in employee is most of the time recorded in a company, otherwise experts have to make an estimation.</td>
<td>Can the decreased turnover rate solely be attributed to usability improvement?</td>
<td>Average</td>
</tr>
<tr>
<td><strong>IT balanced score card</strong></td>
<td>Balanced set of metrics to guide business-oriented IT decisions</td>
<td>Performance indicators</td>
<td>None</td>
<td>Rate</td>
<td>When the indicators (and their relating activities) are achieved, then this means good business.</td>
<td>Find the indicators on the management level. This can be used as an estimation technique.</td>
<td>Are the cause and effect relations clear?</td>
</tr>
<tr>
<td><strong>Information economics</strong></td>
<td>The company’s contribution of a project can be determined and intangible elements evaluated</td>
<td>Performance indicators</td>
<td>None</td>
<td>Rate</td>
<td>The higher the rate the better the score is for the company.</td>
<td>Based on estimations of risk and value categories.</td>
<td>How valid are these estimations?</td>
</tr>
</tbody>
</table>

*Table 6: Summary of information system benefit calculation methods*
### Summary of usability cost calculation methods

<table>
<thead>
<tr>
<th>Calculation Method</th>
<th>Focus on Variables</th>
<th>Combination rules</th>
<th>Measurement type</th>
<th>Assumptions</th>
<th>How to measure in practice?</th>
<th>Non-ambiguous, straightforward?</th>
<th>How easy to measure?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Planned usability engineering program</td>
<td>Worked hours on an activity</td>
<td>Wage per hour Time spent on activity One time cost</td>
<td>Multiplying variables and adding cost of activities</td>
<td>Dollars</td>
<td>Project plan and time sheet of worked hours per activity or estimation.</td>
<td>Yes, it is easy to calculate the costs of different usability activities.</td>
<td>Easy</td>
</tr>
</tbody>
</table>

Table 7: Summary of usability cost calculation methods

### Summary of usability benefit calculation methods

<table>
<thead>
<tr>
<th>Calculation Method</th>
<th>Focus on Variables</th>
<th>Combination rules</th>
<th>Measurement type</th>
<th>Assumptions</th>
<th>How to measure in practice?</th>
<th>Non-ambiguous, straightforward?</th>
<th>How easy to measure?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increased sales</td>
<td>Extra products sold due to usability</td>
<td>Extra sold products Profit margin of a product</td>
<td>Multiplying</td>
<td>Dollars</td>
<td>There will be more products sold, because the product is made more usable.</td>
<td>Most likely estimations, because companies don’t like to give their profit margin away.</td>
<td>Very Difficult</td>
</tr>
<tr>
<td>Yearly Earnings</td>
<td>Values of ideas and the value of usability.</td>
<td>Ideas value Usability value Virtual professionals</td>
<td>Multiplying and division</td>
<td>Dollars</td>
<td>Ideas have values for companies, increase in value of idea’s and usability value will increase total value.</td>
<td>Based on estimations, most companies don’t record value of ideas. Sometimes calculations</td>
<td>Difficult</td>
</tr>
</tbody>
</table>

Table 8: Summary of usability benefit calculation methods

### 2.10 Conclusions

Usability is defined as the extent to what the product supports the user by the execution of his or her task (Hinssen and Vons 2001). In the literature many benefits of usability can be found (see 2.2 Usability explained). Usability needs to be introduced keeping three different aspects in mind: cultural, technical and strategic. A cost-benefit analysis is a method for analyzing projects investment purposes (Burill and Ellsworth 1980 as cited by Karat 1994). The trace-ability and the measurability of benefits can be very difficult, one has to take out not to quantify certain benefits in multiple benefit calculations. Most of the time in a cost-benefit analysis the costs and benefits of a product with usability and a product without usability are compared. The goal of such an analysis is to determine the cash value of the positive difference in a product due to usability engineering. The focus in an usability cost-benefit analysis should be on the benefits that are the most relevant to the group for which the analysis is conducted (Donahue et al. 1999). There are several methodologies for cost-benefit calculation methods. These different methodologies use different kind of calculation methods. The calculation methods that were found were divided in three different groups: general cost-benefit calculation methods, information system calculation methods and usability calculation methods. Most of the calculation methods which were described in the previous section are average or difficult to measure. This is because most methods are not non-ambiguous and straightforward. This means that implementing such a method will be difficult. Most calculation methods that has been found use dollars others use rate as a measurement type. All the general benefit calculation methods use estimations. The information system benefit calculation methods have problems with attributing cost reductions uniquely to usability improvement. Other factors could also have played a
role. Many information system benefit calculation methods are cost savings methods. The benefits are the cost savings by reduction in worked hours for employees.
Chapter 3 Inventory of usability activities within Baan

3.1 Introduction

In this third chapter we will present an inventory of the usability activities within Baan. First we give an overview of the Baan organization by means of organizational charts, with the emphasize on Baan Development. In this way it can be seen where one can position usability consultancy within the entire Baan organization. Then the Baan Development process follows, where their development methodology, DMethod, plays a crucial role. Here we will emphasize what exactly is done in which phase of the development process and in what phase usability activities are performed. In the next section the Baan usability activities within the Baan Development process are highlighted. After this we will make a classification of these usability activities according to Kabel et al. Then the attitude towards usability within the Baan organization is investigated. Finally we will describe how the project management level works, since this is the level at which usability activities are assigned to projects.

3.2 Overview Baan organization

Baan was founded in 1978 in The Netherlands. Since then, they've built on their early expertise in software for the manufacturing industry to become a leading developer of innovative, integrated software solutions for every major area of business today.

Baan develops software solutions and services which help companies to do business in the 'networked economy' - where information, integration and internet collaboration are ever more important.

- Baan Development serve more than 15,000 customer sites all over the world
- Baan has more than 3,000 employees
- Baan is headquartered in Barneveld, The Netherlands, with offices worldwide, in as much as 60 countries.
- Baan is wholly-owned by Invensys, division Production Management.

Below one will find a Figure 9 that represents Baan as an organization, including Baan Development where the assignment takes place.

Figure 9: Baan organization
The next organization chart represents Baan Development (see Figure 10) in more detail, here you can find Usability Consultancy (“usability”) under ERP.

Figure 10: Baan development organization

Legend:
ASG: Application Server Group
BIS: Business Intelligence Solutions
BTG: Baan Translation Group
CAT: Configuration and Assembly
DCS: Development Customer Solutions
ERP: Enterprise Resource Planning
HRM: Human Resource Management
KD: Knowledge Development
MBC: MultiByte Center
PBC: Porting and Benchmark Center
PPO: Project and Process Office
PTG: Product Testing Group
SCS: Supply Chain Solutions
VAT: Vision and Architecture

All boxes that colored red are departments that use activities (see further) performed by Baan Usability Consultants.
3.3 Baan development process

3.3.1 Introduction

The Baan development process is described in what is called DMethod which is an electronic handbook that contains a methodology for developing software and is used by the people at Baan. DMethod specifies which methods can (optional) or must (mandatory) be used in activities for developing software. Explanation is given how the methods should be used in the activities, template documents are available to fill in, and examples can be studied. Although it is stimulated to cover all the stages, not all projects use the DMethod strictly.

3.3.2 Baan development methodology: DMethod

Figure 11 provides an overview and introduces the main concepts, terminology and roles that are used in the DMethod. From the figure can be derived that a project model within Baan contains work products. These work products are precisely defined outcomes of development processes that are executed by work instructions and supported by tutorials. Work products are used by roles, roles are the most important process descriptions. How DMethod is filled in practice can be seen in 3.3.3, also the role of usability consultancy in DMethod is described there.

![Diagram](image)

*Figure 11: DMethod*
3.3.3 Stages in the development process:
The main stages of a standard (release/development) project are presented in Figure 12. The stages represent a waterfall model. Most of the time the development teams are not returning to previous stages, due to lack of time, but it is possible.

![Diagram of stages in the development process]

*Usability Consultancy* marks where Usability Consultancy within DMethod is active, for more detail of their activities in these stages see the next section 3.4.

The requirement stage
In the requirement stage two main questions must be answered: what Baan Development is going to make? When should Baan Development have their products available?

The following activities have to take place:
- Version definition composed
- Preliminary project plan created
- Conceptual Solutions written *(Usability Consultancy)*
- Documents edited, reviewed and approved by the Product Lifecycle Committee (PLCC)

Work Products:
- Version Definition (VD): defines and explains the new or modified functionality for a new version/release of a software product.
- Conceptual Solution (CS): contains a detailed elaboration of the functionality from a business perspective as specified in a Business Requirement. The aim is that a CS is so complete that a team of Software Engineers should be able to complete the Definition Study and/or the Functional Design. *(Usability Consultancy)*
• Project Plan: defines the objective (project result), scope, organization, time schedule, and so on for a project.

The design stage
During the design phase the ‘how’ question will be answered. Functional and technical descriptions of the software will be made.
The following activities have to take place:
• Designs written
• Project Plan updated and approved by the PLCC
• Designs edited, inspected and approved by development managers
• Prototyping (optional)
Work Products:
• Definition Study (DS): is based on the VD and provides an outline of the chosen functionality of the software for the next version.
• Functional Design (FD): contains a detailed design elaboration of the functionality described in the CS and DS. *(Usability Consultancy)
• Technical Design (TD): describes how the functionality specified in a functional design is translated into source code.
• Project Plan: defines the objective (project result), scope, organization, time schedule, and so on for a project.

The realization stage
Code is written, tested and documented in this phase.
The following activities have to take place:
• Code written
• Technical and Functional Unit Tests executed
• User Documentation written
Work Products:
• Software *(Usability Consultancy)
• Test Data (TDA) *(Usability Consultancy)
• User Documentation (UD): documentation in US English that is written for a release development project. Typical products are installation guides, conversion guides, and tuning guides.
• Project Plan: defines the objective (project result), scope, organization, time schedule, and so on for a project.

The testing stage
Two kinds of tests are executed: the Integration Test and the System Test. A performance benchmark is done as well.
The following activities have to take place:
• Integration between units tested
• Benchmark on performance
• System Test executed
• User Documentation written
• Software and Documentation translated
Work Products:
• Software *(Usability Consultancy)
• Documentation *(Usability Consultancy)
• Test Plan (TPL)/Design (TED)/Data (TDA)/Report (TER): The test plan describes the technical and management approach to be followed for testing a release.

• Sizing Guide (SG): is created by the porting and benchmark center (PBC) to be used by presales people who have to propose a suitable hardware configuration for Baan products.

• Project Plan: defines the objective (project result), scope, organization, time schedule, and so on for a project.

Roll out stage
This phase contains acceptance of the new release, knowledge exchange and creating the tapes and cd’s containing the new package.
The following activities have to take place:
  • Support Centers trained and supply information
  • Go/no go decision
  • Creation of media (CD, master tape)

Work Products:
  • Trained people
  • Training material
  • Accepted release
  • Tape/CD with new release

Initial Maintenance stage
During the initial part of this phase the answering of questions of customers, responding to customer support requests and bug fixing is done. In the later part of this phase, e.g. end of production or end of service, Baan Development (BD) is not involved. The Product Engineering Group (PEG) does this. Support is given by the development organization.

3.4 Baan usability activities within the development process

The usability department within Baan consists of 5 usability consultants and 2 visual designers and is located in Barneveld. They are responsible for the products being developed in the Netherlands.

They state their mission as follows; “Delivering usability services to enable development of usable Baan products, which are easy-to-use, attractive and appealing, allowing Baan’s customers to optimize their productivity and work satisfaction.”

Figure 13 gives an overview of the usability design techniques incorporated in DMethod.

Baan products are meant to automate business processes of their customers, therefore business processes are the starting point for the task analysis of the usability consultant. An example of a business process is administrating incoming goods.
3.4.1 Usability techniques used
We will describe the usability techniques used by usability consultants in the Baan development process. Their activities are (optionally) offered to Baan product groups.

3.4.2 Conceptual Solution
The Conceptual Solution as defined in DMethod includes the usability techniques of task analysis, conceptual usability design, prototyping (mockup) and usability walkthrough. These techniques provide insight into the users, their tasks, the kind of information they require, the objects they work with and the actions and views they will need in order to perform their tasks in an efficient and intuitive manner. Below we will describe these techniques in more detail.
Based on the knowledge gathered in the conceptual solution phase, a functional design can be defined more easily, more accurately, and more quickly. It provides a solid base for further development. Particularly, it minimizes the risk of having to redesign the product during a later stage in the development process.

3.4.3 Task Analysis
The task analysis is the first step of the design method and is the basis for the entire design. Goal of this step is to collect relevant information about the user profile, the organizational context and the actual user tasks.
For a task analysis users will be visited in their own environment, thereby collecting the relevant information through interviews, observations and document analysis. Usability consultants explicitly pay attention to the information and other things that a user needs for performing the tasks (e.g. a packing list).
Two different techniques are used to describe task structures: flow diagrams and hierarchical task models. Flow diagrams are used because they match well with the process-oriented nature of the Baan products. Particularly in the phase of establishing usability design within Baan this was important, since it increased acceptance of task analysis and its integration into DMethod. Hierarchical task models are used when there is a need for a detailed elaboration and/or complex task structures must be described. In practice a usability consultant chooses one of both techniques, but sometimes these are also combined.

3.4.4 Task Design
In the task design phase a usability consultant subsequently restructures the activities, taking into consideration user profile and organizational context. Those activities will be combined with activities that will be supported by possible new functionality.
Restructuring activities may include:
- Reordering activities and decision moments in order to increase the effectiveness and efficiency of task performance.
- Solving possible problems with the current system (software product) that were found during task analysis.
- Improving the information exchange between user and system: the system should provide the user with the correct information at the correct moment, and should only ask information that the user has available.
- Guaranteeing sufficient flexibility: whenever necessary the user must be able to adapt the order of activities to the situation.

3.4.5 Conceptual Usability Design
During the conceptual usability design a usability consultant extracts all objects from the task design that will be included in the user interface. For each of these so-called user interface objects usability consultants define what information of the object must be provided by the system and how this information must be grouped and presented (in one or more views). A usability consultant also defines the actions the user must be able to perform on each object and how the user can navigate between all objects. In practice it appears that the goal of conceptual usability design can be explained quite easily by pointing out that this step translates task design to screen design. The method for making the design as such is also considered relatively simple. However, the design decisions (e.g. what are the user interface objects) are not always obvious. Furthermore, persons who are used to making technically oriented designs find it hard to work with “mental” concepts and objects. Therefore it is preferred that a conceptual usability design is made by a usability consultant instead of by a member of a product group.

3.4.6 Prototyping
On the basis of the conceptual usability design a usability consultant makes a screen design for the different user interface objects. Usability consultants already anticipate the technology that will be used to realize the system. The screens are elaborated at such a level that they can be used in the next step (the usability walkthrough). Depending on the situation, a usability consultant makes his/her prototypes in HTML, a visual development environment or a drawing tool. The first two have the advantage of making technically realistic, and they can be used as a basis for developing the actual software product. This both reduces the number of usability defects found during usability reviews and increases acceptance of the designs of Baan. The advantage of using a drawing tool, or just paper and pencil, is the ability to quickly provide insight into concepts without getting bogged down in unnecessary details.

3.4.7 Usability Walkthrough
In order to obtain user feedback as early as possible, a usability consultant uses the screen designs of the prototype for a simple usability test. In this test usability consultants ask a few future users to walk through a number of predefined task scenarios and to indicate how they interpret the presented screens and how they would use them.
The problems found during the usability walkthrough may require modification of the screen designs or even the conceptual usability design. After all modifications are done, the usability design as a whole can be included in the conceptual solution and used as input for the functional design.
During the technical design (TD) and realization (TR) of the product, usability consultancy can support development groups on designing windows, answering questions about which controls to use, on user interface guidelines, and on ad hoc usability issues.

**Usability testing**

To verify the usability of the product, usability consultants perform a usability test on the product (during Integration Test) with a usability lab. This means that at first test scenarios based on real user tasks are defined. Subsequently real end-users are visited and are asked to perform these tasks with the product while thinking aloud. During the test everything can be recorded on video to make sure no information is lost: the remarks of the user, the actions the user performs, the monitor output, the expectations of the user, the duration of each task, the number of screens needed, etc. In the end, the results will be analyzed and a usability test report will be written which contains suggestions on how to improve the usability of the product.

**Visual design and Icon design**

Besides the ‘Feel’ aspects of the user interface usability consultancy also provides services on the ‘Look’. The icon design team designs icons for all Baan Enterprise Solutions: visual images that clearly communicate the meaning of the functions behind toolbar buttons, tree controls, menu items, and small animations. Currently usability consultancy is also doing visual design for all E-enterprise and BaanERP Studio products (both web enabled products and WIN32 applications), which directly results in ‘attractive’ and ‘appealing’ screens but indirectly also in a corporate look for all the products that will be defined in a style guide (see further).

3.4.8 Other Usability Activities

In addition to applying the usability design method, a usability consultant carries out various other usability activities. The first one, promoting usability, is aimed at making the product groups, which develop software within Baan, more usability-minded and at creating support for the other usability activities. The latter activities include further integration of usability in DMethod, usability audits and reviews, and usability style guides and checklists.

All usability activities are interrelated as shown in Figure 13. Further integration of usability in DMethod partly takes place, in addition to inclusion of the usability design method, via the offering and formalization of usability reviews and audits. In order to be able to perform those reviews and audits adequately, style guides and checklists are required in turn. In a few product groups, these three activities have already been started.

3.4.9 Promoting Usability in General

Despite all other activities, it remains essential to increase the usability awareness within Baan product groups. Usability should not only be embedded in processes and documents, but also in the minds of all persons involved. For this purpose, a usability consultant carries out, among other things, the following activities:

- Giving courses to make product groups more aware of usability. Usability consultants sometimes also teach product groups how to apply the usability design method themselves.
• Using the usability Intranet site to offer (references to) all kinds of support to
designers and developers, such as style guides and checklists.
• Making CD ROMs with, for instance, a multimedia presentation of our activities or
a Flash demo to introduce a new user interface design (see Table 13), and
distributing them to relevant persons within Baan.
• Using the video material of a usability test to make a compilation CD, which is
presented to the members of the product group involved in order to make them
aware of the way users work with their software product.
• Pro-actively approaching key persons within Baan, both within and outside the
various product groups, to keep usability in the spotlight.

3.4.10 Further Embedding of Usability in DMethod

The inclusion of the usability design method in DMethod has been an important step
towards making usability design an integral part of software development. Following this
a usability consultant works on further embedding of usability in the relevant steps of
DMethod. Currently it is not mandatory for project managers to include any usability
activity in their project plan, but a project manager can do this if he wants to (see
further).

There are two aspects on which this further embedding of usability in DMethod is
concentrating on:
• Usability during Functional Design
  A usability consultant wants to pay explicit attention to usability in the
  functional design, so that the right usability decisions will be made from the
  start. At the same time usability-related modifications afterwards, which are
generally time-consuming and costly, can be prevented.
• Usability during Testing
  DMethod has a number of test phases, such as the unit tests during the technical
  realization, the integration test and the system test. In most test phases, usability
  is tested by default (by developers and/or test engineers), be it using a checklist
  that deals with usability on a rather rough level. This should be done by a
  usability consultant with more specific knowledge on usability.

Goal of this further embedding of usability in DMethod is to make it not only an
integral, but also a mandatory part. For various products usability should eventually be
used as an “exit” criterion.

3.4.11 Usability Reviews and Audits

Both a usability review and a usability audit can be considered as a specific usability
check, each with its own role in the whole test process:
• The usability review is meant for testing the usability of separate screens. The review
takes place during the unit tests of the technical realization, on the basis of a
usability checklist. Condition is that the user interface of the screens to be reviewed
is finished.
• The usability audit is meant for testing the usability of a complete product. The audit
takes place after the usability review, during the integration test. In addition to the
usability of separate screens, the consistency and navigation between the screens is
also checked. As references the applicable usability style guide and checklist are
used.
Both checks are performed by a usability consultant, who logs usability defects as bugs. These bugs need to be solved subsequently in the concerning step of DMethod.

3.4.12 Style Guides and Usability Checklists
For various products within Baan Development usability consultancy has made style guides containing user interface standards and guidelines, covering all relevant aspects of the user interface. The primary purpose of these style guides is to support designers and developers with product development. Furthermore they are an important reference for the usability consultancy group, since they provide access to a large part of the available usability know-how.

To increase their use, the style guides have been used as a basis to derive compact checklists. Developers can use those checklists during development to check in an efficient way the usability of their product (or screen); the concerning style guide then serves as a reference. By linking them to a (mandatory) usability review, for which the same checklist is used, usability will eventually receive the attention it deserves from a user perspective. Developers will know then that the functionality they have developed will be subject to a usability review and that during this review the same criteria will be applied as included in the checklist.

3.4.13 Assisting in Realization
This activity came forward during different meetings with the usability consultants at Baan. During the development of software the usability consultants assists different people (e.g. software engineers, product consultants, etc.). These activities do not fall under the previously described activities. Assisting in realization consists of four subtasks: preparation of functional design, ad hoc consultancy, logging change requests and testing bugs. Preparation functional design is the activity whereby the usability consultant and product consultant discuss plans for the functionality of a software product. Ad hoc consultancy is an activity whereby team members of a product ask help from the usability consultant when the FD is implemented. Problems can arise because things described in the FD are not possible. The software engineers and the usability consultant try to come to an acceptable solution for the problems that may arise.

Logging change request is an activity where the usability consultant logs change request in a Web Defect Tracker (program for logging problems). Change request are always usability problems. The fourth sub activity is testing bugs. The usability consultant tests the software to find bugs, e.g. if some session is not working.

3.5 Focus on usability activities
We now only have a global description of the usability activities performed by the usability consultants at Baan, by categorizing the usability tasks we want to take a closer look at the usability tasks. This way we can obtain a more specific description and categorization of the usability tasks performed at Baan.

We want to do this according to the framework presented by Kabel et al. The goal we want to achieve by using this framework is twofold. First goal, as said, is to take a closer look (compared to global description) to a usability task. Especially to what categories and heuristics of the framework (see further) this task refers to when conducted by a usability consultant on a Baan product.

Second the role of this framework in relation to our quantification of the usability activities is the “effectiveness” of the task. We can assume that the more filled in heuristics a task will score the more effective this usability task is because it refers to
many different (kinds of) heuristics that one is intending to cover by conducting this usability task. In relation to quantification of usability tasks we can say that the more effective a task is the larger the part of the benefit and thus the revenues it gets assigned to. This way it can also serve as a benefit distribution model and a revenue distribution model. You can see how this is done in practice in section 9.4.

The assumption we made by using this framework and handing out the questionnaire (see section 3.5.1) is that the more weight a usability task has received the more important this task is in the daily activities of the usability consultant. In other words a usability tasks that scores many filled in heuristics is according to the usability consultant a highly effective and general usability task to conduct on a product.

We will now explain the framework of Kabel et al. The framework of Kabel et al. can be used for the evaluation of computer applications, it allows evaluation data to be categorized. So in this way remarks with respect to an application can be classified into different categories. These categories represent different levels of abstraction, and are further specified by means of heuristics that can be employed by users and evaluators for identification and articulation of design errors.

Below you will find the abstraction levels and their categories, which we will elaborate on now. Kabel identifies the following levels and categories in her model:

- **At the lowest abstraction level, a keystroke and a system image category are identified, both representing clearly identifiable, singular, tangible problems.**
  - The **keystroke category** stands for the ‘do’-category. Single, direct user actions belong in this category. For example remarks concerning the ease of carrying out a single action, or remarks concerning the consistency of the implementation of single keystrokes should be placed at this category.
  - The **system image category** represents the system’s manifestation or appearance. The way something is visualized and the consistency of presentations belong to this category.
  - This level also contains a part of the **mental model category**, which relates to the correspondence of the user’s ideas concerning the system and its behavior. A discrepancy between the two may reflect either differences in terminology used (words, terms) or disagreement of the user with the quality of the content. The former difference is part of the low abstraction level, because it is rather close to the actual operation of the system.

- **At the middle level of abstraction, a process category is identified, representing remarks that may be a result from a combination of remarks made at the lowest level of abstraction. In this category, series or sequences of user-actions belong.** The way something is done, whether it works or doesn’t, for example when a sequence of user-actions stagnates, should be categorized in the process category.
At the top level of abstraction, a system content and an efficacy category are identified.

- The system content category stands for the match of the system’s content and the external reality it represents or replaces. The correspondence between the system and its external reality is located in this category. This notion of an external reality can be illustrated with a simple example. Most modern computers have a calculator available on the screen. This calculator is displayed and behaves like an actual calculator. Thus the actual calculator represents the external reality of the computer calculator. In most cases, users expect the same functionality and behavior from the computer calculator as provided by the actual calculator.

- The efficacy category evaluates the effectiveness - the power - of the system. It is examined whether using the system is more efficient than not using it and whether it really solves bottlenecks.

- In addition, the other, more abstract, part of the mental model category is included in this level. The user’s ideas about the system can be expressed in criticism with respect to the quality of the system’s content or of the external reality it represents. One may disagree with (part of) the system’s content, or one may believe that (part of) the system is of good quality. This part of the mental model category should not be confused with the system content category. This category reflects the correspondence between the external reality and the system.

Figure 14: Abstraction levels and categories

According to Kabel, the arcs in this figure indicate that each higher level theoretically results from a lower one.

A number of heuristics that should be easily applicable by users and evaluators of user comments operationalize each of the above categories. Kabel identifies the following heuristics that apply to their respected categories.

1 We do not take the system content category into consideration here due to the irrelevance and complexity of this category for this questionnaire.
Keystroke category

*Heuristics*

K1. A single, direct action is impossible to perform.
K2. A single, direct action is hard or difficult to perform.
K3. A single, direct action is not familiar
K4. With the same single action (for example “double click”), different results are obtained (for example “select” and “open”).
K5. Equal results (for example “open”) can be obtained in different ways, using different keystrokes (for example using a “menu option” and “double click”).

System image category

*Heuristics*

SI1. Something is not legible.
SI2. Something is not visible.
SI3. Something is at an unusual location
SI4. There is no visible effect or result from my action.
SI5. It cannot be seen what this should be used for; additional interpretation is necessary.
SI6. This (form of) presentation suggests an impossible action; the way this looks does not suit the underlying function.
SI7. The presentation is not consistent; two things look the same but have different meanings, or vice versa.
SI8. The presentation is not consistent; something is missing while it is represented elsewhere, for example in an equal or comparable window.

Process category

*Heuristics*

P1. The order of actions is not right.
P2. The sequence of actions does not fit into the natural user task, or into the user’s natural way of working.
P3. Too many actions are necessary for attaining an end; the number of actions could be diminished, so the actions could be more directly performed.

Mental model category

*Heuristics*

Low abstraction

MM1. The user disagrees with the terms used in the system.
MM2. Terms are wrongly interpreted.
MM3. Terms are unfamiliar.
MM4. Terms are inconsistently used and are therefore confusing.

High abstraction

MM5. I disagree with the content.
MM6. I have different expectations of the system.

Efficacy category

*Heuristics*

E1. (This aspect of) the system enables the user to work more efficiently.
E2. (This aspect of) the system makes the user work less efficient.
E3. (This aspect of) the system enables the user to work more effectively.
E4. (This aspect of) the system makes the user work less effective.
3.5.1 Questionnaire focus on usability activities

The “Questionnaire focus on usability activities” (see Appendices E:) is distributed amongst 5 usability consultants and 1 visual designer. These people form the department of usability consultants within Baan. They had to map the usability tasks to the heuristics of the framework of Kabel et al. (see section 3.5). For each usability task they had to fill in the heuristics that they thought it referred to when applied to a Baan software product.

We will first discuss the difficulties that the respondents had in answering the questionnaire and secondly we will point out the results. Overall can be said that the respondents found it hard to understand the model by Kabel et al. This can be explained by the fact that the respondents were unfamiliar with models such as this and thus it took them quite some time to comprehend the model. In order to reduce the “reading time” we took most of the background knowledge for this model out of the actual questionnaire (as advised by our supervisor at Baan). This could also be a reason for the difficulties in comprehending the model.

There were also some very good comments on the applicability of the questionnaire for this purpose. First of all the framework from Kabel et al. is for evaluation purposes, the usability consultants do not however always have an evaluation purpose (although task analysis can be seen as an evaluation of the user). The usability consultants have more of a design task than an evaluation task. This is correct and could maybe be a reason for the difficulties to map such design tasks on this model. Secondly, it was stated (by one usability consultant) that the feeling arose that “something was missing” in the model, and that it was not really straightforward to map the usability tasks to this model.

What struck us immediately is that the respondents most of the time have chosen all heuristics of one category of the model. This can be in favor of the model because this means that the categories are coherent and thus the heuristics cannot be seen apart from each other.

From analyzing the results we can say that most of the respondents filled in those categories that referred to activities that they performed themselves. For occasions that this was not the case we made a footnote and explained the (possible) consequences of this. We have written the results in a hierarchical way, that is the most mentioned heuristics on top and the less mentioned heuristics at the bottom.

The results per usability activity will now be discussed.

Task analysis and task design

Usability improvements achieved by means of a task analysis refer to the process category and it aims at series or sequences of user-actions. This together with a high level of abstraction of the mental model category, which aims at the correspondence of user’s ideas concerning the system and its behavior, and especially at the “agreement” that the user has concerning the system and its behavior. Also the efficacy category where is examined whether using the system is more efficient than not using it and whether it really solves bottlenecks plays a role in applying this usability technique. What is described for task analysis also holds for task design.
Conceptual usability design
Usability improvements achieved by means of a conceptual usability design refers to the whole mental model category where the correspondence of user’s ideas concerning the system and its behavior is examined. Here, it is evaluated whether the user’s image of the system matches the image provided by the system. Also the process category with its heuristic “series or sequences of user-actions” is applicable here.

Prototyping
For prototyping the mental model category is again applicable, this time together with the system image category, which refers to the way something is visualized and the consistency of presentations. The keystroke category plays a minor role here.

Usability walkthrough and usability testing
Almost all of the categories are more or less applicable to usability walkthrough, so no distinctive features can be derived for this. This also holds for usability testing, this even more strongly due to the fact that the responses are more or less equally distributed over the categories.

Visual design and icon design
Now for the two (mainly) visual design activities, visual design and icon design, these according to the respondents refer mainly to the system image category that represents the system’s manifestation or appearance. The way something is visualized and the consistency of presentations belong to this category, in doing these activities the visual designer tries to improve the product for the user.

Usability review
The activity promoting usability in general is not applicable for this model. Since it is not a evaluation or a design task according to the usability consultants, we will leave this task out of this discussion. The same goes for further embedding of usability in DMethod, which can more be seen as strategic task for this group.

By applying usability reviews the usability consultant aims improvements at several categories, but foremost the keystroke category, system image and mental model categories. The first activity, which explicitly refers to the keystroke category, plays a major role here. This category holds remarks concerning the consistency of the implementation of single keystrokes, this is then where the usability consultant aims his attention at when applying this technique. As said, the system image and mental model categories are also mentioned here, but not in such a prominent way as the keystroke category.

Usability audits
As far as usability audits are concerned, the same categories are applicable to usability audits plus the process category, however the system image and mental model categories play an equally important role here next to the keystroke category.

Usability style guide and usability checklists
Usability style guides refer more or less to all (parts of) categories, so we might say that when using these you can tackle all kinds of usability issues that arise. This even holds to a larger extent for usability checklists.
**Assisting in realization**

The task assisting in realization also refers to the keystroke category, but also to the system image and process category, and for a lesser extent to the efficacy category and mental model category. For this task you can say that all categories (in full) are applicable, this is probably so because this is a very general task that can imply a diversity of things that a usability consultant should or can do within this generic task and can thus not be placed in a specific category of the model.

We have learnt here with respect to the applicability of this model is that it was difficult for the usability consultants to place certain design tasks in this evaluation model that was designed for evaluation data, also that some “other tasks” (than design tasks) could not be fitted in the model very well. Most of time whole categories with all their respected heuristics were filled in for a task, this in our view was in favor for the model and especially the coherency of the categories within this model.

Most of these usability tasks referred to all levels of abstraction in this model. Thus by applying such a task one can say that the full spectrum of (possible) improvements of an application can be reached.

However usability reviews and audits explicitly referred to the middle and low level of abstraction. The visual design tasks referred to the low level of abstraction (system image category). These tasks can be seen as more specific usability tasks when applied to improve applications.

<table>
<thead>
<tr>
<th>Usability activity</th>
<th>Activity normally performed by yourself ‘yes/no’</th>
<th>Relates to what category in the framework</th>
<th>Relates to what heuristics in the framework</th>
</tr>
</thead>
<tbody>
<tr>
<td>Task analysis</td>
<td>Process category, Mental model, Efficacy category, System image</td>
<td>P (All) (4x) MM (All) MM5, MM6 (2x) M1, M3 E (All) (2x) E1, E2 SI3, SI7, SI8</td>
<td></td>
</tr>
<tr>
<td>Task design</td>
<td>Process category, Mental model, Efficacy category, System image</td>
<td>P (All) (4x) MM (All) (2x) M1, M3 MM5, MM6 E (all) E1, E2 SI3, SI7, SI8</td>
<td></td>
</tr>
<tr>
<td>Conceptual usability design</td>
<td>Mental model, Process category, Keystroke category, System image</td>
<td>MM (All) (3x) MM5, MM6 P (All) (2x) P1, P2 (2x), P3 K1, K2, K3 SI5, SI6, SI8</td>
<td></td>
</tr>
<tr>
<td>Usability activity</td>
<td>Activity normally performed by yourself ‘yes/no’</td>
<td>Relates to what category in the framework</td>
<td>Relates to what heuristics in the framework</td>
</tr>
<tr>
<td>-------------------</td>
<td>-------------------------------------------------</td>
<td>-----------------------------------------</td>
<td>---------------------------------------------</td>
</tr>
<tr>
<td>Prototyping</td>
<td>Mental model, System image, Keystroke category, Process category, Efficacy category</td>
<td></td>
<td>MM (All) (2x) S1 (All) (2x) S16, S17 K (All) K4, K5 P (All) E (All)</td>
</tr>
<tr>
<td>Usability walkthrough</td>
<td>Process category, Mental model, System image, Keystroke category, Efficacy category</td>
<td></td>
<td>P (All) (5x) MM (All) (5x) S1 (All) (4x) K (All) (3x) E (All) (2x) E3</td>
</tr>
<tr>
<td>Usability testing</td>
<td>Keystroke category, System image, Process category, Mental model, Efficacy category</td>
<td></td>
<td>K (All) (5x) S1 (All) (5x) P (All) (5x) MM (All) (5x) E (All) (3x) E1, E3</td>
</tr>
<tr>
<td>Visual design</td>
<td>System image, Mental model, Efficacy category</td>
<td></td>
<td>S1 (All) (3x) MM5, MM6 E2, E4</td>
</tr>
<tr>
<td>Icon design</td>
<td>System image, Mental model, Efficacy category</td>
<td></td>
<td>S1 (All) (3x) SI7 MM5, MM6 E2, E4</td>
</tr>
<tr>
<td>Promoting usability in general</td>
<td>Mental model</td>
<td></td>
<td>MM5, MM6</td>
</tr>
<tr>
<td>Further embedding of usability in DMethod</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Usability reviews</td>
<td>Keystroke category, System image, Mental model, Process category, Efficacy category</td>
<td></td>
<td>K (All) (4x) S1 (All) (2x) S11, S12, S13, S14, S15, S16 S11 t/m SI7 MM (All) (2x) MM3, MM4 MM1 t/m MM4 P (All) E (All)</td>
</tr>
</tbody>
</table>
We took a closer look at the usability tasks. by means of the questionnaire focus on usability activities (see 3.5.1). We also want to take a closer look at the position of usability within the entire Baan organization. In this way we can tell what the attitude of the employees at Baan is regarding usability. Furthermore we want to see if usability is supported at the management level of Baan. This is done by using the models of Ehrlich and Rohn (in Bias and Mayhew, Chapter 4 P.76) and Nielsen (in Bias and Mayhew, Chapter 11 P. 267) which we both shall explain now.

These models can be used to measure the understanding and acceptance of user centered design in an organization. With this questionnaire we want to find an answer on our third Baan goal “to give advise for improvement of the usability activities within Baan when taking our cost benefit analysis in consideration” (see section 1.2).
3.6.1 Questionnaire positioning of usability activities within Baan

In this questionnaire we have summarized the features of each stage mentioned in the model by Ehrlich and Rohn, and we did the same for the model by Nielsen. Important here is that Nielsen himself says that his 8 features can be classified according to the stages mentioned by Ehrlich and Rohn and are thus are the features described by Nielsen placed under the corresponding stage described by Ehrlich and Rohn. This way we come to a set of features for each stage. The respondent (1 usability consultant) has chosen the features that were applicable to the situation of Baan usability consultancy.

The questionnaire “positioning of usability activities within Baan” and its results can be found at (Appendices F:) and is filled in by one usability consultant. This usability consultant had the “high level” knowledge that was needed to fill in a questionnaire like this that needed somebody with a clear overview of the usability department at Baan.

The results were that usability consultancy at Baan is in stage 2 “curiosity”. In this stage we can classify organizations that are beyond skepticism and start to become curious about what user-centered design can offer. It must be noted that stage 1, skepticism, has several features that (sometimes) apply to this situation. What is even more striking is that a very important feature that is classified under (highest) stage 4, partnership, is also applicable for usability consultancy within Baan. This feature is called “founding a usability group”.

Ehrlich and Rohn also discuss levels within the organization that can be applied to usability engineering, this is the second question of this questionnaire (Appendices F:). The conclusion that can be drawn from this question is that “grassroots effort” is the according level within the Baan organization regarding usability. This means that only individual contributors and some middle management support user centered design within Baan. This clearly describes the current situation of Usability Consultancy of Baan at the moment, because it is currently not mandatory for project managers to include any usability activity in their project plan, but a project manager can do this if he wants to. This can be seen as the “middle management” and “individual contributor” that came forth from the “grassroots effort” of Ehrlich and Rohn. This means that there are projects within Baan in which usability consultancy does not have any role. Although no role is formally assigned to them, the usability consultant can still perform activities on this project in a rather informal way. It is needless to say that these “informal activities” of usability consultancy are not mentioned in the project planning.

3.7 Conclusions from questionnaires regarding our cost benefit analysis

We will now describe the conclusions that can be drawn from the results of our two questionnaires as stated in 3.5.1 and 3.6.1 regarding our cost benefit analysis that we will conduct in further chapters.

The role of the framework of Kabel et al. as used in the questionnaire of 3.5.1 in relation to our cost benefit analysis is the “effectiveness” of the usability activities. An assumption is that the more filled in heuristics a task will score the more effective this usability task is because it refers to many different (kinds of) heuristics that one should intend to cover by conducting this usability task. In relation to our cost benefit analysis of usability tasks we can say that the more effective a task is the larger the part of the
benefit and thus the revenues it gets assigned to. As said it can also serve as a benefit
distribution model and a revenue distribution model. (See section 9.4).
The role of the models of Ehrlich and Rohn as well as Nielsen as used in the
questionnaire of 3.6.1 in relation to our cost benefit analysis is to look at the amount of
resources available for usability. Our research can be very helpful for Baan usability
consultancy to move from the curiosity stage to the acceptance stage as stated in the
model of Ehrlich and Rohn. This would mean an increase of management support for
usability at Baan and hopefully the availability of more resources. This would also affect
outcomes of a future cost benefit analysis.
Chapter 4 Research options

4.1 Introduction

In this chapter the different research options that might be candidates for our research will be explained and compared. The different research options have different advantages and disadvantages for our research at Baan. It is possible that from a theoretical point of view one research option is better than the rest. But because there is few data available at Baan to carry out that particular option, another option must be taken to perform the investigation.

The product names that are used are fictitious and show no relation to Baan products.

4.2 Research options

Definitions:
Activities: Usability activities performed by usability consultants
Product: A Baan (ERP) application
Version A: Release of a product with usability problems, because (little or) no usability activities were performed by usability consultants.
Version B: Release of the same product but on which usability activities by usability consultants were performed. Version B is an improved version of version A.

4.2.1 Research option 1: Product with no usability activities
Reference point: A product (version A) on which to conduct research has no usability activities performed on it. A second version (version B) of the product will be made with usability activities. A calculation must be made of what the costs and benefits are to make the product more usable.

What is known:
- Version A of the product.
- The problems of version A regarding usability.

What is not known:
- How version B of the product will look like.
- The usability activities performed for version B.
- The advantages of version B regarding usability.

What must be calculated/estimated:
- The costs of the usability activities for version B.
- The costs relating to usability problems of version A.
- The costs and benefits of version B regarding usability.
- The comparison of the costs and benefits of version A and version B.

4.2.2 Research option 2: Two versions of a product with and without usability design
Reference point: There are two versions of the same product. One version is without usability design the other is with usability design. The activities performed for version B...
are known. A comparison of the two versions is made to see if usability design delivers more benefits and less cost.

What is known:
- Both versions.
- The usability activities performed for version B.
- The problems of version A regarding usability.

What is not known:
- The advantages of version B regarding usability.

What must be calculated/estimated:
- The costs of the usability activities for version B.
- The costs relating to usability problems of version A.
- The costs and benefits of version B regarding usability.
- The comparison of the costs and benefits of version A and version B.

4.2.3 Research option 3: A product with usability design
Reference point: A product with usability design (version B). It will be estimated what the costs are for version A without usability. This version does not exist.

What is known:
- Version B of the product.
- The usability activities performed for version B.

What is not known:
- How version A of the product will look like.
- The problems of version A regarding usability.
- The advantages of version B regarding usability.

What must be calculated/estimated:
- The costs of the usability activities for version B.
- The costs relating to usability problems of version A.
- The costs and benefits of version B regarding usability.
- The comparison of the costs and benefits of version A and version B.

4.2.4 Research option 4: A product with no comparison of different versions
There is also a research option possible where there will be no comparison between two versions of a product, one version with and one version without usability activities. The product is similar as version B described in research option 3. So it is a version with usability. A large difference with the previous research options is that it there will no investigation of specific usability problems for the two versions. Cost reduction is an important concept in this research option. By making changes earlier in the design life cycle costs savings are made. All the costs of, for example, support, are taken for a specific product and the reduction in costs due to usability activities performed is calculated or estimated.
What is known:

- Version B of the product.
- The usability activities performed for version B.

What is not known:

- The advantages of version B regarding usability.

What must be calculated/estimated:

- The costs of the usability activities for version B.
- The costs and benefits of version B regarding usability.

4.2.5 Research option 5: A combination of the different research options

Research option 5 is a combination of the different research options. If it is not possible to get the data to calculate all the costs and benefits for one product, a combination of different products can be chosen. For example it could be that for one subject of research, such as after-sales like activities, there exists retrievable data for two versions of a product, but it is possible that for another subject of investigation, such as pre-sale like activities, that this is not the case. A different product should than be taken to be able to calculate this other subject of investigation. Note that usability activities are quantified on different Baan products, not just one product as in the first three research options.

4.2.6 Visualization of what is known for the first three different research options

Table 10 shows what is known about the three research options. Research option 4 is not shown because it has no comparison component. Research option 5 is left out, because it is a mix of the first three research options.

<table>
<thead>
<tr>
<th>Option 1</th>
<th>Product</th>
<th>Usability Activities</th>
<th>Act. Beneficial on product</th>
<th>Comparison</th>
</tr>
</thead>
<tbody>
<tr>
<td>Version A</td>
<td>X</td>
<td>n.p.</td>
<td>n.a.</td>
<td>?</td>
</tr>
<tr>
<td>Version B</td>
<td>Fiction</td>
<td>?</td>
<td>?</td>
<td>?</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Option 2</th>
<th>Product</th>
<th>Usability Activities</th>
<th>Act. Beneficial on product</th>
<th>Comparison</th>
</tr>
</thead>
<tbody>
<tr>
<td>Version A</td>
<td>X</td>
<td>n.p.</td>
<td>n.a.</td>
<td>?</td>
</tr>
<tr>
<td>Version B</td>
<td>X</td>
<td>X</td>
<td>?</td>
<td>?</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Option 3</th>
<th>Product</th>
<th>Usability Activities</th>
<th>Act. Beneficial on product</th>
<th>Comparison</th>
</tr>
</thead>
<tbody>
<tr>
<td>Version A</td>
<td>Fiction</td>
<td>n.p.</td>
<td>n.a.</td>
<td>?</td>
</tr>
<tr>
<td>Version B</td>
<td>X</td>
<td>X</td>
<td>?</td>
<td>?</td>
</tr>
</tbody>
</table>

Table 10: Visualization of the first three research options
4.3 Choice of which research option and products will be taken

A choice which research option will be followed depends on theoretical and practical aspects. This section exists of three parts: first the theoretical aspect will be explained. Secondly the practical aspect of the research options will be described. The choice of the research option depends on which product is chosen so thirdly an overview of the best products to conduct research on will also be given.

4.3.1 Theoretical

There are three decision variables for the choice from a theoretical point of view. The first decision variable is what is known about the different versions of a product. The second variable is which cost-benefit calculation method delivers the best result for a research option, i.e. which research option can be best calculated with cost benefit calculation methods. The third decision variable is how many estimations have to be made due to a lack of hard data for the different research options.

What is known?

As can be seen from Table 10 and the explanation of the different research options, that most is known when research option 2 would be performed. Both versions of a product are available and the usability activities, which are performed on version B, are known. For research option 1 and option 3 least is known. Option 4 uses a product what exists or is under development. Data should be available for that product. What is known for option 5 depends on the mix of the research options that are taken. The assumption is that the mix exists of the other research options. Thus there is more known in research option 1, option 3 and option 4 and less known in option 2.

<table>
<thead>
<tr>
<th>Research option</th>
<th>What is known</th>
<th>Cost-benefit calculation methods</th>
<th>Estimations</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Very bad</td>
<td>Average</td>
<td>Many</td>
</tr>
<tr>
<td>2.</td>
<td>Good</td>
<td>Very good</td>
<td>Very few</td>
</tr>
<tr>
<td>3.</td>
<td>Very bad</td>
<td>Average</td>
<td>Many</td>
</tr>
<tr>
<td>4.</td>
<td>Average</td>
<td>Average</td>
<td>Many</td>
</tr>
<tr>
<td>5.</td>
<td>Average</td>
<td>Good</td>
<td>Some</td>
</tr>
</tbody>
</table>

Table 11: Theoretical characteristics of the research options
Cost-benefit calculation methods
There are no special cost-benefit calculation methods for different research options, but with more data available the calculation methods can be better applied. So with research option 2 the most calculation methods can be applied and research option 3 the least (from a theoretical point of view).

How many estimations have to be made
From a theoretical point of view option 3 requires the most estimation to be made; but fewest data which can be quantified by means of cost-benefit calculation methods is available. For research option 1, 3 and 4 many estimations have to be made. However for research option 2 the fewest estimations have to be made and for research option 5 some estimations have to be made.

Conclusion
From Table 11 can be derived that the best research option from a theoretical point of view is research option 2, because most data is available and can be calculated. Option 2 can be taken if there are two versions of a product available. Research option 5 is second best because it is a mix of the first three research options. Research option 4 can be taken when it is difficult to compare different products within a company. Research option 1 and 3 are the worst from a theoretical point of view. The fewest data is known, the most data has to be estimated and the fewest data can be calculated.

4.3.2 Practical
Although from a theoretical point of view research option 2 is the best option to choose, this does not hold for the practical situation within Baan. The first decision variable, which plays a role, is how many products there are available for the different research options. The second is how many data sources are available? The usability consultants in Baan helped with making a list of products and an estimation of available data sources (See Appendices D: for full results.). The product names that are used are fictitious and show no relation to Baan products.
A questionnaire was send to them where they were asked to list products or projects and their usability activities, which they had performed on the products or projects. The products or projects had to be marked under one of the first three research options. It was not necessary to categorize products for research option 4 and 5 because the products, which were categorized under the first three options, can also be categorized under option 4 and 5. The fifth is a mix of the first four so this research option was also not used in the questionnaire. Further they had to give an estimation from 1 (few) through 5 (many) for available data sources for the projects or products. The results of the questionnaire will be discussed for each variable.

How many products are available?
For research option 1 and 3 the usability consultants filled in 18/19 products or projects. The most products/projects were marked as research option 2 (17/18 products or projects), a product with and without usability activities performed on it. Research option 4 has some products available. Because research option 5 is the result of all the research options it has the most products or projects available.

How many data is available at Baan?
This question depends on how many products are available, the time a product is in the market and what data is being stored at Baan. Products without usability are the products, which are longest on the market. The usability consultants most of the time
gave the products or projects a 2 for available data sources. This means that there will be not much data available. Only two times a 4 was given for projects or products. On average research option 2 has some available data sources according the usability consultants. Research option 5 has the most data sources because it is a mix of all the research options.

<table>
<thead>
<tr>
<th>Research Option</th>
<th>Products</th>
<th>Data sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Some</td>
<td>Many</td>
</tr>
<tr>
<td>2.</td>
<td>Many</td>
<td>Some</td>
</tr>
<tr>
<td>3.</td>
<td>Some</td>
<td>Few</td>
</tr>
<tr>
<td>4.</td>
<td>Some</td>
<td>Few</td>
</tr>
<tr>
<td>5.</td>
<td>Many</td>
<td>Many</td>
</tr>
</tbody>
</table>

*Table 12: Practical characteristics of research options*

*Products*

Because there are large differences between products or projects on how much data was available, the decision for a research option is based on comparing different products or projects with different research options. In a meeting, the usability consultants decided which products where the best to choose from. As can be seen from Table 13 four products are chosen, which can be used for the research. According to the usability consultants Product K was not a good choice because it was transferred to India, Product C was a small project and Product Cc had too little available data sources. The usability consultants thought that for ThinBaan most data sources were available and that this product should be chosen to perform research on. The usability consultants also thought that their impact on ThinBaan could be significant due to the amount of activities performed on it. This selection is biased because the usability consultants picked a product of which they knew they had an impact on, this bias might be found back in the amount of benefits that we are going to calculate for this product. The reader must keep this in mind. However it is not our primary goal to prove that usability was beneficial in the software development life cycle of Baan. Our goal is to quantify usability by means of some method that we can use for this. The method that we will use must be independent of the variables found within Baan.

<table>
<thead>
<tr>
<th>Product</th>
<th>Activities performed on</th>
<th>Available data sources</th>
<th>Research option</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Product K</td>
<td>Usability audit</td>
<td>3</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>Product C</td>
<td>Task Design, Conceptual Design, Realization, Screen Design (incl. Wizard), Icons, Usability Test</td>
<td>4</td>
<td>3</td>
<td>-</td>
</tr>
<tr>
<td>ThinBaan</td>
<td>Usability Design, Usability Test, other activities</td>
<td>4</td>
<td>3</td>
<td>-</td>
</tr>
<tr>
<td>Product Cc</td>
<td>Task Analysis, Conceptual Solution, Prototyping, Walkthrough</td>
<td>2</td>
<td>2</td>
<td>Partly implemented</td>
</tr>
</tbody>
</table>

*Table 13: Products and their characteristics*
The research option that has been chosen is option 4. ThinBaan has no version without usability and it is time consuming to make an estimation how that other version would look like. So we decided to investigate how different costs can be reduced because of usability activities that are performed on the product.

4.4 Conclusion

There are five research options with different features. Research options 2 and 4 are from a theoretical point of view the best research option. Looking from a practical view research option 4 is the best to choose. Decided by the usability consultants is that ThinBaan is the best product to investigate. It has the most available data sources and a large usability impact on this product, therefore it is attractive to use option 4. Thus option 4 will be chosen for this research.
Chapter 5  Decision on Cost-Benefit Calculation Methods

5.1  Introduction

In this chapter the decision will be made which methods shall be used within Baan. The decision criteria will be specified below. The decision variables will be filled in for the different methods. A table with data sources and their characteristics will be discussed. These tables will be compared with each other and the best methods will be chosen.

5.2  Decision variables

First a description will be given about which variables will be used. The different calculation methods, which were described in sections 2.6, 2.7 and 2.8, will be used to make a comparison. The decision variables that will be used to compare the different calculation methods with each other are introduced. Also the product will be taken into account in this comparison. The calculation methods with the slightest number of problems will be chosen.

Decision variables

The following decision variables will be used:

1. Where does the method focuses on? What does it try to measure.
2. How to use such a method in practice? Which data should be available?
3. Which data is available at Baan? This is important to know, because it says something about what can be calculated and what must be estimated.
4. How to measure at Baan? This means whether the method can be directly calculated by retrieved data, or that estimations have to be used.
5. The applicability of the method to the chosen product, ThinBaan.

Content of the tables

In Table 14 the general cost calculation methods are discussed. The costs of activities can be calculated with the method “ABC” as well as with the method “activity costs”. The benefit of choosing the method “activity costs” above “ABC” is that it is easier to measure, with less data needed. Both methods can be applied to the product. The method “activity costs” only need data about worked time on an activity and the salary of that person which worked on the activity. With “ABC” data must be known for products, resources and activities. “ABC” however is a more detailed method, which proved itself in practice.

In Table 15 general benefit calculation methods are discussed. What stands out in this table is that for all methods estimations have to be used because Baan has no or very few data available to calculate them. This means that it will not be very easy to use these methods within Baan. The data that is needed falls under Product Management within Baan. As they have other priorities, they do not administrate or collect the data that is needed for these methods. It is the intention of Project Management to keep track of cashflows, ROI and payback periods in the future. The balanced scorecard makes use of strategic goals and actions to achieve these goals. This data can be found in project plans within Baan. The methods cannot be applied to our products, due to a lack of strategic goals that lead to quantifiable benefits that emanate from the usability activities performed on the products in a complex software development process.
In Table 16 information system benefit calculation methods are discussed. Baan has no data available on increased productivity. If this method is used, it has to be based on estimations or a test has to be performed to measure the increased productivity. Another problem is that the increase of productivity cannot be uniquely attributed to a usability improvement, because there can be many other factors involved. Baan has also no data available about decreased cost of training users. A test has to be carried out to generate this data in order to measure this decrease, or estimations coming from domain experts have to be used. “Decreased user error” has some data available in the form of usability tests conducted by usability consultants. Usability tests are not done on every product, so it is possible that for a specific product no data is available. In this way, the decrease in user error has to be based on estimations or a test has to be conducted to measure this decrease.

“Decreased amount of customer support” can be calculated or estimated. There are two databases available with customer problems, but there are not many problems that directly relate to usability (Cazemier, 2002). Bias and Mayhew found also that helpdesk or customer support databases are not rich in problems that directly relate to usability problems (Bias and Mayhew, 1994).

“Decreased turnover rate” must be calculated or estimated. Data could be found at the human resource management department at Baan. It is very difficult to show that the turnover rate decreases because of improved usability. For “IT balanced scorecard” (IT BSC) see “balanced scorecard”, since the same problems occur here. “Information economics” (IE) is based on estimations of risk and value categories that contribute to the IT project, and has inherently the same problem as “IT BSC”, which means that this method is difficult to link directly to usability activities in a project. Measuring is difficult for “IT BSC” and “IE” methods.

Most methods can be related to our product and can calculate (estimated) benefits. Increased productivity, and decreased user error are more benefits for the customer and not in the development process of our product, this is not where our research focuses on. Turnover rate is not an issue for usability consultancy within Baan and their performed activities on products. “IT balanced scorecard” and “information economics” are too difficult to link the product and usability activities too.

<table>
<thead>
<tr>
<th>Calculation Method</th>
<th>Focus on</th>
<th>How to measure in practice?</th>
<th>Data availability at Baan?</th>
<th>How to measure at Baan?</th>
<th>Applicable to product “ThinBaan”?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Activity costs</td>
<td>Performed activities</td>
<td>Time sheet of worked hours per activity or estimation</td>
<td>Time Wizard for worked hours</td>
<td>Based on calculation and sometimes estimation if full data is not available.</td>
<td>Yes, there are activities performed on these products</td>
</tr>
<tr>
<td>Activity Based Costing</td>
<td>“linking resource expenses to the variety and complexity of products produced”</td>
<td>Time spent on activity and demand of product</td>
<td>Time Wizard for worked hours, Project plans</td>
<td>Based on estimations and calculations because full data is not available.</td>
<td>Yes, there are many resource expenses and two products to relate these to</td>
</tr>
</tbody>
</table>

Table 14: Decision variables of general cost calculation methods
<table>
<thead>
<tr>
<th>Calculation Method</th>
<th>Focus on</th>
<th>How to measure in practice?</th>
<th>Data availability at Baan?</th>
<th>How to measure at Baan?</th>
<th>Applicable to product “ThinBaan”</th>
</tr>
</thead>
<tbody>
<tr>
<td>Payback period</td>
<td>Number of years before the return equals the investment</td>
<td>Cash benefits minus costs in a year and investments have to be estimated if the projects are not done yet. Improvements and cash benefits minus costs in a year can be calculated if the project is done.</td>
<td>Product Management should have this information, but on this moment their focus is on other priorities. Thus no data available.</td>
<td>There is no available data within Baan. Should be based on estimations.</td>
<td>Not direct, since no data is available for this method, only after benefit estimation of the usability activities performed on this product can we calculate this for the set of the performed activities.</td>
</tr>
<tr>
<td>Present value of future cash flow</td>
<td>Present value of cashflows</td>
<td>Future cashflows have to be estimated by experts. The discount rate is decided by the project management team.</td>
<td>Product Management, no data available.</td>
<td>There is no available data within Baan. Should be based on estimations.</td>
<td>Not direct, since no data is available for this method, only after benefit estimation of the usability activities performed on this product can we calculate this for the set of the performed activities.</td>
</tr>
<tr>
<td>Net present value</td>
<td>Present value of cashflows and costs</td>
<td>Same remarks as previous method. The costs must be estimated or can be calculated.</td>
<td>Product Management, no data available.</td>
<td>There is no available data within Baan. Should be based on estimations.</td>
<td>Not direct, since no data is available for this method, only after benefit estimation of the usability activities performed on this product can we calculate this for the set of the performed activities.</td>
</tr>
<tr>
<td>Profitability index</td>
<td>Present value of inflows and outflows of different projects</td>
<td>Project inflow and outflow must be estimated by experts or calculated.</td>
<td>Product Management, no data available.</td>
<td>There is no available data within Baan. Should be based on estimations.</td>
<td>Not direct, since no data is available for this method, only after benefit estimation of the usability activities performed on this product can we calculate this for the set of the performed activities.</td>
</tr>
<tr>
<td>Return on investment</td>
<td>Return on investment</td>
<td>Average net profit and investment costs have to be estimated by experts or calculated.</td>
<td>Product Management, no data available.</td>
<td>There is no available data within Baan. Should be based on estimations.</td>
<td>Not direct, since no data is available for this method, only after benefit estimation of the usability activities performed on this product can we calculate this for the set of the performed activities.</td>
</tr>
<tr>
<td>Balanced scorecard</td>
<td>Strategic goals and actions to achieve these goals</td>
<td>Find the indicators on the management level, else this can be used as an estimation method.</td>
<td>Project plan</td>
<td>Based on estimations</td>
<td>No, since it is nearly impossible to link strategic goals of this project to usability in this large and complex development process.</td>
</tr>
</tbody>
</table>

Table 15: Decision variables of general benefit calculation methods
<table>
<thead>
<tr>
<th>Calculation Method</th>
<th>Focus on How to measure in practice?</th>
<th>Data availability at Baan?</th>
<th>How to measure at Baan?</th>
<th>Applicable to product “ThinBaan”</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increased productivity</td>
<td>Increased productivity</td>
<td>Most of the time based on certain estimations</td>
<td>Based on estimations, no data available. A test has to be conducted to generate this data, then it can be calculated.</td>
<td>Yes, when tests for this are (going to be) conducted for both products</td>
</tr>
<tr>
<td>Decreased cost of training users</td>
<td>Training hours</td>
<td>Reduction time of training can be based on judgments of trainers, so most of the time there are certain estimations</td>
<td>Must be estimated is no data available about this at Baan. A test has to be conducted to generate this data, then it can be calculated</td>
<td>Yes, training is given for this product internally and externally, which means that training can be measured</td>
</tr>
<tr>
<td>Decreased number of user errors</td>
<td>Errors</td>
<td>User errors can be observed during a (usability) test. The time it cost to recover from these errors can during these tests be measured. It is possible to estimate the errors and recovery time, this must be done by experts</td>
<td>Usability tests</td>
<td>Can be calculated because data is available, but maybe not for all products. Can also be based on estimations. A test has to be conducted to generate this data, then it can be calculated</td>
</tr>
<tr>
<td>Decreased amount of customer support</td>
<td>Telephone calls of customers</td>
<td>Call duration and eliminated calls can be tracked in a support databases</td>
<td>Scopus and Knowledge Base CSS Calls can be found in database, usability issues are not explicitly referred to (see Bias and Mayhew 1994)</td>
<td>Yes, support is given which means that customer support could benefit from usability activities performed on the product</td>
</tr>
<tr>
<td>Decreased turnover rate</td>
<td>Turnover of employees</td>
<td>Salary of personnel should not be too difficult to find. Turnover in employee is most of the time recorded in a company, otherwise experts have to make an estimation</td>
<td>HRM intranet site, documents, database</td>
<td>Based on estimations and calculations</td>
</tr>
<tr>
<td>Savings from making changes earlier in design life cycle</td>
<td>Costs made during the design life cycle of a product</td>
<td>Eliminated errors can be tracked in a database. It can be calculated or estimated by rules of experience or expert</td>
<td>Defect Tracker, TCS, PEG log errors and bugs</td>
<td>Based on estimations and calculations</td>
</tr>
<tr>
<td>IT balanced scorecard</td>
<td>Balanced set of metrics to guide business-oriented IT decisions</td>
<td>Find the indicators on the management level. This can be used as an estimation technique</td>
<td>Project Plan</td>
<td>Based on estimations</td>
</tr>
<tr>
<td>Information economics</td>
<td>The company’s contribution of a project can be determined and the intangible elements evaluated</td>
<td>Based on estimations of risk and value categories that contribute to the IT project</td>
<td>Project plan</td>
<td>Based on estimations</td>
</tr>
</tbody>
</table>

Table 16: Decision variables of information system benefit calculation methods
In Table 17 usability cost calculation methods are discussed. A “planned usability engineering program”, can be used to calculate or estimate the costs of usability activities. The worked hours for an activity are booked in Time Wizard. It should be possible to get some data out of this program. This method can be used on our product. Table 18 usability benefit calculation methods are discussed. “Increased sales” is always based on estimation, because the extra products sold due to improved usability is very difficult to establish. Data about products sold and profit margin could be found at the sales department, marketing and/or release management. “Yearly Earnings” is always based on estimations because Baan has no data about values of ideas or on the NPV. Increased sales are too difficult to link the product and usability activities performed on them. The methods “yearly earnings” is just too abstract to put into operation for our products.

### 5.3 Data sources

During several meetings with the usability consultants of Baan and searches over the Baan Intranet sites we found several data sources, which seemed interesting. To decide which data sources could be useful, a short inventory was made.

**Variables**

The variables that are used in Table 19 are:

1. The ease of access to the source. This ranges from very easy to very difficult.
2. What is the use of the data source, what is the purpose of the data source?
3. What is missing in the data source?
4. By which method can the data source be used?
Description of the table
The data sources are grouped in seven different classes to which they are related:
general, hours & salary, support, training, bugs, usability related, sales and other.

General
• In this class we have only the Baan website. It has general information about Baan. It is very easily accessible. The Baan website gives, for example, an overview of the products they sell. Specific information cannot be found on the Baan website. It is not suitable for a calculation method.

Hours & Salary
In the class hours & salary there are two data sources.
• The intranet site from HRM, contains information about salary, training budgets, turnover rate, etc. This is easy to access. The salary figures are minimum and maximum figures. It is better to use the average salary of a department. Some figures are on the intranet site, others are coming from documents on the intranet site from HRM. “ABC”, “decreased user training”, “support”, “increased sales” and “savings gained from making changes earlier in the design life cycle” can use the data at HRM.
• Time wizard is a program, which registers the hours an employee works at Baan. For the usability consultancy department it is easy accessible, but for other departments it is difficult because each department has other passwords. Time wizard it too general. Task are not split up in activities, this still needs to be done. The data from this data source can be applied to the same methods as described in the previous data source (HRM).

Support
The third class is support and this class contains three data sources, which are related to the support department of Baan.
• Database Support consists of two different databases, Scopus and Knowledge Base. Customer problems are logged in these databases. It has an average ease of access because for Scopus passwords have to be arranged. It can be found on the intranet site of Baan. This data source can be used for the “decreased amount of customer support” method.
• The second data source is the performance reports of support. The report shows how well the CS&S (Customer Service and Support) works according to Baan customers. The reports can be found in the public folders. Cost savings can use the data from this data source.
• The third data source is the satisfaction survey. It is a form, which registers the customers’ satisfaction with the CS&S. What the source lacks, is information about usability and the questions that are asked to the companies. It cannot be applied to a method.

Bugs & errors
The fourth class is bugs & errors. There are five data sources for this class.
• Test control system (TCS) is a program where bugs and errors are logged during development of software product at Baan. The accessibility is average, because the program is not easy to use. All data sources of the class bugs & errors are applicable to the method “savings gained from making changes earlier in the design life cycle.”
• PEG data source is Scopus, the program where bugs and errors are logged when they are found after the release of a software product. For support this database can also be used.
• The third is Defect Tracker, a database where faults and improvements are logged. The ease of access is average, passwords have to be arranged.
• A product consultant has measured by himself the time that it takes to go through different screens within a Baan application.
• The last data source of this class is developers who demonstrate products. They have knowledge about errors and bugs in the software products.

Training
The class training has three data sources. All three data sources in this class can be used for the method “decreased user training”.
• The first data source is Baan Educatieve Services (BES). It has training material and education plans. Accessibility is difficult because there is no or little contact from the usability consultants with this department.
• Training Need Analysis (TNA) can be used to measure the need of training by customers. The accessibility is difficult because the usability consultants do not have much contact with the department of BES.
• A product consultant for ThinBaan gives training and knows things about training and training problems of ThinBaan.

Usability related
The class usability related has the most data sources.
• The first data source is the requirements database. In this database remarks are noted down about usability problems with an application, which are logged by usability consultants. These remarks can be found in the public folders and are easy to access.
• The log files of the style guide are also easy to access. The usability consultants keep track of people who use the style guide within Baan. The log file only contains data from a few weeks.
• Projects plans and TSE sheets give an estimation of the worked hours on a product, its goals, etc. It can be found in Cyberdocs (online document center at Baan). It depends on what is described in the documents, but it could be applied to the following methods: “ABC”, “decreased amount of customer support”, “training”, “increased sales” and “savings gained from making changes earlier”.
• Progress reports from UC are easy to access. In these reports the status of the project, which the usability consultant works on, are described.
• The accessibility of release management is difficult because usability consultancy has no contact with that department. Release management is responsible for the start and end of a product.
• The seventh data source is the Suco server, the archive of usability consultancy. All types of documents are placed on the Suco, but they are not applicable to a specific method.
• The design documents of a product are difficult to obtain. The role of usability is most of the time not mentioned. They can be found in Cyberdocs and cannot be applied to a method.
Usability consultancy has done usability tests, those tests are saved on cd’s. They are easy to access but there are not many usability tests done for ThinBaan. The data from those tests could be used for “decreased amount of customer support” and “savings gained from making changes earlier in the design life cycle”.

The tenth data source is the documentation on Phoenix. Phoenix is the predecessor of ThinBaan, but was never implemented. It can be used as background information and is not applicable to a method.

The last data source of this class is the usability consultant of ThinBaan.

Sales

The seventh class is Sales. Sales has four data sources.

People from sales are difficult to access. They have knowledge about (usability) problems with software. This could be used for “increased productivity” or “decreased amount of customer support”.

Marketing has knowledge about profit margin and prices of products. This is interesting for increased Sales.

The third is sales, Baan sells better with ThinBaan than without ThinBaan.

The last data source is list of failed deals. This will be very difficult to get access to. The person who knows about this will not give the list to usability consultancy. It is not known if an estimation can be made of the number of failed deals because of a lack of usability.

<table>
<thead>
<tr>
<th>Data source</th>
<th>Easy to access the source?</th>
<th>What is the use of the source?</th>
<th>What is missing in the source?</th>
<th>Applicable to what method?</th>
</tr>
</thead>
<tbody>
<tr>
<td>General</td>
<td></td>
<td></td>
<td></td>
<td>None</td>
</tr>
<tr>
<td>Baan website</td>
<td>Very easy</td>
<td>Product overview</td>
<td>Specifics cannot be found</td>
<td>None</td>
</tr>
<tr>
<td>Hours &amp; Salary</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intranet HRM</td>
<td>Easy</td>
<td>Salaries (only min. and max.)</td>
<td>Min. and max. salaries are not so important. We need a relevant average and additional costs.</td>
<td>Activity Based Costing, cost savings support, cost savings training, increased sales and savings gained from making changes earlier</td>
</tr>
<tr>
<td>Time Wizard</td>
<td>Easy for UC /difficult for others</td>
<td>Electronic hour registration form</td>
<td>Too general tasks are stated, needs to be derived what precisely is done in that general task</td>
<td>Activity Based Costing, cost savings support, cost savings training, increased sales and savings gained from making changes earlier</td>
</tr>
<tr>
<td>Data source</td>
<td>Easy to access the source?</td>
<td>What is the use of the source?</td>
<td>What is missing in the source?</td>
<td>Applicable to what method?</td>
</tr>
<tr>
<td>-------------</td>
<td>----------------------------</td>
<td>-------------------------------</td>
<td>--------------------------------</td>
<td>---------------------------</td>
</tr>
<tr>
<td><strong>Support:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Database Support</td>
<td>Average</td>
<td>Scopus: customers can log in here to report bugs and problems. Knowledge base: ?</td>
<td></td>
<td>Cost savings support</td>
</tr>
<tr>
<td>Performance Reports (public folder)</td>
<td>Average</td>
<td>Performance of customer support is measured.</td>
<td></td>
<td>Cost savings support</td>
</tr>
<tr>
<td>Satisfaction survey (public folder)</td>
<td>Average</td>
<td>Survey sent out to customers every X months. (see magazine)</td>
<td>The questions of the survey and usability information</td>
<td>None</td>
</tr>
<tr>
<td><strong>Bugs &amp; Errors</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TCS</td>
<td>Easy</td>
<td>Developers and UC logs bugs here.</td>
<td></td>
<td>Savings gained from making changes earlier</td>
</tr>
<tr>
<td>PEG</td>
<td>Average</td>
<td>Logging of bugs in software that is already released (is Scopus).</td>
<td></td>
<td>Savings gained from making changes earlier</td>
</tr>
<tr>
<td>Defect Tracker (Product Q/ThinBaan)</td>
<td>Average</td>
<td>Database with faults and improvements</td>
<td>No time estimation for fixing bug</td>
<td>Savings gained from making changes earlier</td>
</tr>
<tr>
<td>Product Consultant of Service</td>
<td>Difficult</td>
<td>Product Consultants, who knows about a customer of “Service”, who measured by himself the time that it takes to go through screens</td>
<td></td>
<td>Savings gained from making changes earlier</td>
</tr>
<tr>
<td>Developers who give demo's</td>
<td>Average</td>
<td>Problems with giving demo's</td>
<td></td>
<td>Savings gained from making changes earlier</td>
</tr>
<tr>
<td><strong>Training</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baan Educative Services</td>
<td>Difficult</td>
<td>Education plans and materials (located at Professional Services) (see magazine)</td>
<td></td>
<td>Cost saving trainings</td>
</tr>
<tr>
<td>Training Need analyses</td>
<td>Difficult</td>
<td>Form to analyze the degree of training that is needed by a customer</td>
<td></td>
<td>Cost savings training</td>
</tr>
<tr>
<td>Product consultant for ThinBaan</td>
<td>Average</td>
<td>Knows things about training</td>
<td></td>
<td>Cost savings training</td>
</tr>
<tr>
<td>Data source</td>
<td>Easy to access the source?</td>
<td>What is the use of the source?</td>
<td>What is missing in the source?</td>
<td>Applicable to what method?</td>
</tr>
<tr>
<td>-------------------------------------------------</td>
<td>-----------------------------</td>
<td>--------------------------------</td>
<td>--------------------------------</td>
<td>---------------------------</td>
</tr>
<tr>
<td>Usability related</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Requirements database (BRD) (public folders)</td>
<td>Easy</td>
<td>Usability remarks on products</td>
<td>Does not give the costs of the improvement</td>
<td>Cost savings support and savings gained from making changes earlier</td>
</tr>
<tr>
<td>Log file Style guide</td>
<td>Easy</td>
<td>Who (developer) accessed the style guide for what period of time and for what product.</td>
<td>Are only saved for a short period</td>
<td>None</td>
</tr>
<tr>
<td>Project plans, TSE sheets,</td>
<td>Difficult</td>
<td>Indication of estimated working hours, role of usability, benefits of a product are mentioned</td>
<td>Role of usability is most of the time not explicitly mentioned</td>
<td>Activity Based Costing, cost savings support, cost savings training, increased sales and savings gained from making changes earlier</td>
</tr>
<tr>
<td>Progress reports</td>
<td>Easy (for some people other then UC not)</td>
<td>Status of the projects on, which the usability consultants works on, is described</td>
<td></td>
<td>None</td>
</tr>
<tr>
<td>Release management</td>
<td>Difficult</td>
<td>begin and end of a product</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Suco server</td>
<td>Easy</td>
<td>All types of documents by usability consultants</td>
<td>Information about ThinBaan</td>
<td>None</td>
</tr>
<tr>
<td>Design documents on products</td>
<td>Difficult</td>
<td>Role of usability is most of the time not explicitly mentioned</td>
<td></td>
<td>None</td>
</tr>
<tr>
<td>Usability consultancy</td>
<td>Easy</td>
<td>Usability tests (cd's en documenten)</td>
<td>Little information about ThinBaan</td>
<td>Cost savings support and savings gained from making changes earlier</td>
</tr>
</tbody>
</table>
Table 19: Available data sources within Baan

<table>
<thead>
<tr>
<th>Data source</th>
<th>Easy to access the source?</th>
<th>What is the use of the source?</th>
<th>What is missing in the source?</th>
<th>Applicable to what method?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Documents on Phoenix</td>
<td>Easy (although not all)</td>
<td>Background information on Phoenix (= menubrowser = pre-ThinBaan)</td>
<td>None</td>
<td>Activity Based Costing, costs saving support, cost saving training, cost saving sales and saving gained from making changes earlier</td>
</tr>
<tr>
<td>Usability consultant of ThinBaan</td>
<td>easy</td>
<td>Mails to her from sales with specific (usability) problems and is a member of the project of ThinBaan</td>
<td>Increased Sales and cost savings support</td>
<td></td>
</tr>
</tbody>
</table>

Sales

| Sales people                  | Difficult                  | Sales people need to "cover" usability related problems when presenting a product to the customer | Increased Sales and cost savings support                                                        |                                                                  |
| Marketing                     | Average                    | Profit margins, prices of products (products are sold through a subscription model)             | Increased Sales and cost savings support                                                        |                                                                  |
| Sales                        | Difficult                  | Baan sells better with ThinBaan then without                                                   | Increased Sales and cost savings support                                                        |                                                                  |
| List of failed deals          | Very difficult             | To see if a lack of usability leads to missed deals (sales)                                    | None                                                                                           |                                                                  |

5.4 The methods that will be used

The decision about what methods will be chosen to apply within Baan, will be based on Tables 14 to 18 and Table 19. The decision is made by the Baan usability consultants and the authors. The choice for a product was already made in Chapter 3, Table 13, this is the Baan ThinBaan.

The decision that is made, will be explained by referring to the research model as described in Chapter 2,
The literature on cost-benefit calculation methods for usability has been studied. This gave a number of possible cost-benefit calculation methods for usability that could be used for the practical research within Baan as described in Chapter 2 and is summarized in Tables 4 to 8. The chosen calculation methods will be related to the practical activities that are planned to conduct research on within Baan.

First, Baan usability consultants use no calculation methods whatsoever in their daily work. Second, the choice of methods is, from our perspective it’s fairly independent of the already chosen products and related research option. So no selection criteria for a calculation method come from these two angles. The last column in Tables 14 to 18 already tells more or less, which methods can be applied within Baan for the product that has been chosen. Based on Tables 14 to 18, especially the last column together with the available data sources (Table 19), one can tell whether or not a method can be practically applied within Baan.

It was decided that for the cost side “Activity Based Costing” (ABC) will be used instead of the “activity costs” method. This was mainly due to the fact that “ABC” consists of many more detailed calculations to calculate resource expenses. It gives a clearer picture of what indirect and support expenses are drivers for usability activities and processes, and then finally for the product. This more or less equals the “planned usability engineering program” method, because all our calculations will involve usability related activities, however “ABC” also takes the indirect and support costs into account.

The benefit side is far more difficult to quantify in general and (thus) also in this specific situation. This is mainly due to the fact that Baan does not use any of the general benefit calculation methods as described in Table 5. So these are very hard to use in this research. It is also nearly impossible to calculate the revenues of a Baan product due to the usability activities performed on this product. This is due to the fact that usability consultancy is involved in a long and complex software development process. Therefore no strategic goals can be set for usability alone in the development process, plus that the Baan usability consultants often do not have a distinctive place in a project plan. So it is decided to use information system benefit calculation methods (Table 6). Due to lack of time, not all methods can be used. Baan Usability Consultancy and we decided that the following methods could best be used: “Training”, “Sales”, “Customer support” and “savings from making changes earlier in the development cycle”. Finally the return on investment will be calculated over this set of methods for the product, to see if the usability activities were beneficial or not.

**Summary**

As can be seen from section 5.2 and 5.3 most methods have to be based on estimations because little data is available in Baan to calculate them in a straightforward manner. This means that methods will be taken, which has some data available or where otherwise the variables could be estimated.

**Cost side:**
The cost of the usability activities will be calculated with “Activity Based Costing”.

---

Figure 2. The literature on cost-benefit calculation methods for usability has been studied. This gave a number of possible cost-benefit calculation methods for usability that could be used for the practical research within Baan as described in Chapter 2 and is summarized in Tables 4 to 8. The chosen calculation methods will be related to the practical activities that are planned to conduct research on within Baan.
Benefits side:

1. Savings from making changes earlier in the design life cycle are calculated with the method, “savings from making changes earlier in design life cycle”. Errors are logged in Defect Tracker and TCS.

2. For customer support, “decreased amount of customer support” will be taken as the calculation method. The databases Scopus and Knowledge Base will be used to extract information about customer problems.

3. For training the following aspects will be investigated. First, we will look at the Training Need Analysis (TNA). Second, interviews will be held with people from training. Training externally is for customers. Here it is important if trainers are paid per module or hour. Training internally is for people in Baan. For example people from CS&S have to learn how to work with particular products. The method that will be used is “decreased training costs”.

4. The satisfaction survey will be used to find out whether or not one can find usability problems in this survey.

5. Return of Investment will be used to calculate the return of investment of usability. This is done by calculating the total costs and divide it by the average net profit.

6. For Sales, the extra time needed to prepare for a presentation for the customers due to a lack or no usability will be estimated. This is done via a cost savings method. Increased sales due to usability will be difficult to measure. If there is sufficient time this will be investigated. The increased sales method will be used. Missed deals, due to a lack of usability, will not be easy to research. The average profit of a product will be taken to calculate the missed benefits.

Because it is difficult to see how much time is needed to calculate each method, they will be prioritized, which ones to use first. The first three methods will definitely be done. Sales has a very low priority because people of sales are difficult to get in contact with. They are paid per hour they spent on sales, and are not paid when they are interviewed. The data sources for errors and bugs look promising, so its priority is high. Because support has also to do with bugs and errors, if is decided to give support also a high priority. Training has an average priority, because it is not clear how easy the data sources are accessible. Satisfaction survey is given a low priority because it is not precisely clear what is asked to the customers in the survey. Return of investment can always be done, if there is time left.

5.5 Conclusion

A decision is made in this chapter which calculation methods will be used. For the cost side “ABC” will be used. For the benefits side: “decreased amount of customer support”, “savings gained from making changes earlier in the design life cycle” and “decreased user training”. When time allows, the following benefit calculation methods will be also used: cost savings sales, “return of investment” and there will be looked at the satisfaction survey. This decision is based on decision variables described in 5.2 and Table 19.
Chapter 6 Case: ThinBaan

6.1 Introduction

After deciding to do most of our calculation activities on the Baan product “ThinBaan” we will now give some more specific information regarding this product. First the context of ThinBaan within Baan will be discussed, secondly the relation of usability consultancy with ThinBaan will be described, and next the usability effort on this product is summarized.

The product names that are used are fictitious and show no relation to Baan products. The numerical data shown here is fictitious and shows no relation to Baan figures.

6.2 Context ThinBaan within Baan

ThinBaan (1.1) belongs to the interface layer components that are needed for the customer, in order to work with other Baan products. As far as the different User Interfaces are concerned:

- Product Q will be the standard User Interface for various Baan products and will therefore be shipped as part of the bundle
- ThinBaan (web-enabled version of Product Q) version 1.1 will be an LA (limited available) product that will be shipped on customer request (for free)
- The static menu browser will only be shipped on customer request

ThinBaan is the web-enabled version of the Product Q, which is the “thick” WIN32 version.

In the ThinBaan related project plan, Baan states that the added value of ThinBaan consists of:

- No client-side installation, so lower total cost of ownership (TCO)
- Global access to the BaanERP data: “any time, any place” access
- Improved usability and personalization possibilities

The “improved usability” as mentioned in the project plan is not the “real” kind of usability that we try to quantify in performing this research. The term usability used in the project plan can be seen more as a marketing term and not as the definition that the usability consultants would use.

6.3 Usability consultancy in relation to ThinBaan

Currently there is one usability consultant permanently assigned to ThinBaan. The usability consultant has been involved in this product from the start (January 2000) up till now (July 2002).

6.4 Usability consultant’s effort on ThinBaan

According to the usability consultant who is assigned to ThinBaan there have been certain impacts on this product, which can exclusively be assigned to the usability consultant. Examples of this are:
• Feedback messages to the user
• Use of language within the system
• Help
• Keyboard support within application
• Visual design
• Intuitive feel

Also a significant effort is done by the usability consultant on the “personalization” part of the application, examples of this are:

• Shortcut bar
• Omitting columns
• Different skins, e.g., color of the interface of the product

Not so much effort was spent by the usability consultant in relation to the navigation for the application.

6.5 Conclusion

We can conclude that a significant usability effort has been put into this product. Also can we conclude that we have found some characteristics that will influence our calculation efforts:

1. The time in the market of ThinBaan is very short, only version 1.0 and very recently only 1.1 are released.
2. Since it is a web enabled product not too many customers will “only” use this product in their day to day work activities, since there is the standard interface “Product Q” (WIN32 version of ThinBaan) that is provided as the standard interface for BaanERP.
3. ThinBaan is provided free of charge for Baan customers.

These are the main characteristics that will (amongst others) influence our cost benefit calculations with regard to usability on ThinBaan. These calculations will follow in the next chapters.
Chapter 7  Costs of usability

7.1 Introduction

In this chapter the costs of the usability activities on ThinBaan are calculated. This will be done by using the method Activity Based Costing, which is explained in subsection 2.6.1. First the activities that were performed on ThinBaan will be described. Secondly the division of hours over activities will be explained. The final two issues that will be described in this chapter are the costs by activity and the costs by product. The numerical data shown here is fictitious and shows no relation to Baan figures.

7.2 Activities performed on ThinBaan

During several interviews with the usability consultant of ThinBaan, it became clear that the following activities were performed on ThinBaan: task analysis, task design, prototyping, visual design, icon design and the four subtasks of assisting in realization. The activities that were described in section 3.4 are transformed to the language that “ABC” uses.

Activity: Task analysis
Activity driver measure: Total number of hours worked on ThinBaan
Resource driver measure: Time needed by the usability consultant
Agents: Usability consultant
Description: Relevant information about the user profile, the organizational context and the actual user tasks is collected.
Results in: Description of users, organizational context and user tasks

Activity: Task design
Activity driver measure: Total number of hours worked on ThinBaan
Resource driver measure: Time needed by the usability consultant
Agents: Usability consultant
Description: The activities, taking into consideration user profile and organizational context are restructured. Those activities can be combined with activities that will be supported by possible new functionality.
Results in: Description of users, organizational context and user tasks

Activity: Prototyping
Activity driver measure: Total number of hours worked on ThinBaan
Resource driver measure: Time needed by the usability consultant
Agents: Usability consultant
Description: A screen design is made for the different user interface objects.
Results in: A screen design, which is a prototype of ThinBaan

Activity: Usability test
Activity driver measure: Total number of hours worked on ThinBaan
Resource driver measure: Time needed by the usability consultant
Agents: Usability consultant
Description: The usability of the product is verified, usability consultant performs a usability test on the product (during integration test).
Results in: An evaluation of a part of the system or the system
Activity: Visual design
Activity driver measure: Total number of hours worked on ThinBaan
Resource driver measure: Time needed by the usability consultant
Agents: Usability consultant
Description: The user interface of ThinBaan is made during this activity.
Results in: The visual design of ThinBaan

Activity: Icon design
Activity driver measure: Total number of hours worked on ThinBaan
Resource driver measure: Time needed by the usability consultant
Agents: Usability consultant
Description: The icons of ThinBaan are made, implemented in ThinBaan.
Results in: The icons of ThinBaan

Activity: Assisting in realization; preparation FD
Activity driver measure: Total number of hours worked on ThinBaan
Resource driver measure: Time needed by the usability consultant
Agents: Usability consultant
Description: The usability consultant gives advice to the product consultant on making preparations for the FD.
Results in: A functional design

Activity: Assisting in realization; ad hoc consultancy
Activity driver measure: Total number of hours worked on ThinBaan
Resource driver measure: Time needed by the usability consultant
Agents: Usability consultant
Description: The usability consultant gives advice to team members about usability issues.
Results in: Improvements in ThinBaan

Activity: Assisting in realization; logging change requests
Activity driver measure: Total number of hours worked on ThinBaan
Resource driver measure: Time needed by the usability consultant
Agents: Usability consultant
Description: The usability consultant logs change requests in Web Defect Tracker.
Results in: Logs with change requests for ThinBaan

Activity: Assisting in realization; testing bugs
Activity driver measure: Total number of hours worked on ThinBaan
Resource driver measure: Time needed by the usability consultant
Agents: Usability consultant
Description: The usability consultant tests parts of the system to find bugs.
Results in: Found bugs in ThinBaan

7.3 Distributing hours over activities

In Table 22 the time that an activity takes to be completed is shown. The activities are performed by an agent, this is a usability consultant of ThinBaan. The resource that is used is the time to complete an activity in hours for an employee, these are costs. The
hours that the usability consultant worked are logged in Time Wizard. Hours are distributed over different tasks in Time Wizard, such as training, project meetings, etc. The descriptions of most of the tasks in Time Wizard were too general to decide if they belong to ThinBaan. In Table 20 an example is given how the Time Wizard task ERP Usability was distributed over ThinBaan. This information was given by the usability consultant of ThinBaan during different meetings. In this section only a short example of allocating time to tasks of ThinBaan (Table 20) and allocating time to activities from tasks (Table 21). The full tables can be found in Appendices G:. When ThinBaan1.1 started the usability consultant could invest more time in the tasks for ThinBaan, than for the other products she simultaneously worked on. That's the reason why a split is made for ThinBaan1.0 and ThinBaan1.1.

<table>
<thead>
<tr>
<th>Tasks from Time Wizard</th>
<th>Task exists for x % of time used for ThinBaan</th>
</tr>
</thead>
<tbody>
<tr>
<td>ERP Usability</td>
<td>ThinBaan1.0</td>
</tr>
<tr>
<td></td>
<td>50%</td>
</tr>
</tbody>
</table>

*Table 20: Allocating time to tasks over ThinBaan*

The task descriptions were also too general to derive time spent on the usability activities, which were explained in section 3.4 Baan usability activities within the development process. Therefore the usability consultant of ThinBaan divided the time of the task over the different usability activities. In Table 21 an example is given for the Time Wizard task ERP Studio.

<table>
<thead>
<tr>
<th>Tasks from Time Wizard</th>
<th>Activities from Chapter 3</th>
<th>% Time used for usability activity per task</th>
</tr>
</thead>
<tbody>
<tr>
<td>ERP Usability</td>
<td>Prototyping</td>
<td>17</td>
</tr>
<tr>
<td></td>
<td>Usability testing</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Visual design</td>
<td>17</td>
</tr>
<tr>
<td></td>
<td>Icon design</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Preparation FD</td>
<td>7.5</td>
</tr>
<tr>
<td></td>
<td>Ad hoc consultancy</td>
<td>22.5</td>
</tr>
<tr>
<td></td>
<td>Logging change requests</td>
<td>7.5</td>
</tr>
<tr>
<td></td>
<td>Testing bugs</td>
<td>22.5</td>
</tr>
</tbody>
</table>

*Table 21: Allocating time to activities from tasks*

The final result of the distribution over activities can be seen in Table 22. The hours are rounded upwards. So the actual costs are a bit lower than the cost presented in this chapter. Assisting in realization is a task, which is not defined on the usability intranet site as an activity of a usability consultant. This activity appeared during different meetings with the usability consultants at Baan. After the hours were distributed to the different activities, assisting in realization consumed 56% of the total hours. It was the least clear defined activity. So during a meeting with the usability consultant of ThinBaan, the activity of assisting in realization was divided into four sub-activities (see also subsection 3.4.13).

<table>
<thead>
<tr>
<th>Activities performed for ThinBaan</th>
<th>Agents</th>
<th>Resource</th>
<th>Time duration in hours</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### 7.4 Costs by activity

Table 23 shows the cost of the resource that is used by the activities. The resource total cost \( RTC_i \) is the average costs of an employee (usability consultant) per year for Baan. These costs consists of salary, taxes, premiums, etc. \( $45,000 \) and travel and office costs \( $25,000 \). Resource total consumption \( RTV_i \) is the total hours the resource is used per year. The resource driver cost \( RDC_i \) is the average costs of the resource per hour for Baan.

<table>
<thead>
<tr>
<th>Resource</th>
<th>( RTC_i ) (in US $)</th>
<th>( RTV_i ) (in hours)</th>
<th>( RDC_i ) (in US $)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Usability consultant</td>
<td>70,000</td>
<td>2,000</td>
<td>35.00</td>
</tr>
</tbody>
</table>

Table 23: Resource used and the costs

In Table 24 the total costs per activity are shown. The Resource driver cost \( RDC_i \) is the costs of an usability consultant per hour for Baan. This is \( $35.00 \) per hour. The resource driver measure \( RDM_{i,j} \) is the total of hours worked on an activity. The total hours spent on the different activities for ThinBaan is 2,045 hours. The frequency an activity \( Fa_j \) is used, is 100% for all the activities. The total cost \( TCA_j \) of an activity must be calculated by multiplying \( RDM_{i,j} \), \( RDC_i \) and \( Fa_j \). For example, the costs for the activity task analysis are: \( 65 \times 35.00 \times 1 = $2,275 \). The total cost for all the usability
activities on ThinBaan is $71,575. The activity ad hoc consultancy costs most of all activities.

<table>
<thead>
<tr>
<th>Activities performed for ThinBaan</th>
<th>$RDM_{i,j}$ (in hours)</th>
<th>RDC(_j) (in US $)</th>
<th>Fa(_j) (in %)</th>
<th>TCA(_j) (in US $)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Task Analysis</td>
<td>65</td>
<td>35.00</td>
<td>100</td>
<td>2,275</td>
</tr>
<tr>
<td>Task Design</td>
<td>65</td>
<td>35.00</td>
<td>100</td>
<td>2,275</td>
</tr>
<tr>
<td>Prototyping</td>
<td>350</td>
<td>35.00</td>
<td>100</td>
<td>12,250</td>
</tr>
<tr>
<td>Usability Testing</td>
<td>20</td>
<td>35.00</td>
<td>100</td>
<td>700</td>
</tr>
<tr>
<td>Visual Design</td>
<td>300</td>
<td>35.00</td>
<td>100</td>
<td>10,500</td>
</tr>
<tr>
<td>Icon Design</td>
<td>75</td>
<td>35.00</td>
<td>100</td>
<td>2,625</td>
</tr>
<tr>
<td>Assisting in realization: logging change requests</td>
<td>400</td>
<td>35.00</td>
<td>100</td>
<td>14,000</td>
</tr>
<tr>
<td>Assisting in realization: testing bugs</td>
<td>140</td>
<td>35.00</td>
<td>100</td>
<td>4,900</td>
</tr>
<tr>
<td>Assisting in realization: ad hoc consultancy</td>
<td>450</td>
<td>35.00</td>
<td>100</td>
<td>15,750</td>
</tr>
<tr>
<td>Assisting in realization: preparation FD</td>
<td>180</td>
<td>35.00</td>
<td>100</td>
<td>6,300</td>
</tr>
<tr>
<td>Total</td>
<td>2,045</td>
<td></td>
<td></td>
<td>71,575</td>
</tr>
</tbody>
</table>

Table 24: Activity costs in the usability consultancy process

### 7.5 Costs by product

In Table 25 the costs are distributed over the four different products. This is done because in this way we can see what amount of hours is used for what product. In a meeting with the usability consultant of ThinBaan it was decided that the activities contribute to or produce the following products: ThinBaan, training, help and awareness. ThinBaan is the software product. The usability consultant helps with making training material and the help (user support) for the software product. Help is seen as a different product in Baan.

The usability consultant of ThinBaan is a permanent member of the team that develops ThinBaan. Because she is a permanent member of that team, she creates awareness of usability with the other team members. She had to convince her team members that usability was important and therefore she was needed as a member of the team.

According to the usability consultants it can be regarded as a different product. The activity total consumption ($ATV\(_j\)$) is 100%, so the activity driver cost ($ADC\(_j\)$) is equal to the total cost of an activity ($TCA\(_j\)$). The usability consultant divided the $ADC\(_j\)$ over the different products, this is the activity driver measure ($ADM\(_{j,k}\)$). The incurred cost of a product ($ICP\(_{j,k}\)$) is thus a percentage of the $ADC\(_j\)$. For example, for task analysis the $ADM\(_{j,Webtop}\)$ consumes 80% of the ($ADC\(_j\)$) $2,275, that’s $1,820 for the
product ThinBaan. For the product training the $ADM_{j,training}$ is 5% for task analysis, that's $113.75.

<table>
<thead>
<tr>
<th>Activities performed for ThinBaan</th>
<th>ADC $j$ (in US $)</th>
<th>ADM $j_{Webtop}$ (in %)</th>
<th>ICP $j_{Webtop}$ (in US $)</th>
<th>ADC $j_{training}$ (in %)</th>
<th>ICP $j_{training}$ (in US $)</th>
<th>ADM $j_{help}$ (in %)</th>
<th>ICP $j_{help}$ (in US $)</th>
<th>ADM $j_{aw}$ (in %)</th>
<th>ICP $j_{aw}$ (in US $)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Task Analysis</td>
<td>2,275</td>
<td>80</td>
<td>1,820</td>
<td>5</td>
<td>113.75</td>
<td>10</td>
<td>227.50</td>
<td>5</td>
<td>113.75</td>
</tr>
<tr>
<td>Task Design</td>
<td>2,275</td>
<td>80</td>
<td>1,820</td>
<td>5</td>
<td>113.75</td>
<td>10</td>
<td>227.50</td>
<td>5</td>
<td>113.75</td>
</tr>
<tr>
<td>Prototyping</td>
<td>12,250</td>
<td>80</td>
<td>9,800</td>
<td>15</td>
<td>1,837.50</td>
<td>5</td>
<td>612.50</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Usability Testing</td>
<td>700</td>
<td>50</td>
<td>350</td>
<td>30</td>
<td>210</td>
<td>20</td>
<td>140</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Visual Design</td>
<td>10,500</td>
<td>80</td>
<td>8,400</td>
<td>20</td>
<td>2,100</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Icon Design</td>
<td>2,625</td>
<td>90</td>
<td>2,362.50</td>
<td>10</td>
<td>262.50</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Assisting in realization:</td>
<td>14,000</td>
<td>80</td>
<td>11,200</td>
<td>20</td>
<td>2,800</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>logging change requests</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Assisting in realization:</td>
<td>4,900</td>
<td>90</td>
<td>4,410</td>
<td>10</td>
<td>490</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>testing bugs</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Assisting in realization:</td>
<td>15,750</td>
<td>60</td>
<td>9,450</td>
<td>5</td>
<td>787.50</td>
<td>25</td>
<td>3,937.50</td>
<td>10</td>
<td>1,575</td>
</tr>
<tr>
<td>ad hoc consultancy</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Assisting in realization:</td>
<td>6,300</td>
<td>70</td>
<td>4,410</td>
<td>5</td>
<td>315</td>
<td>15</td>
<td>945</td>
<td>10</td>
<td>630</td>
</tr>
<tr>
<td>preparation FD</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 25: Distributing activity costs over products

Table 26 gives an overview of the total cost per product. The costs are calculated by adding the incurred cost of the different products (ICP), which can be found in Table 25. Most of the costs are made for ThinBaan and least for Training.

<table>
<thead>
<tr>
<th>Product</th>
<th>Total cost of product (in US $)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ThinBaan</td>
<td>54,022.50</td>
</tr>
<tr>
<td>Training</td>
<td>1,330</td>
</tr>
<tr>
<td>Help</td>
<td>13,037.50</td>
</tr>
<tr>
<td>Awareness</td>
<td>3,185</td>
</tr>
<tr>
<td>Total</td>
<td>71,575</td>
</tr>
</tbody>
</table>

Table 26: Cost per product

7.6 Conclusion

In this chapter the hours the usability consultant worked on the product ThinBaan are divided over the different usability activities. The activity assisting in realization got the most of the hours. Because the description of this activity was at that moment not clear, a decomposition had to be made in different sub-activities. The sub-activity ad hoc
consultancy received the most of the hours (450). The total cost for Baan of an usability consultant per hour is $ 35.00. The total cost of all the activities is $ 71,575. The costs were also distributed over the four identified products. ThinBaan (software product) generates the most of the costs ($ 54,022.50).

The numerical data shown here is fictitious and shows no relation to Baan figures.
Chapter 8 Benefits of usability

8.1 Introduction

In this chapter an inventory of customer service and support at Baan will be described first. After that is done and the features of this department and their work processes have been found out, the methods “savings gained from making changes earlier in the design life cycle” and “Decreased amount of customer support” will be calculated. The calculation method “Making changes earlier in the design life cycle” that is used in this chapter, was explained in subsection 2.7.2. The cost of making changes earlier in the design life cycle should be less than changing it later. To come to the savings gained from making changes earlier in the design life cycle, Web Defect Tracker and cases of PEG (Product Engineering Group) were used. Finally we will also be look at internal training of employees for ThinBaan and reduction in training time due to usability activities will be calculated.

The numerical data shown here is fictitious and shows no relation to Baan figures.

Since we can calculate the benefits in different ways we will work with scenarios. We will do all benefit calculations for a conservative scenario and an average scenario. The conservative scenario has the most conservative estimations and calculations for all methods that are going to be used. The average scenario also has average estimations and calculations, but still conservative numbers are used.

8.2 Frequently used numbers and definitions

Here we will make available several frequently used numbers and definitions. In this way we do not have to mention these numbers over and over again in the following benefit calculations.

<table>
<thead>
<tr>
<th>Function</th>
<th>Avg. personnel costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Usability Consultant</td>
<td>$ 35.00</td>
</tr>
<tr>
<td>Trainer</td>
<td>$ 40</td>
</tr>
<tr>
<td>Software Engineer (ThinBaan)</td>
<td>$ 40</td>
</tr>
<tr>
<td>Software Engineer (in general)</td>
<td>$ 40</td>
</tr>
<tr>
<td>Software Engineer (PEG)</td>
<td>$ 40</td>
</tr>
<tr>
<td>Support Analyst</td>
<td>$ 35</td>
</tr>
</tbody>
</table>

Table 27: Average personnel costs

Definitions used:
Solution = Modifications to one or more software components
Case = Term that is used by Customer Service and Support (CS&S) for customer calls that are logged by Baan customers, consisting of questions and problems.
Defect = Bug in software
8.3 Inventory Customer Service & Support

The customer service and support at Baan is called Baan Global Support (BGS) consists of Support Group and a Product Engineering Group. Support group delivers 1st and 2nd line support for customer cases, this is done by support analysts. First line calls can be solved quickly, mostly within a day. Second line calls need further investigation and are solved within a longer period of time. If 3rd line support (bug fixing) is required, a hand-over to the Product Engineering Group (PEG) will take place. Solutions that come from PEG are also delivered by BGS to the customer.

8.3.1 The Support Group Process

A case (this term is used by Support Group for a customer call) consisting of questions and problems is logged by Baan customers. A support analyst looks to see if existing answers or solutions are available, and if not, the analysis process begins. As long as the problem can be solved without changing code, the case will stay at the Support Group. Baan Global Support has defined five priority codes, which assist them in determining the seriousness or level of priority for support cases being reported by their customers. The customers have the discretion of assigning the level of priority according to their implementation status.

<table>
<thead>
<tr>
<th>Priority Code</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Priority 10</td>
<td>Business Standstill</td>
</tr>
<tr>
<td></td>
<td>-The customer's live system is at a halt and unable to process data through Baan software as a result of a catastrophic event in the system database or Baan Tools.</td>
</tr>
<tr>
<td></td>
<td>-A major application failure in a critical processing period.</td>
</tr>
<tr>
<td>Priority 20</td>
<td>Major Problem</td>
</tr>
<tr>
<td></td>
<td>-Reported problem in the software that causes serious disruption of a major business function and that cannot be (temporarily) solved by a workaround.</td>
</tr>
<tr>
<td>Priority 30</td>
<td>Problem</td>
</tr>
<tr>
<td></td>
<td>-A non-critical problem in the software where the user is able to continue to run the system and/or application.</td>
</tr>
<tr>
<td></td>
<td>-A problem in the software that does not function as documented.</td>
</tr>
<tr>
<td></td>
<td>-A problem for which an acceptable work around is available.</td>
</tr>
<tr>
<td></td>
<td>-A reported problem in the software that does not qualify as a priority 10 or 20.</td>
</tr>
<tr>
<td>Priority 40</td>
<td>Question</td>
</tr>
<tr>
<td></td>
<td>-All questions and requests for information on the use or implementation of Baan products. This includes requests for explanation of documentation, procedures, parameters, menus, screens, fields and reports.</td>
</tr>
<tr>
<td>Priority 50</td>
<td>Enhancement requests</td>
</tr>
<tr>
<td></td>
<td>-All cases related to suggested improvements to Baan software or documentation such as requests for new functionality, changed functionality and, improved user interfaces. Each support request for enhancement needs to be submitted in writing via fax or the Interactive Support Website.</td>
</tr>
</tbody>
</table>

Table 28 Priority codes BGS
8.3.2 The PEG Process

The Product Engineering Group (PEG) is the 3rd level of BGS. PEG uses the deliverables created by 2nd level support and does further research, program modifications, programming and testing to resolve customer cases. A planned solution date (PSD) is given. Once resolved, the defect will be closed and the resolution will be handed over to support for further communication to the customer. All solutions are published for customer use at the PEG website.

PEG uses the Baan Support System (internally known as “Scopus”) for tracking the maintenance modifications that are made to the software product (ThinBaan in our case). Problems in the software commonly known as “bugs” are called “Defects” in Scopus terminology. A Scopus “Solution” is a fix for a “Defect”.

In most cases, a Solution involves modifications to one or more software components. PEG can determine the smallest component that can be delivered as a Solution. This is commonly known as a “patch”. A collection of several solutions (namely all bug-fixes that have been done in a certain amount of time) is called a service pack.

8.4 Savings gained from making changes early in the development cycle

8.4.1 Context

When a product is released this product is no longer part of the development cycle of Baan and the product is transferred from the ThinBaan implementation team. People within Baan development and outside Baan development however still find defects in this product. These defects can sometimes emerge from customer calls to the Customer Service and Support (CS&S) department at Baan. The defects are solved by software engineers in and outside Baan Development (not the “original” software engineers of ThinBaan).

Other defects of the same kind are solved by ThinBaan Software engineers due to the fact that Support Groups seeks direct contact with this team. These are defects that are still found in ThinBaan after its release, although the usability consultant had performed usability activities on this product.

What we will calculate are the real benefits that were gained by investing in usability at Baan.

A calculation will be made for the benefits that are gained in reality due to performing usability activities on ThinBaan by a usability consultant. This will be done with the help of Web Defect Tracker as information source and by using the method “savings gained from making changes early in the development cycle”.

8.4.2 Processing the data

Now the data will be processed that has to do with the time needed to solve a defect at PEG.

On average we found that a PEG software engineer takes 40 days to solve a defect for priorities 20 and 30. We come to this average by calculating the average time to solve a defect with an internal Baan tool called “solving time 2001 q3”. This tool calculates the solving time per defect in the 3rd quarter of 2001, the output can be seen in Table 29.

This average, 40 days applies to all applications within Baan that have defects to be
solved by PEG, not specifically for ThinBaan. There was no such data available for ThinBaan, which is the reason why we will calculate with this average. However we will make some nuances on this average number. First of all, it can be seen from Table 29 that 55% of this 40 days is spent on receiving and previewing a defect at PEG. Secondly another 15% is spent on assigning a defect to a PEG software engineer. In order to come to a conservative calculation we will not take this 53% + 15% = 68% into consideration. This leaves us with 32% of the in initial 40 days, which is 12 days and 6 hours solving time per defect at PEG. This equals 102 hours.

On the other hand we know from estimations by a domain expert that the original ThinBaan implementation team takes on average 3 days to solve a defect found after ThinBaan has been released. But the majority of these defects are not solved by them.

<table>
<thead>
<tr>
<th>Time / Defect</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Received</td>
<td>9.6</td>
</tr>
<tr>
<td>Previewed</td>
<td>11.6</td>
</tr>
<tr>
<td>Assigning</td>
<td>6</td>
</tr>
<tr>
<td>X2</td>
<td>1.8</td>
</tr>
<tr>
<td>X3</td>
<td>1</td>
</tr>
<tr>
<td>X4</td>
<td>1</td>
</tr>
<tr>
<td>X5</td>
<td>1</td>
</tr>
<tr>
<td>X6</td>
<td>1</td>
</tr>
<tr>
<td>X7</td>
<td>1</td>
</tr>
<tr>
<td>X8</td>
<td>1</td>
</tr>
<tr>
<td>X9</td>
<td>1</td>
</tr>
<tr>
<td>X10</td>
<td>1</td>
</tr>
<tr>
<td>X11</td>
<td>1</td>
</tr>
<tr>
<td>X12</td>
<td>1</td>
</tr>
<tr>
<td>X13</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>40</td>
</tr>
</tbody>
</table>

Table 29: Solving time per defect for priority 20 and 30

8.4.3 Results after processing the data

First of all it must be emphasized that every defect that occurs will lower the usability of a software product.

As an average solving time per defect by PEG we will take 12 days and 6 hours (102 hours). In our opinion this average number can be seen as “working time” and not as turnaround time for solving a defect of priorities 20 and 30 by PEG. We will use this average time for the changes made after ThinBaan has been released because in future situations it is very likely that PEG needs to make this kind of changes to ThinBaan. For the moment these changes are being made by Baan Development, due to a lack of JAVA programming skills within PEG.
8.4.4 Calculation
What we can say is that detecting defects at Baan later in the development cycle is much more costly than when the same defects are detected earlier. This cost approximately a factor 4.25 more, as can be seen from this calculation:

\[
\frac{W_e \cdot \text{PEG Engineer} \times \text{Time in hours spent per late change}}{W_a \cdot \text{Webtop Engineer} \times \text{Time in hours spent per early change}} = \text{factor \_ x \_ spent \_ more \_ less \_ per \_ late \_ change}
\]

This comes for Baan to:

\[
\frac{40 \times 102 \text{ hours}}{40 \times 24 \text{ hours}} = 4.25
\]

The factor 4.25 that is more per late change compared to making changes earlier in the development cycle however is a number based on real figures within Baan.

8.4.5 Web Defect Tracker

8.4.6 Context
One of the activities that the usability consultant performs is logging change requests. During this activity the usability consultant logs the problems found in the software in Web Defect Tracker. Web Defect Tracker is a program where change requests, defects and planned code changes are logged. The software engineers fix the change requests, defects and planned code changes and can alter the status.

8.4.7 Acquiring the data
The usability consultant of ThinBaan has logged problems for ThinBaan1.0 and ThinBaan1.1. Table 30 and Table 31 represent the logs that are made by the usability consultant of ThinBaan. The issues are logged according to severity, priority and type of issue. Severity has to do with the seriousness of the problem and priority in which order the issues should be fixed. There are three types of issues. Planned code changes are changes that have to be made in the underlying code of ThinBaan. Defects are defects in the system of ThinBaan. The issues the usability consultant of ThinBaan logged as change requests are all usability issues.

8.4.8 Processing the data
The usability consultant logged in total 300 problems for ThinBaan1.0 and ThinBaan1.1. Almost all problems were solved by the ThinBaan implementation team (97%), the other 3% is already taken into account because of the conservative estimation that is going to be made of the change requests (see next). At ThinBaan1.1 the usability consultant logged change requests most of the time as defects, because they got a higher priority. This means that the software engineers from the ThinBaan team would fix defects earlier than change requests. For ThinBaan1.0 124 request changes are logged, that is 69% of all logs. ThinBaan1.1 has only 26% change requests. Because it is known that part of the defects are actually change requests in ThinBaan1.1, the number of change request should be higher. It is safe to estimate that 50% of all the logs are change requests, because for ThinBaan1.0 it was 69%. The total of change requests would be 184 change requests.
<table>
<thead>
<tr>
<th>Severity</th>
<th>Priority</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Critical (2/180)</td>
<td>Not specified (2/2)</td>
<td>Change request (2/2)</td>
</tr>
<tr>
<td>Serious (12/180)</td>
<td>Not specified (12/12)</td>
<td>Change request (8/12)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Defect (4/12)</td>
</tr>
<tr>
<td>Medium (122/180)</td>
<td>High (1/122)</td>
<td>Defect (1/1)</td>
</tr>
<tr>
<td></td>
<td>Medium (6/122)</td>
<td>Change request (4/6)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Planned code change (2/6)</td>
</tr>
<tr>
<td></td>
<td>Not applicable (2/122)</td>
<td>Change request (1/2)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Defect (1/2)</td>
</tr>
<tr>
<td></td>
<td>Not specified (113/122)</td>
<td>Change request (79/122)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Defect (32/122)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Planned code change (2/122)</td>
</tr>
<tr>
<td>Low (45/180)</td>
<td>Low (1/45)</td>
<td>Change request (1/1)</td>
</tr>
<tr>
<td></td>
<td>Not applicable (2/45)</td>
<td>Defect (2/2)</td>
</tr>
<tr>
<td></td>
<td>Not specified (42/45)</td>
<td>Change request (29/42)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Defect (13/42)</td>
</tr>
</tbody>
</table>

*Table 30: Logs for ThinBaan 1.0*

The software engineers from ThinBaan estimate to need 1 to 3 workdays to make a modification to ThinBaan. To make a conservative estimation of the costs to fix a change request, 3 workdays are chosen, most of the change requests are of medium severity. So the costs are actually lower. Further, an estimation has to be made about how many usability issues would not have been found without a usability consultant in the ThinBaan team. The estimation is 50%, because there can be some noise in the data. Things that are not typical usability issues have been filtered out by not looking at the defects and planned code change. So the real usability issues are the change request. The authors and the usability consultants think that 50% is a conservative estimation and the actual percentage is higher. So 92 change requests should not have been found if there was no usability consultant. These 92 change requests would have been found after the product was released. This would mean that PEG must solve these problems. The time that PEG needs to repair something is 12 days and 6 hours (102 hours).

This is only one way of how to calculate the costs of the changes made late in the design life cycle. The literature gives also examples how this could be calculated. Boehm (Boehm 1987 as cited by Royce 1999) says that finding and fixing a software problem after delivery costs 100 times more than finding and fixing the problem in early design phases. The authors think that Boehm means finding and fixing bugs in critical software.
systems, because Boehm develops critical software systems for the ministry of defense. For Baan this estimation is far too high, as said earlier for Baan a number of 4.25 is applicable.

<table>
<thead>
<tr>
<th>ThinBaan 1.1 (120/300)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Severity</strong></td>
</tr>
<tr>
<td>Serious (24/120)</td>
</tr>
<tr>
<td>Not specified (22/24)</td>
</tr>
<tr>
<td>Not specified (22/24)</td>
</tr>
<tr>
<td>Medium (60/120)</td>
</tr>
<tr>
<td>Not specified (22/60)</td>
</tr>
<tr>
<td>Not specified (22/60)</td>
</tr>
<tr>
<td>Planned code change (1/22)</td>
</tr>
<tr>
<td>Low (36/120)</td>
</tr>
<tr>
<td>Low (2/36)</td>
</tr>
<tr>
<td>Not specified (33/36)</td>
</tr>
<tr>
<td>Not specified (33/36)</td>
</tr>
<tr>
<td>Planned code change (1/33)</td>
</tr>
</tbody>
</table>

*Mantei and Teorey (Mantei and Teorey 1988 as cited by Mayhew and Mantei 1994) give also an estimation and say that the cost is 4 times higher to make change late in the development life cycle. This is a conservative estimation according to Mayhew and Mantei (1994). The different ways to calculate the cost of the changes are placed in different scenarios. One average scenario and one conservative scenario.*

**8.4.9 Results after processing the data**

The numbers of logs is reduced to 92 during the process. The number of change requests is taken conservatively. The actual number is higher. So the savings can be higher than the number that is taken here. There are two different options which can be used to come to the result: the actual figures of Baan (92) or the late change costs that are 4 times higher than early changes from Mantei and Teorey.
8.4.10 Calculation
The literature formula as described in subsection 2.7.2 is:

\[
CSED = X \cdot (W_n \cdot Ch \cdot t_{ch}) - (W_n \cdot Ch \cdot t_{ch})
\]

Where:
- \(CSED\) = Total cost saving changes made earlier in the development cycle per year
- \(W_n\) = Fully loaded wage for personnel type \(n\) per hour
- \(Ch\) = Number of changes made per year
- \(t_{ch}\) = Time in hours spent per early change
- \(X\) = Penalty factor for making changes late in the development life cycle

Conservative scenario
Conservative scenario is the scenario where a conservative calculation is used. This means that this will yield the lowest expected benefits.

92 changes made early
24 hours to make an early change by a ThinBaan software engineer
Cost per hour of software engineer ThinBaan for Baan: $40
Late change costs are 4x as costly as early change costs (Mantei and Teorey 1988 as cited by Bias and Mayhew 1994)

\[
\text{Late change costs} = \text{early change costs} \times 4 \times (4 \cdot (W_n \cdot Ch \cdot t_{ch}) = $353,280
\]
\[
\text{Early change costs} = $40 \times 92 \times (Ch \times 24 = $88,320
\]
\[
CSED = X \cdot (W_n \cdot Ch \cdot t_{ch}) - (W_n \cdot Ch \cdot t_{ch}) = $264,960
\]

In reality the factor “4x early change costs” that is used by Bias and Mayhew (1994) is 4.25x at Baan. The calculation to come to the “4.25x” at Baan can be found in subsection 8.4.4.

Average scenario
The average scenario is the scenario where an average calculation will be used.

92 changes early
24 hours to make an early change by a ThinBaan software engineer
Cost per hour of software engineer ThinBaan for Baan: $40
Late change costs are 4.25 x early change costs

\[
\text{Late change costs} = \text{early change costs} \times 4.25 \times (W_n \cdot Ch \cdot t_{ch}) = $375,360
\]
\[
\text{Early change costs} = $40 \times 92 \times (Ch \times 24 = $88,320
\]
\[
CSED = X \cdot (W_n \cdot Ch \cdot t_{ch}) - (W_n \cdot Ch \cdot t_{ch}) = $287,040
\]

This calculation again is based on the factor 4.25 that is spent more in time per late change compared to making a change early in the development cycle at Baan.
8.5 Decreased amount of customer support

8.5.1 Context
The context is already described extensively in section 8.3. We will now only give a short summary of the context that is applicable to the method “decreased amount of customer support”.
The method itself is described in subsection 2.7.2.
A customer of Baan can log a problem or question in the form of a case. A support analyst (SA) takes care of this case.

When the SA comes to the conclusion that this case has to do with a bug in the software, or at least thinks that this might be so, a defect is being logged by him/her. This defect is being linked to the corresponding case(s). There were also occasions that Support Analysts sought direct contact with the original ThinBaan implementation team. We cannot know if these cases were usability related and we will therefore not take these into account.

8.5.2 Acquiring the data
Data found regarding total amount of customers and incoming calls from users at Baan is found in Baan internal data sources.
Also domain experts such as two Support Analysts and a ThinBaan Product Consultant have provided us with (estimated) data and useful information on this data.

8.5.3 Processing the data
Although we found that 65% of all current ThinBaan cases are linked to “usability” defects and are thus “usability” related cases. The definition of “usability related call” is a call that could have been prevented by usability activities. We do think that is quite a large number to take for the total amount of ThinBaan “usability” cases. These cases that are logged are cases linked to defects at PEG, we do not know:
- The number of incoming calls (cases) on ThinBaan
- What percentage of these calls can be related to usability
These data could not be found. However we do know that a very small percentage of the incoming calls (cases) at Baan are about usability. Customers and Support Analysts do not classify calls or cases as cases or calls that are about usability (Cazemier 2002). We therefore have to make more estimation of several numbers.

Average working time for a ThinBaan case
A Support Analyst who delivered support on ThinBaan told us that it will never take more than 3 days to solve a case that can be solved by first or second line helpdesk support at Baan. He states that for a ThinBaan case an average working time of 1 day (8 hours) is a reliable estimation. We will therefore calculate with this number.

Average estimated number of current users for ThinBaan
A ThinBaan Product Consultant has informed us about the number of customers for ThinBaan.
- So far there have been 10 official shipments to partners and customers.
- He estimates that the unofficial shipments (including pre-releases) will be approximately 20. This makes a total of 30 shipments for ThinBaan 1.0.
The amount of “copies” that is made of ThinBaan he estimates is around 25 to 30. He bases this on the fact that he got questions from people who he did not even thought were ThinBaan customers. This comes to a total of 55 to 60 customers for ThinBaan.

The amount of users of ThinBaan is unknown, in other words it is unknown to the product consultant how many users there really are in the 55 to 60 customers of ThinBaan. Therefore we need to make an estimation. We will do this in the following conservative way:

- We assume that not all ThinBaan customers actually use ThinBaan since it is free of charge and therefore is attractive to “try out” or to just obtain it just in case you want to use it (as an add-on). We assume that 50% out of these 55 customers will actually use ThinBaan. Thus results in 27 customers.

We have focused here on customers and its users, not on internal Baan users of ThinBaan since we assume that they do not ask for support in the way average “real” customers would have to do (through the Support Group).

8.5.4 Calculations
The literature formula as described in subsection 2.7.2 is:

\[ \text{CSCS} = \text{CP} \cdot \text{EC} \cdot \text{DC} \cdot W_n \]

Where:
- \( \text{CSCS} \) = Cost saving customer support per year
- \( \text{CP} \) = Size of customer population
- \( \text{EC} \) = Number of eliminated calls per customer per year
- \( \text{DC} \) = Average duration of call time in hours per day
- \( W_n \) = Fully loaded hourly wage for support personnel per hour

Conservative scenario
Mayhew and Mantei (1994) say that it is a conservative to assume that a reduction of four calls per customer per year can be achieved due to better usable products. They do however not give a percentage of users that seek help desk support, because there can be assumed that not all users of this product will seek help desk support. We found that within Baan on average 10% of the users seek help desk support. Furthermore a more conservative estimation is taken then Bias and Mayhew did with their reduction of four calls per user per year. A reduction is assumed of one call per user per year in our conservative scenario.

\[ \text{CSCS} = \text{CP} \cdot \text{EC} \cdot \text{DC} \cdot W_n \]

\[ \text{CSCS} = 27 \times 2 \times 8 \times \$ 35 = \$ 15,120 \]
Average scenario

For the average scenario a reduction is assumed of four calls per user per year.

\[ \text{CSCS} = CP \cdot EC \cdot DC \cdot W_n \]

\[ \text{CSCS} = 27 \times 4 \times 8 \times \$35 = \$30,240 \]

8.6 Decreased cost of training

8.6.1 Context

Knowledge Development looks after training in Baan. Baan distinguishes two different kinds of training. External training is given to the customers of the Baan product. Internal training is given to the employees of Baan who work with the product, e.g. to maintain it, sell, it give support on it etc. In this research we will only look at the internal training of employees who work with ThinBaan. The training is given to different people within Baan, but most of the time this are general software engineers, support analysts or PEG software engineers.

8.6.2 Acquiring the data

For ThinBaan there is one trainer within Baan. The trainer was contacted and asked if he could answer some questions, which he did.

8.6.3 Processing the data

- ThinBaan1.0 and ThinBaan1.1 have 4 official trainings given.
- The average time spent by a ThinBaan trainer on a training can be divided into different parts:
  - Preparation time for the official training is 20 hours, traveling time is 8 hours and the training is 30 hours.
  - Every official training is given by two trainers, the unofficial training is given by one trainer.
  - There is also unofficial training given within Baan, in total 10 unofficial trainings.
  - Average preparation time for an unofficial training is 8 hours.
  - The length of trainings varies from 1 hour to several days.
  - To make a conservative estimation 4 hours is taken as the average for the duration of a training.
- The average number of people participating in training is 10.
- Bias and Mayhew (1994) give a 10% reduction in training time, according to Bias and Mayhew (1994) this is a conservative estimation.
- We will also calculate with a 10% reduction in preparation time for a training
- The average costs of a trainer is $40, of a general Software Engineer $40, of a PEG software engineer $40 and of a support analyst $35. From these costs the average is taken to arrive at a good estimation of what it Baan costs to give a training to her employees, this is $38.75.
8.6.4 Calculation

The literature formula as described in subsection 2.7.2 is:

\[ CSTU = R_t \cdot W_n \cdot TP \]

Where:
- \( CSTU \) = Cost saving training users per year
- \( R_t \) = Reduction in hours per training per user
- \( W_n \) = Fully loaded wage for training personnel per hour
- \( TP \) = Size of trainee population

Differences between our calculation and the literature

When looking at the data above, the calculation method has to be modified at some places. First, there are official trainings (OT) and unofficial trainings (UT). The number of trainers can vary. The preparation time, travel time and training time varies with the kind of training. Bias and Mayhew do not distinguish travel time, training time and preparation time. Not only the costs of the trainer are reduced, but also the costs of the participants because it’s an internal training. The costs of training calculated with the data that have been estimated by the trainer, are costs with the reduction from usability included. So the costs of training without usability have to be estimated and calculated. The formulas would be:

\[ OTTC = T_n \cdot W_n \cdot (PT_{ot} + TVT_{ot} + TNT_{ot}) \cdot OT_n \]

Where:
- \( OTTC \) = Official Training Trainer Cost
- \( T_n \) = Number of Trainers
- \( W_n \) = Fully loaded wage for training personnel per hour
- \( PT_{ot} \) = Average preparation time for official training in hours
- \( TVT_{ot} \) = Average travel time for official training in hours
- \( TNT_{ot} \) = Average training time for official training in hours
- \( OT_n \) = Number of official trainings
$$OTPC = P_n \cdot W_n \cdot TNT_{ot} \cdot OT_n$$

Where:

$OTPC$ = Official Training Participant Cost

$P_n$ = Number of participants

$W_n$ = Fully loaded wage for training personnel per hour

$TNT_{ot}$ = Average training time for official training in hours

$OT_n$ = Number of official trainings

$$TOTC = OTTC + OTPC$$

Where:

$TOTC$ = Total Official Training Cost

$OTTC$ = Official Total Training Cost

$OTPC$ = Official Training Participant Cost

The calculation of the TOTC would be:

$$OTTC = T_n \cdot W_n \cdot (PT_{ut} + TVT_{ut} + TNT_{ut}) \cdot OT_n$$

$$OTTC = 2 \times 40 \times (20 + 8 + 30) \times 4 = \$ 18,560$$

$$OTPC = P_n \cdot W_n \cdot TNT_{ot} \cdot OT_n$$

$$OTPC = 10 \times 38.75 \times 30 \times 4 = \$ 46,500$$

$$TOTC = \$ 65,060$$

$$UTTC = T_n \cdot W_n \cdot (PT_{ut} + TVT_{ut} + TNT_{ut}) \cdot UT_n$$

Where:

$UTTC$ = Unofficial Training Trainer Cost

$T_n$ = Number of Trainers

$W_n$ = Fully loaded wage for training personnel per hour

$PT_{ut}$ = Average preparation time for unofficial training in hours

$TVT_{ut}$ = Average travel time for unofficial training in hours

$TNT_{ut}$ = Average training time for unofficial training in hours

$UT_n$ = Number of unofficial trainings
\[ UTPC = P_n \cdot W_n \cdot TNT_{ut} \cdot UT_n \]

Where:
- \( UTPC \) = Unofficial Training Participant Cost
- \( P_n \) = Number of participants
- \( W_n \) = Fully loaded wage for training personnel per hour
- \( TNT_{ut} \) = Training time for unofficial training in hours
- \( UT_n \) = Number of unofficial trainings

\[ TUTC = UTTC + UTPC \]

Where:
- \( TUTC \) = Total Unofficial Training Cost
- \( UTTC \) = Unofficial Training Trainer Cost
- \( UTPC \) = Official Training Participant Cost

The total unofficial training cost would be:

\[ UTTC = T_n \cdot W_n \cdot (PT_{ut} + TVT_{ut} + TNT_{ut}) \cdot UT_n \]
\[ UTTC = 1 \times 40 \times (8 + 0 + 4) \times 10 = \$ 4,800 \]
\[ UTPC = P_n \cdot W_n \cdot TNT_{ut} \cdot UT_n \]
\[ UTPC = 10 \times 38.75 \times 4 \times 10 = \$ 15,500 \]

\[ TUTC = \$ 20,300 \]

The total cost can be calculated by:

\[ TTC = TOTC + TUTC \]

Where:
- \( TTC \) = Total Training Cost
- \( TOTC \) = Total Official Training Cost
- \( TUTC \) = Total Unofficial Training Cost

\[ TOTC = \$ 65,060 \]
\[ TUTC = \$ 20,300 \]

\[ TTC_{normal} = \$ 85,360 \]

To calculate the cost savings, a factor is taken to reduce the training time (TNT). Two different scenario’s are followed. The average scenario, which has a 10% reduction of TNT given by Bias and Mayhew. The conservative scenario, which has a 5% reduction. Because in this case the normal situation is the situation of ThinBaan, we have to take an increase of 5% or 10% to calculate the costs of training for ThinBaan without usability.
\[ \text{CSTU} = \text{TTC}_{\text{increase}} - \text{TTC}_{\text{normal}} \]

Where:
\[ \text{CSTU} = \text{Cost saving training users per year} \]
\[ \text{TTC}_{\text{normal}} = \text{Total Training Cost in situation with usability} \]
\[ \text{TTC}_{\text{increase}} = \text{Total Training Cost in situation without usability} \]

**Conservative scenario**
\[ \text{TNT}_{ot} \] would become 31.5 hours of training, \[ \text{PT}_{ot} \] would become 21 hours, \[ \text{TNT}_{ut} \] would become 4.2 hours and \[ \text{PT}_{ut} \] would become 8.4 hours.
Cost saving factor 5% due to usability (according to Bias and Mayhew 10%), in our case this means a 5% increase of costs because a reduction in training and preparation time due to usability activities was already accomplished.

\[ \text{OTTC} = T_n \cdot W_n \cdot (\text{PT}_{ot} + \text{TNT}_{ot} + \text{TNT}_{ut}) \cdot OT_n \]
\[ \text{OTTC} = 2 \times 40 \times (21 + 8 + 31.5) \times 4 = \]
\[ \$ 19,360 \]

\[ \text{OTPC} = P_n \cdot W_n \cdot \text{TNT}_{ot} \cdot OT_n \]
\[ \text{OTPC} = 10 \times 38.75 \times 31.5 \times 4 = \]
\[ \$ 48,825 \]
\[ \text{TOTC} = \]
\[ \$ 68,185 \]

\[ \text{UTTC} = T_n \cdot W_n \cdot (\text{PT}_{ut} + \text{TNT}_{ut} + \text{TNT}_{ut}) \cdot UT_n \]
\[ \text{UTTC} = 1 \times 40 \times (8.4 + 0 + 4.2) \times 10 = \]
\[ \$ 5,040 \]

\[ \text{UTPC} = P_n \cdot W_n \cdot \text{TNT}_{ut} \cdot UT_n \]
\[ \text{UTPC} = 10 \times 38.75 \times 4.2 \times 10 = \]
\[ \$ 16,275 \]
\[ \text{TUTC} = \]
\[ \$ 21,315 \]

\[ \text{TTC}_{\text{increase}} = 68,185 + 21,315 = \]
\[ \$ 89,500 \]

\[ \text{CSTU} = \text{TTC}_{\text{increase}} - \text{TTC}_{\text{normal}} \]
\[ \text{CSTU} = 89,500 - 85,360 = \]
\[ \$ 4,140 \]

**Average scenario**
\[ \text{TNT}_{ot} \] would become 33 hours of training, \[ \text{PT}_{ot} \] would become 22 hours, \[ \text{TNT}_{ut} \] would become 4.4 hours and \[ \text{PT}_{ut} \] would become 8.8 hours.
Cost saving factor 10%, due to usability, in our case this means a 10% increase of costs because a reduction in training and preparation time due to usability activities was already accomplished.
\[ OTTC = T_n \cdot W_n \cdot (PT_{ot} + TVT_{ot} + TNT_{ot}) \cdot OT_n \]
\[ OTTC = 2 \times 40 \times (22 + 8 + 33) \times 4 = \$ 20,160 \]

\[ OTPC = P_n \cdot W_n \cdot TNT_{ot} \cdot OT_n \]
\[ OTPC = 10 \times 38.75 \times 33 \times 4 = \$ 51,150 \]

\[ TOTC = \$ 71,310 \]

\[ UTTC = T_n \cdot W_n \cdot (PT_{at} + TVT_{at} + TNT_{at}) \cdot UT_n \]
\[ UTTC = 1 \times 40 \times (8.8 + 0 + 4.4) \times 10 = \$ 5,280 \]

\[ UTPC = P_n \cdot W_n \cdot TNT_{at} \cdot UT_n \]
\[ UTPC = 10 \times 38.75 \times 4.4 \times 10 = \$ 17,050 \]

\[ TUTC = \$ 22,130 \]

\[ TTC_{increase} = 71,310 + 22,130 = \$ 93,440 \]

\[ CSTU = TTC_{increase} - TTC_{normal} \]
\[ CSTU = 93,440 - 85,360 \]
\[ CSTU = \$ 8,080 \]

8.7 Summary

In Table 32 an overview is given of the different outcomes when varying the scenarios. The total benefits between the conservative and average scenario is not very big. Between the conservative and average there is a large difference. This is caused by the different scenarios in the early changes in development cycle.

<table>
<thead>
<tr>
<th>Subject</th>
<th>Total benefits conservative scenario (in US $)</th>
<th>Total benefits average scenario (in US $)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Early changes in development</td>
<td>264,960</td>
<td>287,040</td>
</tr>
<tr>
<td>Customer Support</td>
<td>15,120</td>
<td>30,240</td>
</tr>
<tr>
<td>Training</td>
<td>4,140</td>
<td>8,080</td>
</tr>
<tr>
<td><strong>Total Benefits</strong></td>
<td><strong>284,220</strong></td>
<td><strong>325,360</strong></td>
</tr>
</tbody>
</table>

Table 32: overview of the benefits of usability

So the total benefit for the conservative scenario is $284,220 and for the average scenario the average total benefit is $325,360
8.8 Conclusion

In this chapter the benefits have been calculated using three methods, “savings made by making changes earlier in the development”, “decreased customer support” and “decreased training”. For all methods two different scenarios are calculated. A scenario where an average benefit is chosen and another scenario where a conservative scenario is chosen. As total result two options are given. Total benefits for the conservative scenario are $284,220. This is the most conservative scenario. Total benefits for the average scenario are $325,360.

The conservative scenario has the most conservative estimations and calculations for all methods that are used. The average scenario has average estimations and calculations for all methods, but still conservative numbers are used. The benefit calculations with the lowest outcomes were classified under the conservative scenario while the higher outcomes were placed under the average scenario.
Chapter 9 Revenues of usability

9.1 Introduction

In this chapter an overview will be given of the costs and the benefits. The benefits per activity and per scenario will be shown. The benefits are distributed over two models. The first model takes the worked hours for an activity into account and the second model is based on the framework of Kabel (see section 3.5) After that the revenues (benefit minus cost) per activity and per scenario are given. The results are discussed per benefit distribution model. The numerical data shown here is fictitious and shows no relation to Baan figures.

9.2 Payback period and return of investment

In this section the payback period and the return of investment will be calculated. To do this a short overview will be given of the different costs, benefits and results.

9.2.1 Overview of costs and benefits

The total costs made by the usability consultant for Baan was $71,575. These costs were made during approximately 26 months.

The benefits consist of two different kinds of benefits. There exist benefits, which are made once, and benefits, which are received every year for a product as long as the product is kept alive. The product life span within Baan is typically about three to five years. The benefits made by decreased amount of training and benefits gained from making changes earlier in the development life cycle are benefits, which are only made once. Internal training to people is only given when a new product is introduced. The early changes are of course only made when a product is developed so the savings gained from it are only one-time benefits. The benefits gained from decreased amount of customer support are benefits, which return every year as long as new customers use the product. So the benefits over two years would be the benefits over one year + the benefits of decreased amount of customer support. At this moment the product has just been introduced to the market so not many customers use it. The expectation is that the benefits will increase in the future, because new customers will be going to use the product.

The benefits of savings gained from making earlier changes in the development life cycle are in the conservative scenario $264,960 and in the average scenario $287,040. These savings were made between January 2000 and February 2002.

The benefits of decreased training are in the conservative scenario $4,140 and in the average scenario $8,080. These benefits were made over one year.

The benefits of customer support are in the conservative scenario $15,120 and in the average scenario $30,240. The benefits were made over one year.

The total revenues for the conservative scenario are $212,645 and for the average scenario this comes to $253,785.

An overview of these data is given in Table 33.
An overview of the total costs, total benefits and total revenues can be found in Figure 15, from this figure can be derived that the benefits are 4 times higher than the costs for the conservative scenario. The benefits are 5 times higher than the costs for the average scenario. The revenues are therefore for both scenario’s very positive.

<table>
<thead>
<tr>
<th></th>
<th>Conservative Scenario</th>
<th>Average Scenario</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cost</strong></td>
<td>71,575</td>
<td>71,575</td>
</tr>
<tr>
<td>Early changes in</td>
<td>264,960</td>
<td>287,040</td>
</tr>
<tr>
<td>development life</td>
<td></td>
<td></td>
</tr>
<tr>
<td>cycle</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Customer Support</td>
<td>15,120</td>
<td>30,240</td>
</tr>
<tr>
<td>Training</td>
<td>4,140</td>
<td>8,080</td>
</tr>
<tr>
<td><strong>Revenues</strong></td>
<td>212,645</td>
<td>253,785</td>
</tr>
</tbody>
</table>

Table 33 Overview: costs, benefits and revenues

**Figure 15:** Total costs, total benefits and total revenues

### 9.2.2 Payback Period

The payback period shows the time that is needed to refund the investment from the moment the investment becomes profitable. The literature gives the following formulae to calculate the payback period:

\[ R_1 + R_2 + \ldots + R_k \geq C \]

Where:

- \( R_k \) = cash benefits in a year minus the costs in that year
- \( C \) = initial development costs
Instead of cash benefits in a year there will be used cash benefits in a month. The \( C = 71,575 \).

The benefits for the first year for the conservative scenario is:
First year benefits early changes + training + customer support =
\[ 122,289.23 + 4,140 + 15,120 = 141,549.23 \]

As can be seen this is already much higher than the costs so the payback period is within one year. The benefits per month are: \( 11,795.77 \). The payback period for the conservative scenario would than be:
\[ \frac{71,575}{11,795.77} = 6.06 \text{ months} \]

So within 7 months the total costs are already earned back if the conservative scenario is taken. The assumption was made that the savings gained by making changes earlier in the development can be equally distributed over the 26 months during which they are gained.

The benefits for the first year for the average scenario is:
\[ 132,480 + 8,080 + 30,240 = 170,800 \]

The benefits per month are: \( 14,233.33 \). The payback period for the average scenario would than be:
\[ \frac{71,575}{14,233.33} = 5.03 \text{ months} \]

So within 6 months the total cost are already earned back if the average scenario is taken.

### 9.2.3 Return of investment

The return on investment (ROI) is a method to calculate the return for an investment.

\[
\text{ROI} = \frac{\text{average.net.profit}}{\text{InvestmentCosts}}
\]

For both scenarios the ROI shall be calculated for the first year.

\[
\text{ROI}_{\text{defensive}} = \frac{\text{average.net.profit}}{\text{InvestmentCosts}} = \frac{141,549.23}{71,575} = 1,98
\]

So for every dollar invested in usability at ThinBaan in the conservative scenario, \$1,98 is earned back.

\[
\text{ROI}_{\text{average}} = \frac{\text{average.net.profit}}{\text{InvestmentCosts}} = \frac{170,800}{71,575} = 2,39
\]

So for every dollar invested in usability at ThinBaan in the average scenario, \$2,39 is earned back.

### 9.3 Distributing benefits by percentage of total worked hours for an activity on ThinBaan

For each activity a percentage is calculated which reflects what it contributes to the total hours made for ThinBaan. That percentage is used to calculate the percentage of benefits that the task will get from the total benefits.
<table>
<thead>
<tr>
<th>Activity performed</th>
<th>On ThinBaan</th>
<th>% Activity cost of total cost</th>
<th>Total benefits defensive scenario (in US $)</th>
<th>Total benefits average scenario (in US $)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Task Analysis</td>
<td>3.18</td>
<td>9,038.20</td>
<td>10,346.45</td>
<td></td>
</tr>
<tr>
<td>Task Design</td>
<td>3.18</td>
<td>9,038.20</td>
<td>10,346.45</td>
<td></td>
</tr>
<tr>
<td>Prototyping</td>
<td>17.12</td>
<td>48,658.46</td>
<td>55,701.63</td>
<td></td>
</tr>
<tr>
<td>Usability Testing</td>
<td>0.98</td>
<td>2,785.36</td>
<td>3,188.53</td>
<td></td>
</tr>
<tr>
<td>Visual Design</td>
<td>14.67</td>
<td>41,695.07</td>
<td>47,730.31</td>
<td></td>
</tr>
<tr>
<td>Icon Design</td>
<td>3.67</td>
<td>10,430.87</td>
<td>11,940.71</td>
<td></td>
</tr>
<tr>
<td>Assisting in realization: logging change requests</td>
<td>19.55</td>
<td>55,565.01</td>
<td>63,607.88</td>
<td></td>
</tr>
<tr>
<td>Assisting in realization: testing bugs</td>
<td>6.85</td>
<td>19,469.07</td>
<td>22,287.16</td>
<td></td>
</tr>
<tr>
<td>Assisting in realization: ad hoc consultancy</td>
<td>22</td>
<td>62,528.40</td>
<td>71,579.20</td>
<td></td>
</tr>
<tr>
<td>Assisting in realization: preparation FD</td>
<td>8.8</td>
<td>25,011.36</td>
<td>28,631.68</td>
<td></td>
</tr>
</tbody>
</table>

**Table 3.4: Distributing benefits by percentage of total worked hours for an activity**

The costs and benefits for both scenarios are compared in Figure 16.

*Figure 16: Costs and benefits per activity*

By subtracting the cost from the benefit of an activity, the total revenue for that activity is calculated.
<table>
<thead>
<tr>
<th>Activity performed on ThinBaan</th>
<th>Total Cost Activities (in US $)</th>
<th>Total revenues defensive scenario (in US $)</th>
<th>Total revenues average scenario (in US $)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Task Analysis</td>
<td>2,275.00</td>
<td>6,763.20</td>
<td>8,071.45</td>
</tr>
<tr>
<td>Task Design</td>
<td>2,275.00</td>
<td>6,763.20</td>
<td>8,071.45</td>
</tr>
<tr>
<td>Prototyping</td>
<td>12,250.00</td>
<td>36,408.46</td>
<td>43,451.63</td>
</tr>
<tr>
<td>Usability Testing</td>
<td>700.00</td>
<td>2,085.36</td>
<td>2,488.53</td>
</tr>
<tr>
<td>Visual Design</td>
<td>10,500.00</td>
<td>31,195.07</td>
<td>37,230.31</td>
</tr>
<tr>
<td>Icon Design</td>
<td>2,625.00</td>
<td>7,805.87</td>
<td>9,315.71</td>
</tr>
<tr>
<td>Logging Change Requests</td>
<td>14,000.00</td>
<td>41,565.01</td>
<td>49,607.88</td>
</tr>
<tr>
<td>Testing Bugs</td>
<td>4,900.00</td>
<td>14,569.07</td>
<td>17,387.16</td>
</tr>
<tr>
<td>Ad Hoc Consultancy</td>
<td>15,750.00</td>
<td>46,778.40</td>
<td>55,829.20</td>
</tr>
<tr>
<td>Preparation FD</td>
<td>6,300.00</td>
<td>18,711.36</td>
<td>22,331.68</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>71,575.00</strong></td>
<td><strong>212,645.00</strong></td>
<td><strong>253,785.00</strong></td>
</tr>
</tbody>
</table>

Table 35: Distributing revenues by percentage of total worked hours for an activity

Figure 17 Distributing revenues by percentage of total worked hours for an activity

In Figure 17 a more graphical form the revenues by percentage of total worked hours for an activity can be found.

9.4 Distributing benefits via the framework of Kabel

The benefits can also be distributed via the framework of Kabel, which was explained in section 3.5.
The difference with the other benefit distribution model is that not only the usability tasks performed on ThinBaan are taken into consideration, but all usability tasks are taken into consideration.

We have taken the results of the questionnaire, which can be found in subsection 3.5.1 and re-calculated the number of filled in heuristics in to percentages. In this way it becomes clear which usability tasks scored the most remarks. Thus for each specific usability task a “weight” is being calculated. We can assume that the more filled in heuristics a task will score the more effective this usability task is because it refers to many different (kinds of) heuristics that one is intending to cover by conducting this usability task. In relation to quantification of usability tasks we can say that the more effective a task is the larger the part of the benefit and thus the revenues it gets assigned to. This way the framework of Kabel et al. serves as a benefit distribution model and a revenue distribution model. The advantage of using this benefit distribution model over the benefit distribution model that uses the percentages of total worked hours for an activity on ThinBaan is that it does not make the assumption that the present situation is the correct one. This is the case when you look at worked hours on a product. This weight does not show any relation to a specific product such as ThinBaan.

<table>
<thead>
<tr>
<th>Activity performed on ThinBaan</th>
<th># of filled in heuristics</th>
<th>% Heuristics of total defensive scenario filled in heuristics</th>
<th>Total benefits (in US $)</th>
<th>Total benefits average scenario (in US $)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Task Analysis</td>
<td>37</td>
<td>4.790</td>
<td>13,613.59</td>
<td>15,584.12</td>
</tr>
<tr>
<td>Task Design</td>
<td>37</td>
<td>4.787</td>
<td>13,605.07</td>
<td>15,574.36</td>
</tr>
<tr>
<td>Conceptual usability design</td>
<td>37</td>
<td>4.787</td>
<td>13,605.07</td>
<td>15,574.36</td>
</tr>
<tr>
<td>Prototyping</td>
<td>49</td>
<td>6.339</td>
<td>18,015.99</td>
<td>20,623.75</td>
</tr>
<tr>
<td>Usability walkthrough</td>
<td>101</td>
<td>13.066</td>
<td>37,134.70</td>
<td>42,509.84</td>
</tr>
<tr>
<td>Usability Testing</td>
<td>124</td>
<td>16.041</td>
<td>45,589.91</td>
<td>52,188.91</td>
</tr>
<tr>
<td>Visual Design</td>
<td>28</td>
<td>3.622</td>
<td>10,294.04</td>
<td>11,784.07</td>
</tr>
<tr>
<td>Icon Design</td>
<td>29</td>
<td>3.752</td>
<td>10,663.51</td>
<td>12,207.02</td>
</tr>
<tr>
<td>Promoting usability in general</td>
<td>2</td>
<td>0.259</td>
<td>736.10</td>
<td>842.65</td>
</tr>
<tr>
<td>Further embedding of usability</td>
<td>0</td>
<td>0.000</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>In Dmethod</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Usability reviews</td>
<td>74</td>
<td>9.573</td>
<td>27,207.29</td>
<td>31,145.47</td>
</tr>
<tr>
<td>Usability audits</td>
<td>94</td>
<td>12.160</td>
<td>34,559.77</td>
<td>39,562.19</td>
</tr>
<tr>
<td>Usability style guides</td>
<td>47</td>
<td>6.080</td>
<td>17,279.88</td>
<td>19,781.10</td>
</tr>
<tr>
<td>Assisting in realization</td>
<td>88</td>
<td>11.384</td>
<td>32,354.31</td>
<td>37,037.50</td>
</tr>
<tr>
<td>Usability checklists</td>
<td>26</td>
<td>3.364</td>
<td>9,560.78</td>
<td>10,944.67</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>773</strong></td>
<td><strong>100</strong></td>
<td><strong>284,220.00</strong></td>
<td><strong>325,360.00</strong></td>
</tr>
</tbody>
</table>

*Table 36: Distributing benefits via the framework of Kabel*

We did not subtract the cost from the benefits in order to arrive at the total revenue for that activity. We did not do this because some usability activities were not performed on
ThinBaan and thus had no costs, therefore we left the TCA column blank. In this way we can compare each usability activity with another usability activity and not only the activities that have been performed on a product and generated costs. Again no explicit relation with ThinBaan is shown here.

<table>
<thead>
<tr>
<th>Total revenues</th>
<th>Total revenues</th>
</tr>
</thead>
<tbody>
<tr>
<td>defensive scenario</td>
<td>average scenario</td>
</tr>
<tr>
<td>(in US $)</td>
<td>(in US $)</td>
</tr>
<tr>
<td>Task Analysis</td>
<td>13,613.59</td>
</tr>
<tr>
<td>Task Design</td>
<td>13,605.07</td>
</tr>
<tr>
<td>Conceptual usability design</td>
<td>13,605.07</td>
</tr>
<tr>
<td>Prototyping</td>
<td>18,015.99</td>
</tr>
<tr>
<td>Usability walkthrough</td>
<td>37,134.70</td>
</tr>
<tr>
<td>Usability Testing</td>
<td>45,589.91</td>
</tr>
<tr>
<td>Visual Design</td>
<td>10,294.04</td>
</tr>
<tr>
<td>Icon Design</td>
<td>10,663.51</td>
</tr>
<tr>
<td>Promoting usability in general</td>
<td>736.10</td>
</tr>
<tr>
<td>Further embedding of usability in Dmethod</td>
<td>-</td>
</tr>
<tr>
<td>Usability reviews</td>
<td>27,207.29</td>
</tr>
<tr>
<td>Usability audits</td>
<td>34,559.77</td>
</tr>
<tr>
<td>Usability style guides</td>
<td>17,279.88</td>
</tr>
<tr>
<td>Assisting in realization</td>
<td>32,354.31</td>
</tr>
<tr>
<td>Usability checklists</td>
<td>9,560.78</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>284,220.00</td>
</tr>
</tbody>
</table>

*Table 37: Distributing revenues via the framework of Kabel*

In a more graphical form revenues via the framework of Kabel for an activity look like this.
9.5 Discussion results

All restrictions and comments that we found as a result of distributing our questionnaire on the framework of Kabel are discussed in section 3.5.1 and are also applicable to this calculation.

The most striking is that due to the fact that there were relatively few people that filled in the tasks “visual design” and “icon design”, these tasks thus scored few remarks, which resulted in a relative low percentage of benefits and thus revenues attributed to these tasks.

The same goes for “Promoting usability in general” and “Further embedding of usability in DMethod”. The usability tasks that stand out here are usability walkthrough, usability testing, usability reviews and usability audits. Also assisting in realization is quite important here.

9.6 Conclusion

The traditional tasks in a software development life cycle consume the main part of the revenues in both models. These tasks are prototyping, visual design and assisting in realization.

While the more specific usability tasks have far less revenues attributed to them, we can still see in the framework of Kabel that the usability consultants see a great importance in them which results in high revenues for tasks such as usability testing.

As far as the costs and benefits is concerned we can conclude that performing usability activities in the software development process at Baan is very beneficial. For the conservative scenario we can conclude that the benefits outnumber the costs 6 times, this is even 8 times when we look at the average scenario.
Chapter 10 Discussion and Conclusions

10.1 Introduction

In this chapter we will answer all our research questions and sub questions, which we mentioned in section 1.2. The questions are placed in sections, which represent the subjects to which the research question is applicable.

10.2 Usability activities

First we will answer our research questions regarding the usability activities performed by the usability consultants within Baan. These questions are “By what methods are the usability activities applied within the Baan development process?” and “What are the usability engineering activities of the Baan usability consultants performed in the development process of Baan?”

These questions are simple to answer, the method used within Baan is their methodology called DMethod, which can be found in section 3.3.2. The usability activities that are performed are described in section 3.4.

10.3 Methods

Secondly we will answer our research questions regarding the methods that we have used. Questions that we asked ourselves regarding calculation methods were: “Which methods are available to measure the costs of usability engineering?”, “Which methods are available to measure the benefits of usability engineering?”, “How difficult are these methods to use?” “Are there any cost calculation methods in use by the usability consultants of Baan?” and “What method could be applied best to quantify the usability activities that are being performed in terms of costs and benefits?”

No cost calculation methods were in use by the usability consultants of Baan. From our point of view there are three categories of methods that can be applied to calculate costs and benefits of usability engineering. These categories of methods are general cost benefit calculation methods, information systems cost benefit calculation methods and usability cost benefit calculation methods. The majority of all the methods we found were in theory not very difficult to use. However in practice a lot of methods could not be applied mainly due to the lack of all kind of hard data available at Baan which was needed for the methods, an example of this is the method “cash flow” which was not in use within projects at Baan and could thus not be calculated by us.

The cost benefit methods that could best be applied to quantify the usability activities, were the usability cost benefit collection methods. Although we still suffered from a lack of hard data available we made estimations based on the literature.

10.4 Results

This subject had two research questions “If we consider cost and benefits together, what are the revenues of the usability activities that were performed?” and “What are the extra costs of possible usability problems in Baan products?”

It can be seen from the previous chapter that our calculations on usability showed a positive revenue for Usability Consultancy at Baan. To be precise a revenue of $ 284,220
for the conservative scenario was reached and a revenue of $325,360 for the average scenario was noted. These revenues were gained from activities performed by a usability consultant on ThinBaan.

It is also interesting to look at how these revenues are split up over the usability activities. We can conclude that the traditional tasks in a software development life cycle consume the main part of the revenues in the model that distributes the revenues by percentage of total worked hours for an activity. These tasks are prototyping, visual design, assisting in realization (both logging change request and ad hoc consultancy).

The assumption when calculating the revenues with the models that distributes the revenues by percentage of total worked hours for an activity is that a usability task that is used more often, in other words has more worked hours attributed to, also gains more revenues. This way it looks at the present situation and says implicitly that the way usability consultancy works at this moment is also “the right one”.

This assumption is not present when revenues are distributed via the framework of Kabel. Here the usability consultants themselves filled in “weight” for each usability activity that can be performed on a product.

The assumption here is that the more weight a usability task has attributed to itself the more important this task is in the daily activities of the usability consultant.

When we distributed this same amount of benefits in Dollars gained from activities performed on ThinBaan via the framework of Kabel et al. we can see different usability tasks stand out. These tasks are usability walkthrough, usability testing, usability reviews and usability audits. These are more usability specific tasks instead of the tasks in a software development life cycle. However the usability task assisting in realization again consumes a relatively large part of the revenues when using the framework of Kabel et al. as a distribution model for the revenues.

The extra costs of possible usability problems in Baan products are not so clear to come by with the methods that we used. What can be said is that detecting usability related defects is much more expensive when detected after the product has been released, to be precise this is a factor 4.25 within Baan.

Also two research questions for other departments at Baan were formulated, these were “What costs are being made by activities performed in relation to usability?” and “What costs should have not been made if usability engineering was being performed more adequately within the Baan development process.”

The costs of other departments that are made in relation to usability are very clear. For instance PEG has to fix usability related issues after the product has been released. This is 4.25 times higher then when this was fixed within the development process of the product.

The job that PEG has to do will always be there, however we have seen that usability can achieve a great reduction in detecting usability related issues early in the development life cycle of a product.

### 10.5 Applicability of the model

On the subject of applicability of the model we had three research questions: How applicable was the model for Baan? Can it be used for different products? Can it be used by different organizations? We will answer these questions below.
The method which has been constructed during the months of research is not solely applicable for Baan. The method, which is applied in Baan, is product independent. Usability departments of other companies could use the same methods if they have some data available. They could use the cost-benefit calculation methods from Chapter 2. If there are small differences between the data those companies have and the data necessary for the calculation method, then they can transform the calculation method. This is also done for some calculations at Baan, for example decreased training costs (see section 8.6).

Because the cost-benefit calculation methods, which are described in Chapter 2, are not specific usability calculation methods other departments could use the calculation methods too. The general calculation methods can be used by all kinds of companies, companies who develop information systems or who are somehow related to information systems could use the information system calculation methods. The usability calculation methods could be transformed to information system calculation methods or general calculation methods (as is described in section 2.8).

### 10.6 Limitations

There are several limitations to this method, which is described in this research. The first limitation is that many estimations are used. If Baan had more data the results would be more reliable. Because of the estimations two scenario’s were used in the research, a conservative and an average one. By doing that the limitation of estimation would be neutralized. If Baan wants a clearer picture of what the benefits and the costs are than they should collect and keep tract of the data that is necessary to calculate the costs and benefits of usability.

- For Activity Based Costing the hours are needed by usability activity, although they keep track of hours they do not register them on usability activities per project. If they would do that estimations would not be necessary.
- There is no specific data about how long it takes on average for a PEG engineer to fix a late defect for ThinBaan, so data about general fixes was taken.
- Average number of hours that a ThinBaan software engineer uses to fix an early defect is not recorded, this was based on estimations of ThinBaan software engineers.
- The number of early defects that are logged for ThinBaan are not divided into usability problems, this meant that an estimation had to be made of this.
- For training the number of people who went to a ThinBaan training is not recorded. The hours needed for preparation time, traveling time and training time are not recorded. The number of official ThinBaan training and unofficial ThinBaan training are not recorded. These data were based on estimations.
- Because ThinBaan has been released shortly, no hard data was available about customer support. The average number of cases for all the products where support is delivered was taken in the research. From that number an estimation was made how many cases would relate to ThinBaan. In the future hard data will be available for this.
- No data is available on how much percent of the total support cases usability cases are.
• No data is available on the average time a support analyst needs for making a solution for a case for ThinBaan. An estimation was used in the research.
• An estimation was made about how many users ThinBaan has. On this moment there is no hard data available about the number of users.

Another limitation is that due to a lack of time not all aspects could be researched. The following subjects are not researched:

• Sales: usability could have had some increase in the number of sold products.
• The look and the feel of the standard interface and the influences that this has is not researched.
• Users of the product have not been researched. Usability could increase productivity, decrease user errors and decrease turnover rate of personal. This was not researched because this would not increase Baan’s benefits. Only if a connection could be made between increase sales and this it would become interesting from Baan’s point of view.
• Training given to the users, Baan uses external trainers to give training to users. If usability would reduce this training time as well it would also save costs.

So as can be seen from the points above the revenues of usability should be higher than is calculated in this research. To research also the points that are named above would make the picture clearer of what the total benefits and costs of usability would be.

10.7 Improvement suggestions

The research question on the subject of improvement suggestion is: “how can costs be minimized and benefits (by sales) maximized?”

We have not looked at the sales department of Baan, so nothing can be said about maximizing sales due to usability.

What can be concluded is that according to our research usability consultancy has the most impact on the number of defects detected early in the development lifecycle. The costs are far less than fixing a defect after the product is released. The first suggestions is that usability consultants should be involved in the process of developing software as early as possible. The earlier they get involved the less defects there will be at the end of the development lifecycle. Task analysis and task design is in most of the cases not done by usability consultants.

A second improvement suggestion is that customers of Baan should get more involved in the development lifecycle. By detecting this defects and errors earlier customers will get the feeling that their problems are taken seriously. This means also that usability consultants should perform tests with customers.

To maximize the benefits of usability consultancy within Baan, a usability consultant should be involved in every software development project. On this moment this is not possible due to not having a fixed (mandatory) position in the standard development methodology (DMethod) in Baan and a lack of resources (usability consultants) to assign to every software development project in Baan.

10.8 Conclusion

The method that is used within Baan is not strictly only for Baan applicable. Organizations can change calculation methods to make it applicable for their company. The result could be made more reliable if Baan would gather more data. The results could be higher because not everything was researched in this research due to limited time. By making two different scenarios the results that are shown in previous chapters
are reliable and convincing. The usability consultants should be earlier involved into the
development lifecycle to maximize the profits. Baan should involve users more in the
development process.

10.9 Further research

It would be interesting to look at the effectiveness of a usability task on a software
product versus the gained benefits. Is it so that when an (assumed) effective usability
task is being performed in the software development life cycle of a software product
more benefits are gained then when an assumed less effective usability task is being
preformed on the same product? We more or less did theoretically by using the
framework of Kabel et al. but could not bring this in practice for a real product. If a new
project started and the usability tasks that scored many heuristics in the framework of
Kabel et al. were performed, would the total revenues due to performing usability tasks
be relatively larger then those we calculated now?
Another point that can be researched is relatively “simple” usability tasks that consume
not much time and the revenues that are gained by performing these tasks.
Appendices A: References

A1: Literature


A2: Internet and Intranet sites

- Baan: [http://www.baan.com](http://www.baan.com)
- Usability Consultancy: [http://baandev-secure/ue/UC_home.htm](http://baandev-secure/ue/UC_home.htm)
## Appendices B: Abbreviations

### B1: Abbreviations in text

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Full Form</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABC</td>
<td>Activity Based Costing</td>
</tr>
<tr>
<td>APAC</td>
<td>Asian, Pacific</td>
</tr>
<tr>
<td>ASG</td>
<td>Application Server Group</td>
</tr>
<tr>
<td>B2B</td>
<td>Business to Business</td>
</tr>
<tr>
<td>BBM</td>
<td>Baan Benchmark Methodology</td>
</tr>
<tr>
<td>BD</td>
<td>Baan Development</td>
</tr>
<tr>
<td>BDM</td>
<td>Baan Development Method</td>
</tr>
<tr>
<td>BES</td>
<td>Baan Educative Services</td>
</tr>
<tr>
<td>BGS</td>
<td>Baan Global Support</td>
</tr>
<tr>
<td>BIS</td>
<td>Business Intelligence Solutions</td>
</tr>
<tr>
<td>BSC</td>
<td>Balanced ScoreCard</td>
</tr>
<tr>
<td>BSM</td>
<td>Baan Sizing Method</td>
</tr>
<tr>
<td>BTG</td>
<td>Baan Translation Group</td>
</tr>
<tr>
<td>BU BSC</td>
<td>BU siness Balanced ScoreCard</td>
</tr>
<tr>
<td>CAT</td>
<td>Configuration and Assembly</td>
</tr>
<tr>
<td>CEA</td>
<td>Cost Effectiveness Analysis</td>
</tr>
<tr>
<td>CIN</td>
<td>Cambridge Information Network</td>
</tr>
<tr>
<td>CRM</td>
<td>Customer Relation Management</td>
</tr>
<tr>
<td>CS</td>
<td>Conceptual Solution</td>
</tr>
<tr>
<td>CSF</td>
<td>Critical Success Factor</td>
</tr>
<tr>
<td>CS&amp;S</td>
<td>Customer Service &amp; Support</td>
</tr>
<tr>
<td>CPI</td>
<td>Critical Performance Indicator</td>
</tr>
<tr>
<td>DCS</td>
<td>Development Customer Solutions</td>
</tr>
<tr>
<td>DS</td>
<td>Definition Study</td>
</tr>
<tr>
<td>EMEA</td>
<td>Europe, Middle East, Africa</td>
</tr>
<tr>
<td>ERP</td>
<td>Enterprise Resource Planning</td>
</tr>
<tr>
<td>FD</td>
<td>Functional Design</td>
</tr>
<tr>
<td>HRM</td>
<td>Human Resource Management</td>
</tr>
<tr>
<td>HTML</td>
<td>HyperText Markup Language</td>
</tr>
<tr>
<td>IE</td>
<td>Information Economics</td>
</tr>
<tr>
<td>IRR</td>
<td>Internal Rate of Return</td>
</tr>
<tr>
<td>IS</td>
<td>Information Systems</td>
</tr>
<tr>
<td>ISO</td>
<td>International Organization for Standards</td>
</tr>
<tr>
<td>IT</td>
<td>Information Technology</td>
</tr>
<tr>
<td>IT BSC</td>
<td>Information Technology Balanced ScoreCard</td>
</tr>
<tr>
<td>KBS</td>
<td>Knowledge Based Systems</td>
</tr>
<tr>
<td>KD</td>
<td>Knowledge Development</td>
</tr>
<tr>
<td>LA</td>
<td>Limited Available</td>
</tr>
<tr>
<td>LAN</td>
<td>Local Area Network</td>
</tr>
<tr>
<td>MBC</td>
<td>Multibyte Center</td>
</tr>
<tr>
<td>NPV</td>
<td>Net Present Value</td>
</tr>
<tr>
<td>PBC</td>
<td>Porting and Benchmark Center</td>
</tr>
<tr>
<td>PC</td>
<td>Personal Computer</td>
</tr>
<tr>
<td>PEG</td>
<td>Product Engineering Group</td>
</tr>
<tr>
<td>PI</td>
<td>Profitability Index</td>
</tr>
<tr>
<td>Abbreviation</td>
<td>Full Form</td>
</tr>
<tr>
<td>--------------</td>
<td>-----------</td>
</tr>
<tr>
<td>PLCC</td>
<td>Product LifeCycle Committee</td>
</tr>
<tr>
<td>PPO</td>
<td>Project and Process Office</td>
</tr>
<tr>
<td>PSD</td>
<td>Planned Solution Date</td>
</tr>
<tr>
<td>PTG</td>
<td>Product Testing Group</td>
</tr>
<tr>
<td>PVIF</td>
<td>Present Value Interest Factor</td>
</tr>
<tr>
<td>ROI</td>
<td>Rate On Investment</td>
</tr>
<tr>
<td>SA</td>
<td>Support Analyst</td>
</tr>
<tr>
<td>SCS</td>
<td>Supply Chain Solutions</td>
</tr>
<tr>
<td>SG</td>
<td>Sizing Guide</td>
</tr>
<tr>
<td>SWI</td>
<td>Social Science Informatics (Dutch: Sociaal Wetenschappelijke Informatica)</td>
</tr>
<tr>
<td>TCO</td>
<td>Total Cost of Ownership</td>
</tr>
<tr>
<td>TCS</td>
<td>Test Control System</td>
</tr>
<tr>
<td>TD</td>
<td>Technical Design</td>
</tr>
<tr>
<td>TDA</td>
<td>Test Data</td>
</tr>
<tr>
<td>TDE</td>
<td>Test Design</td>
</tr>
<tr>
<td>TER</td>
<td>Test Report</td>
</tr>
<tr>
<td>TNA</td>
<td>Training Need Analysis</td>
</tr>
<tr>
<td>TPL</td>
<td>Test Plan</td>
</tr>
<tr>
<td>TR</td>
<td>Technical Realization</td>
</tr>
<tr>
<td>TSTS</td>
<td>Time Savings Times Salary approach</td>
</tr>
<tr>
<td>VD</td>
<td>Version Definition</td>
</tr>
<tr>
<td>UC</td>
<td>Usability Consultancy</td>
</tr>
<tr>
<td>UD</td>
<td>User Documentation</td>
</tr>
<tr>
<td>UI</td>
<td>User Interface</td>
</tr>
<tr>
<td>VAT</td>
<td>Vision and Architecture</td>
</tr>
<tr>
<td>WBS</td>
<td>Work Breakdown Structure</td>
</tr>
</tbody>
</table>

**B2: Abbreviations in equations**

- **A** Activity
- **ACP** Activity Cost of Product
- **ADC** Activity Driver Cost
- **ADM** Activity Driver Measure
- **ARM** Activity Resource Measure
- **ARV** Activity Resource consumption
- **ATV** Activity Total consumption
- **BV** Batch Volume
- **C** Present value of present Cost
- **Ca** Number of Cases
- **CA** Cost of Activity
- **Ch** Changes (made)
- **CP** Size of Customer Population
- **CSCS** Cost Savings Customer Support
- **CSED** Total Cost Savings Earlier made in Development cycle
- **CSIP** Cost Savings Increased Productivity
- **CSTC** Cost Savings Turnover Cost
- **CSTU** Cost Savings Training Users
- **CSUE** Cost Savings User Errors
- **CT** Cost Turnover
<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>D</td>
<td>Number of Workdays</td>
</tr>
<tr>
<td>DC</td>
<td>Direct Cost (in ABC) / Average Duration of Call (in Decreased amount of Customer Support)</td>
</tr>
<tr>
<td>E</td>
<td>Number of error elimination</td>
</tr>
<tr>
<td>EC</td>
<td>Number of Eliminated Calls</td>
</tr>
<tr>
<td>ES</td>
<td>Number of extra Systems sold</td>
</tr>
<tr>
<td>F</td>
<td>Future Cashflow</td>
</tr>
<tr>
<td>Fa</td>
<td>Frequency of activity</td>
</tr>
<tr>
<td>i</td>
<td>Discount rate (in Present value), Number of ideas (in Yearly Earnings)</td>
</tr>
<tr>
<td>ICP</td>
<td>Incurred Cost of Product</td>
</tr>
<tr>
<td>IRR</td>
<td>Internal Rate of Return</td>
</tr>
<tr>
<td>IS</td>
<td>Increased Sales</td>
</tr>
<tr>
<td>IV</td>
<td>Idea Value</td>
</tr>
<tr>
<td>n</td>
<td>Number / earnings period used in NPV calculation (in Yearly earnings)</td>
</tr>
<tr>
<td>NPV</td>
<td>Net Present Value</td>
</tr>
<tr>
<td>NPVb</td>
<td>x % improvement in the NPV from the business cases of the remaining projects</td>
</tr>
<tr>
<td>NPVd</td>
<td>values that have been added to projects through field measurements</td>
</tr>
<tr>
<td>NPVe</td>
<td>values that are estimated for projects based on specific usability improvements</td>
</tr>
<tr>
<td>OC</td>
<td>Outcome Cost</td>
</tr>
<tr>
<td>OT</td>
<td>Number of Official Training</td>
</tr>
<tr>
<td>OTC</td>
<td>One-Time Cost</td>
</tr>
<tr>
<td>OTPC</td>
<td>Official Training Participant Cost</td>
</tr>
<tr>
<td>OTTC</td>
<td>Official Training Trainer Cost</td>
</tr>
<tr>
<td>P</td>
<td>Product (in ABC) / Present Value (in Present value of future cash flow)/Number participants (in Decreased training users)</td>
</tr>
<tr>
<td>PCSED</td>
<td>Potential total Cost Savings Earlier made in Development cycle</td>
</tr>
<tr>
<td>PI</td>
<td>Profitability Index</td>
</tr>
<tr>
<td>PM</td>
<td>Profit Margin</td>
</tr>
<tr>
<td>PR</td>
<td>Productivity Ratio</td>
</tr>
<tr>
<td>PT</td>
<td>Preparation Time</td>
</tr>
<tr>
<td>PV</td>
<td>Product Volume</td>
</tr>
<tr>
<td>PVIF</td>
<td>Present Value Interest Factor</td>
</tr>
<tr>
<td>R</td>
<td>Resource (in ABC) / Revenue (in Payback Period) / Reduction (in benefit calculation method)</td>
</tr>
<tr>
<td>RDC</td>
<td>Resource Driver Cost</td>
</tr>
<tr>
<td>RDM</td>
<td>Resource Driver Measure</td>
</tr>
<tr>
<td>ROI</td>
<td>Return On Investment</td>
</tr>
<tr>
<td>RT</td>
<td>Recovery Time</td>
</tr>
<tr>
<td>RTC</td>
<td>Resource Total Cost</td>
</tr>
<tr>
<td>RTV</td>
<td>Resource Total consumption</td>
</tr>
<tr>
<td>RURC</td>
<td>Reduced Usability Related Calls</td>
</tr>
<tr>
<td>S</td>
<td>Average Salary</td>
</tr>
<tr>
<td>t</td>
<td>Time in hours</td>
</tr>
<tr>
<td>T</td>
<td>Number of Trainers</td>
</tr>
<tr>
<td>TAOC</td>
<td>Total Amount Of Cases</td>
</tr>
<tr>
<td>TAUC</td>
<td>Total Amount of Usability (related) Calls</td>
</tr>
<tr>
<td>TCA</td>
<td>Total Cost Activity</td>
</tr>
<tr>
<td>TCS</td>
<td>Total Cost Savings</td>
</tr>
<tr>
<td>TNT</td>
<td>Average Training Time</td>
</tr>
<tr>
<td>Abbreviation</td>
<td>Description</td>
</tr>
<tr>
<td>--------------</td>
<td>-------------</td>
</tr>
<tr>
<td>TOTC</td>
<td>Total Official Training Cost</td>
</tr>
<tr>
<td>TP</td>
<td>Training Population</td>
</tr>
<tr>
<td>TTC</td>
<td>Total Training Cost</td>
</tr>
<tr>
<td>TUTC</td>
<td>Total Unofficial Training Cost</td>
</tr>
<tr>
<td>TV</td>
<td>Total Value</td>
</tr>
<tr>
<td>TVT</td>
<td>Average TraVel Time</td>
</tr>
<tr>
<td>UP</td>
<td>Size of User Population</td>
</tr>
<tr>
<td>URC</td>
<td>Usability Related Calls</td>
</tr>
<tr>
<td>UT</td>
<td>Number of Unofficial Training</td>
</tr>
<tr>
<td>UTPC</td>
<td>Unofficial Training Participant Cost</td>
</tr>
<tr>
<td>UTTC</td>
<td>Unofficial Training Trainer Cost</td>
</tr>
<tr>
<td>UV</td>
<td>Usability Value</td>
</tr>
<tr>
<td>VP</td>
<td>Virtual Professionals</td>
</tr>
<tr>
<td>W</td>
<td>fully loaded Wage in hours</td>
</tr>
<tr>
<td>YE</td>
<td>Yearly Earning</td>
</tr>
<tr>
<td>X</td>
<td>Penalty factor for making changes late in the development life cycle</td>
</tr>
</tbody>
</table>
Appendices C: Cost-benefit calculation examples

An overview will be given of the different cost-benefit calculation examples. It’s goal is to show how the calculation methods should be used, once the necessary data is found.

Planned usability engineering program
An example is given of how a planned usability-engineering program could look like. Each technique and task should be put into the program with the costs of the particular technique. Then it must be multiplied with the number of times that the technique is used.

<table>
<thead>
<tr>
<th>Life Cycle Stage</th>
<th>UI Task / Technique</th>
<th>Cost / Technique</th>
<th>Number / Technique</th>
<th>Total Cost ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Functional specification</td>
<td>Task Analysis</td>
<td>2,425</td>
<td>4</td>
<td>9,700</td>
</tr>
<tr>
<td></td>
<td>User interviews</td>
<td>6,000</td>
<td>1</td>
<td>6,000</td>
</tr>
<tr>
<td>Design</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
</tbody>
</table>
| Total cost | | | | ...

*Table 38: planned usability-engineering program (From Chapter2 Bias and Mayhew 1994)*

The costs for each usability technique are calculated as followed:

User Interviews:
10 interviewees for 1 hour @ $25 / hour $250
Interviewer @ $35 / hour
16 hours designing interview $1,890
10 hours conducting interview
28 hours analyzing results
3 support staff @ 5 hours each @ $15 / hour $225
Videotapes $60+
Total $2,425

Increased productivity
The assumption that is made here is that if a usability engineer were involved in the development process the result would be that a user could process a screen one second faster then when no usability was done during the development process of the same application. This is not a one-time benefit, but a benefit that is realized each year.

250 users
60 screens per day
230 days per year
Hourly rate of $25
Processing time per screen reduced by 1 second

250 users x 60 screens x 230 days x 1/3600 hours @ $25 / hour $23,958
Donahue gives also an example of increased productivity, but uses job applications instead of screens. In the example, which is used, processes are done by workers on the computer. The goal is to improve the system. The hours that are needed to make the change should be multiplied with the hourly-loaded salary of a developer. Then the average number of hours to process one job in the existing system should be multiplied with the average hourly loaded salary of data entry staff. Those are the costs of processing one job in the existing system. This number multiplied with the total jobs in a year gives the average annual costs of processing job applications and the costs made for the improvement.

\[
1000 \text{ job applications } @ 4 \text{ hours each } @ \$30 / \text{ hour } = \$120,000
\]

Assume that the new system will bring a 25% reduction in processing time for each job applicant. The expected average annual cost of processing job application costs will be:

\[
1000 \text{ job applications } @ 3 \text{ hours each } @ \$30 / \text{ hour } = \$90,000
\]

The anticipated first year saving are $120,000 - $90,000 = $30,000. The expected first year benefit = $30,000 - $2,100 (improvement costs, see page x) = $27,900. If it is a system with a lifespan of 3 years, the benefits will look as follows:

- Expected first-year benefit = $27,900
- Anticipated second- and third-year benefit combined = $60,000
- Anticipated total benefit = $87,900

The cost-benefit ratio is a ratio, \$87,900 : \$2,100 = \$41.85, cost-benefit ratio is 1 : 41.85 (Donahue 1999)

**Decreased cost of training users**
The estimate that was being made by Mayhew & Mantie is that by applying usability engineering techniques an interface would be easier to use and thus 10% easier to learn which would reduce training time by 10%.

Typical one-week training course reduced by 10% or 4 hours
250 users
Hourly rate of $25

\[
250 \text{ employees x 4 hours } @ \$25 / \text{ hour } = \$25,000
\]

This is a one-time benefit, which is realized when the system was first introduced.
Decreased number of user errors
This is not a one-time benefit, but a benefit that is realized each year.

250 users
0.2 errors eliminated per user per day
2 minutes in recovery time per error
230 workdays a year
Hourly rate of $25

250 users \times 0.2 \text{ errors} \times 230 \text{ days} @ \$0.833 / \text{ error} = \$9,580

Savings gained from making changes earlier in the design life cycle
Changes made earlier cost \( \frac{1}{4} \) of changes made after implementation
20 changes early
1 day per change
Hourly rate of $35

\begin{align*}
\text{Early change cost} &= 20 \text{ changes} \times 8 \text{ hours} @ \$35 \\
\text{Late change cost} &= 4 \times \text{early change cost} \\
\text{Savings} &= \text{Late change cost} - \text{early design cost} \\
\text{The resulting benefit is a one-time benefit.}
\end{align*}

Increased sales
25 more systems sold due to enhanced usability
Profit margin per product = $2,500

25 systems \times $2,500 = $62,500

Decreased amount of customer support
Another factor that should be looked at is the decreased amount of customer support because of increased usability. This is a yearly benefit, as long as the product is in use.

2000 customers
Eliminate 4 calls per year per customer
10 minutes per call
Customer support engineer fully loaded hourly wage = $35

2000 customers \times 4 \text{ calls} \times 1/6 \text{ hours} @ \$35 / \text{ hour} = \$46,667

Decreased turnover costs
Total costs of employee turnover are 1.5 times the employee’s annual salary. A business has 500 employees using a dedicated software system in the performance of their jobs. There is currently a 25% employee turnover rate per year. Average annual employee salary is $20,000. The user interface of the system is improved, based on user
requirements, and employee turnover is reduced by 20%. What is the value of the resulting 20% reduction in employee turnover the first year?

Previous yearly employee turnover = 125  
New yearly employee turnover = 100  
Reduction in employee turnover = 25  
Average annual employee salary = $20,000  
Value of reduction in employee turnover = 25 x 20,000 x 1.5 = $750,000

**Payback Period**
A project requires an initial outlay of $75,000  
The net cash flows for the project in the first five years are $10,000, $25,000, $20,000, $20,000 and $10,000.  
The organization’s standard payback period for projects is four years.  
Should this project be selected for investment purposes?

Cash Flow1  $10,000  
Cash Flow2  $25,000  
Cash Flow3  $20,000  
Cash Flow4  $20,000 +  
Total  $75,000  

The answer is yes, as the sum of the net income for the first four years is equal or to the initial investment outlay.  
Shortcoming is the fact that this technique does not adjust for the timing of cash inflows.

**Present value of future cash flow**
If a project will result in one future cash inflow of $50,00 in the second year and the discount rate is 15%, what is the present value of the future yield?

F = $50,000  
PVIF = 0,7561  
P = $50,00 (0.7561) = $37,805

An example of present value of several cash flows is given:  
If the projected cash flows from a project are $50,000, $100,000 and $200,000 for years 1-3, respectively, and the discount rate is 17% what is the present value of the projected benefits?

F1 = $50,000  
F2 = $100,000  
F3 = $ 200,000  
i = 17%  
n = 3  
P = 50,000 (0,8547) + 100,000 (0,7305) + 200,000 (.6244)  
= 42,735 + 73,050 + 124,880 = $240,665
Net present value
In the previous example, the present value of the project’s projected inflows for the first three years was $240,665. If the present value of the project’s cost (outflows) is $200,000, should the project be invested for investment? The answer to this is positive.

\[
\text{NPV} = 42,735 = 73,050 = 124,880 - 200,000 \\
= 240,665 - 200,000 = $40,665
\]

Profitability index
Data is used from the previous example to calculate the PI
\[
\text{PI} = 240,665 / 200,000 = 1,20
\]

Internal rate of return
In the previous example, NPV = $40,665 when I = 17 %. Since NPV is positive, select a higher value for the discount rate to lower NPV towards zero. With i = 27%.

\[
\text{NPV} = 50,000 (0.7874) + 100,000 (0.6200) + 200,000 (0.4882) - 200,000 \\
= 39,370 + 62,000 + 97,640 - 200,000 = -$990
\]

Since the NPV is now on the negative side, lower the discount rate to raise the NPV towards zero. With i = 26%.

\[
\text{NPV} = 50,000 (0.7937) + 100,000 (0.6299) + 200,000 (0.4999) - 200,000 \\
= 39,685 + 62,990 + 99,980 - 200,000 = $2,655
\]

Therefore, the IRR is between 26% and 27%.
Appendices D: Collecting product data and data sources

In this appendix can the questions we asked on the topic of products and data sources to the usability consultants and their answers be found. The product names that are used are fictitious and show no relation to Baan products.

Questionnaire
On this moment the research is in a stadium where a decision has to be taken about which research option will be used. As you maybe can remember from the previous presentation depends this decision on the products and product data sources that are available within Baan. Because we do not know enough of the various products and product data sources within Baan, we ask you to help us make an inventory of this. We would like that your answer are related to the specified research options. The research options are mentioned in the added attachment as mnemonic device. It will take about a half an hour to answer the questions.

If you have any questions you can e-mail or call us. Please sent your answers at the latest Monday 15 April, so we can process your data in our presentation of Wednesday 17 April?

Thank you for your cooperation.

Michael and Kelvin

Questions

1. Make a list of products you worked on.
   Indicate under which of the tree research options the product falls.
   *A fictitious example of the answer on this question:
   I have worked on Baan product …………… (to be filled in by you).
   This product is suitable for research option …………… (to be filled in by you).

1.1 Indicate which usability activities you have performed for each product.
   *A fictitious example of the answer on this question:
   For Baan product …………… (list from previous question) have I performed the following usability activities: …………… (to be filled in by you).

2. Indicate the present data sources within Baan that apply for that product where you have worked on. (do this on a scale of 1 through 5, where 1 is few and 5 is a lot)
   Examples of data sources are: Time Wizard, data of clients, log of telephone calls by the helpdesk, etc.
   *A fictitious example of the answer on this question:
   For Baan product …………… (list from first question) I give an …………… (1 through 5) for available data sources.

Attachment: research options
Answers
This is the data received from the usability consultants.

<table>
<thead>
<tr>
<th>Product</th>
<th>Relates to research option number</th>
<th>Usability activities performed on the product</th>
<th>Performed by</th>
<th>Number of available data sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Product A</td>
<td>3</td>
<td>Screen design, realization, guidelines</td>
<td>Usability Consultant1</td>
<td>2</td>
</tr>
<tr>
<td>Product B</td>
<td>3</td>
<td>Task Design, Conceptual Design, Screen design, Realization, Icons</td>
<td>Usability Consultant1</td>
<td>2</td>
</tr>
<tr>
<td>Product C</td>
<td>3</td>
<td>Task Design, Conceptual Design, Realization, Screen Design (incl. Wizard), Icons, Usability Test</td>
<td>Usability Consultant1</td>
<td>4</td>
</tr>
<tr>
<td>Product D</td>
<td>2</td>
<td>Task Design, Conceptual Design, Screen Design, Icons</td>
<td>Usability Consultant1</td>
<td>3</td>
</tr>
<tr>
<td>Product E</td>
<td>1 (not implemented)</td>
<td>Task Description, Conceptual Design, Prototyping</td>
<td>Usability Consultant1</td>
<td>1</td>
</tr>
<tr>
<td>Product F</td>
<td>3</td>
<td>Task Design, UI Design</td>
<td>Usability Consultant1</td>
<td>2</td>
</tr>
<tr>
<td>Product G</td>
<td>2</td>
<td>Task Design, Conceptual Design, Usability Walkthrough, Prototyping (allen door engineer, coaching door Usability Consultant), Realization</td>
<td>Usability Consultant1</td>
<td>2</td>
</tr>
<tr>
<td>Product H</td>
<td>1</td>
<td>-</td>
<td>Usability Consultant1</td>
<td>1</td>
</tr>
</tbody>
</table>

Table 39: Data received from Usability Consultant1
<table>
<thead>
<tr>
<th>Product</th>
<th>Relates to research option number</th>
<th>Usability activities performed on the product</th>
<th>Performed by</th>
<th>Number of available data sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Product I</td>
<td>1</td>
<td>Usability design</td>
<td>Usability Consultant2</td>
<td>2</td>
</tr>
<tr>
<td>Product J</td>
<td>1</td>
<td>Usability audit, Usability design</td>
<td>Usability Consultant2</td>
<td>2</td>
</tr>
<tr>
<td>Product K</td>
<td>1</td>
<td>Usability audit</td>
<td>Usability Consultant2</td>
<td>3</td>
</tr>
<tr>
<td>Product L</td>
<td>1</td>
<td>Usability audit</td>
<td>Usability Consultant2</td>
<td>3</td>
</tr>
<tr>
<td>Product M</td>
<td>3</td>
<td>Task analysis</td>
<td>Usability Consultant2</td>
<td>1</td>
</tr>
<tr>
<td>Product N</td>
<td>1</td>
<td>Usability audit</td>
<td>Usability Consultant2</td>
<td>1</td>
</tr>
<tr>
<td>Product O</td>
<td>3</td>
<td>Review of functional design</td>
<td>Usability Consultant2</td>
<td>1</td>
</tr>
<tr>
<td>Product P</td>
<td>3</td>
<td>Review of technical design</td>
<td>Usability Consultant2</td>
<td>1</td>
</tr>
</tbody>
</table>

*Table 40: Data received from Usability Consultant2*

<table>
<thead>
<tr>
<th>Product</th>
<th>Relates to research option number</th>
<th>Usability activities performed on the product</th>
<th>Performed by</th>
<th>Number of available data sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Product Q</td>
<td>2</td>
<td>Usability tests, Survey, other activities</td>
<td>Usability Consultant3</td>
<td>4</td>
</tr>
<tr>
<td>ThinBaan</td>
<td>3</td>
<td>Usability Design, Usability Test</td>
<td>Usability Consultant3</td>
<td>4</td>
</tr>
</tbody>
</table>

*Table 41: Data received from Usability Consultant3*
<table>
<thead>
<tr>
<th>Product</th>
<th>Relates to research option number</th>
<th>Usability activities performed on the product</th>
<th>Performed by</th>
<th>Number of available data sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Product R</td>
<td>2</td>
<td>Usability Design</td>
<td>Usability Consultant4</td>
<td>2</td>
</tr>
<tr>
<td>Product S</td>
<td>1 of 2 (no release yet)</td>
<td>Usability Design</td>
<td>Usability Consultant4</td>
<td>2</td>
</tr>
<tr>
<td>Product T</td>
<td>2</td>
<td>Usability Design</td>
<td>Usability Consultant4</td>
<td>2</td>
</tr>
<tr>
<td>Product U</td>
<td>2</td>
<td>Usability Design, Walkthrough, Object-Action, Usability Review</td>
<td>Usability Consultant4</td>
<td>3 (2 for object action and audit)</td>
</tr>
<tr>
<td>Product V</td>
<td>2</td>
<td>Usability Review</td>
<td>Usability Consultant4</td>
<td>2</td>
</tr>
<tr>
<td>Product W</td>
<td>2</td>
<td>Usability Review</td>
<td>Usability Consultant4</td>
<td>2</td>
</tr>
<tr>
<td>Product X</td>
<td>2</td>
<td>Usability Review, Walkthrough</td>
<td>Usability Consultant4</td>
<td>3</td>
</tr>
<tr>
<td>Product Y</td>
<td>2</td>
<td>Usability Test</td>
<td>Usability Consultant4</td>
<td>3</td>
</tr>
<tr>
<td>Product Z</td>
<td>2 (partly implemented)</td>
<td>Usability Test</td>
<td>Usability Consultant4</td>
<td>3</td>
</tr>
<tr>
<td>Product Aa</td>
<td>2</td>
<td>Object-Action</td>
<td>Usability Consultant4</td>
<td>2</td>
</tr>
</tbody>
</table>

*Table 42: Data received from Usability Consultant4*
<table>
<thead>
<tr>
<th>Product</th>
<th>Relates to research option number</th>
<th>Usability activities performed on the product</th>
<th>Performed by</th>
<th>Number of available data sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Product Bb</td>
<td>1 (not implemented)</td>
<td>Task Analysis, Conceptual Solution, Prototyping</td>
<td>Usability Consultant5</td>
<td>1</td>
</tr>
<tr>
<td>Product Cc</td>
<td>2 (partly implemented)</td>
<td>Task Analysis, Conceptual Solution, Prototyping, Walkthrough</td>
<td>Usability Consultant5</td>
<td>2</td>
</tr>
<tr>
<td>Product Dd</td>
<td>2 (partly implemented in SMI)</td>
<td>Task Analysis, Conceptual Solution, Prototyping, Walkthrough</td>
<td>Usability Consultant5</td>
<td>2</td>
</tr>
<tr>
<td>Product Ee</td>
<td>2 (partly implemented)</td>
<td>Task Analysis, Conceptual Solution, Prototyping, Walkthrough</td>
<td>Usability Consultant5</td>
<td>2</td>
</tr>
<tr>
<td>Product Ff</td>
<td>2 (implemented in Reger)</td>
<td>Task Analysis, Conceptual Solution, Prototyping, Walkthrough</td>
<td>Usability Consultant5</td>
<td>2</td>
</tr>
<tr>
<td>Product Gg</td>
<td>2 (partly implemented in Reger)</td>
<td>Usability Review</td>
<td>Usability Consultant5</td>
<td>2</td>
</tr>
<tr>
<td>Product Hh</td>
<td>3</td>
<td>Task Analysis, Conceptual Solution, Prototyping, Walkthrough</td>
<td>Usability Consultant5</td>
<td>2</td>
</tr>
</tbody>
</table>

Table 43: Data received from Usability Consultant5
Appendices E: Questionnaire Focus on Usability Activities

We want to take a closer look at the level on which the usability activities of Baan are aiming their improvements of their applications at. We want to do this according to the framework presented by Kabel et al., which we shall introduce now.

This framework can be used for the evaluation of computer applications, it allows evaluation data to be categorized. So in this way remarks with respect to an application can be classified into different categories. These categories are further specified by means of heuristics that can be employed by users and evaluators for identification and articulation of design errors.

The categories and their respected heuristics are now explained. You will need these categories and heuristics when filling in the questionnaire.

Keystroke category
This category stands for the ‘do’-category. Remarks about single, direct user actions belong in it. For example remarks concerning the ease of carrying out a single action, or remarks concerning the consistency of the implementation of single keystrokes should be placed in this category.

Heuristics
K1. A single, direct action is impossible to perform.
K2. A single, direct action is hard or difficult to perform.
K3. A single, direct action is not familiar
K4. With the same single action (for example “double click”), different results are obtained (for example “select” and “open”).
K5. Equal results (for example “open”) can be obtained in different ways, using different keystrokes (for example using a “menu option” and “double click”).

System image category
The system image category represents the system’s manifestation or appearance. The way something is visualized and the consistency of presentations belong to this category.

Heuristics
SI1. Something is not legible.
SI2. Something is not visible.
SI3. Something is at an unusual location
SI4. There is no visible effect or result from my action.
SI5. It cannot be seen what this should be used for; additional interpretation is necessary.
SI6. This (form of) presentation suggests an impossible action; the way this looks does not suit the underlying function.
SI7. The presentation is not consistent; two things look the same but have different meanings, or vice versa.
SI8. The presentation is not consistent; something is missing while it is represented elsewhere, for example in an equal or comparable window.
Process category
In this category, series or sequences of user-actions belong. The way something is done, whether it works or doesn’t, (for example when a sequence of user-actions stagnates), should be classified into the process category.

Heuristics
P1. The order of actions is not right.
P2. The sequence of actions does not fit into the natural user task, or into the user’s natural way of working.
P3. Too many actions are necessary for attaining an end; the number of actions could be diminished, so the actions could be more directly performed.

Mental model category
The mental model category relates to the correspondence of user’s ideas concerning the system and its behavior. Here, it is evaluated whether the user’s image of the system matches the image provided by the system. The discrepancy that possibly exists may show in terms of wrong use or interpretation of words and terms. The user’s ideas about the system may also be expressed in criticism with respect to the quality of the system’s content or of the external reality it represents. One may disagree with (part of) the system’s content, or one may believe that (part of) the system is of good quality.

As has been said, the “terms” part belongs to the low abstraction level, and the "agreement" part to the high abstraction level.

Heuristics
Low abstraction
MM1. The user disagrees with the terms used in the system.
MM2. Terms are wrongly interpreted.
MM3. Terms are unfamiliar.
MM4. Terms are inconsistently used and are therefore confusing.
High abstraction
MM5. I disagree with the content.
MM6. I have different expectations of the system.

Efficacy category
In the efficacy category, the effectiveness - the power - of the system (in terms of its added value compared to unsupported or existing ways of doing things) is evaluated. It is examined whether using the system is more efficient than not using it and whether it really solves bottlenecks.

Heuristics
E1. (This aspect of) the system enables the user to work more efficiently.
E2. (This aspect of) the system makes the user work less efficient.
E3. (This aspect of) the system enables the user to work more effectively.
E4. (This aspect of) the system makes the user work less effective.

Questionnaire “Focus of Usability Activities”

Below you will find a questionnaire in the form of a table regarding the focus of the usability activities that you are performing.

We would like you to relate the usability activities to the categories and heuristics as stated in the given framework that is attached. So to what heuristic(s) in the framework does your performed usability activities (in general) relate to?
Some usability activities mentioned in the table may not be applicable to you specifically; if this is the case you can leave the according activity blank. However if you do feel that you have any knowledge about that mentioned usability activity you are allowed to classify this task also, then please do state “no” in the “Activity normally performed by yourself” column.

An example of a fictitious answer is provided in the up most row of the questionnaire.

The information about the framework is attached, document “Questionnaire focus of usability activities (hand out version).”

We would like to have this questionnaire back at the latest on 3rd of May 2002 (preferably e-mail). Please let us know when you can’t make this date on beforehand and then tell us what date you will make.

The questionnaire will take about 30 to 45 minutes of your time.

Success and thank you for your cooperation,

Kelvin and Michael

<table>
<thead>
<tr>
<th>Usability activity</th>
<th>Activity normally performed by yourself ‘Yes/no’</th>
<th>Relates to what category in the framework</th>
<th>Relates to what heuristics in the framework</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Example:</strong></td>
<td></td>
<td></td>
<td><strong>Example:</strong></td>
</tr>
<tr>
<td>Task analysis</td>
<td><strong>Example:</strong> Yes</td>
<td><strong>Example:</strong> System image category</td>
<td><strong>Example:</strong> S12, MM3, MM4, E2</td>
</tr>
<tr>
<td>Task design</td>
<td></td>
<td>Mental model category</td>
<td></td>
</tr>
<tr>
<td>Conceptual usability design</td>
<td></td>
<td>Efficacy category</td>
<td></td>
</tr>
<tr>
<td>Prototyping</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Usability walkthrough</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Usability activity</td>
<td>Activity normally performed by yourself ‘Yes/no’</td>
<td>Relates to what category in the framework</td>
<td>Relates to what heuristics in the framework</td>
</tr>
<tr>
<td>----------------------------------------</td>
<td>-------------------------------------------------</td>
<td>------------------------------------------</td>
<td>---------------------------------------------</td>
</tr>
<tr>
<td>Usability testing</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Visual design</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Icon design</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Promoting usability in general</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Further embedding of usability in DMethod</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Usability reviews</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Usability audits</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Usability style guides</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Assisting in realization</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Usability checklists</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other activities: ?</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 44: Table questionnaire focus of usability activities
Appendices F: Questionnaire Positioning of Usability Activities

Below you will find some questions about the positioning of usability activities within Baan.

Stages of acceptance of user centered design

The success of usability engineering depends partly on the acceptance of it by the product group. According to Grudin [1991] as cited by Ehrlich and Rohn there are many barriers that prevent effective incorporation of good design practices into organizations. It is also observed that organizations vary widely in their degree of understanding and acceptance of user centered design according to Dayton [1993] as cited by Ehrlich and Rohn. Those who have a more accepting attitude are also more successful in developing useful and usable products. There are four stages of acceptance that affect the cost-benefit ratio of performing usability engineering.

**Question 1:**

Can you fill in the given features of the stages described that are applicable to the situation of Baan Usability Consultancy? You can do this by means of putting a cross in the boxes that are in front of the features. (This means you will have to print this form, we will collect this form again from you at the agreed date as mentioned in the e-mail or you can send it by internal mail.)

**Stage 1: Skepticism**

In this stage we can classify organizations that have never been involved with user centered design. It is viewed with skepticism because it is unclear what the benefits are. Features of this stage are:

- A. Fear that the inclusion of usability testing will lengthen their development cycle, causing them to miss the market window.
- B. Too focused on the product features and its development schedule and less concerned with the usability of the product.
- C. Meeting schedule deadlines get rewarded over quality, user input, or collaboration with other groups.
- D. If a usability expert is involved at all, then this happens late in the development process where he functions more as a consultant with no real influence on the product.
- E. Developers may listen to the evaluation of their product but feel that they are under no obligation to follow the recommendations.
- F. Usability does not matter
- G. Usability is important but good interfaces can surely be designed by the regular development staff as part of their general system design.

---

2 These features are sometimes applicable to the situation of usability consultancy within Baan.
Stage 2: Curiosity
In this stage we can classify organizations that are beyond skepticism and start to become curious about what user-centered design can offer.
Features of this stage are:
- A. It is recognized that the products need improving by means of usability
- B. It is still not quite clear what usability engineers and user-interface designers actually do.
- C. It needs some convincing in order to get money and resources.
- D. A product group is open minded about the benefits of user-centered design, but they need to be educated about user-interface design and usability engineering
- E. Management brings in one user centered design person in a project who fulfills both the role of usability engineer and user interface designer.
- F. A usability expert has the opportunity to influence some of the covert characteristics of the product but may not be able to change some of the deeper problems that relate to the overall goals and features of the product.
- G. Engineers do not want to give control over the design of the user interface away to someone who is not also implementing it.
- H. Developers recognize they do not know everything about usability, so a specialist is called to look over their design. This is done too late in the project and no end-users are involved.
- I. Usability engineers are being brought in from the start to advise on the graphical user interface. Although this is done without a prior task analysis.

Stage 3: Acceptance
In this stage we can classify the organization that understands and relies on the involvement of one or more user centered design people on the project team.
Features of this stage are:
- A. The role and expertise of user centered design people are well understood and appreciated as an important part of product development.
- B. There is a high degree of communication among members of the project group.
- C. Often more than one user centered design person is on the project team, such as a usability engineer and a graphic designer.
- D. Depending on the breadth of the project there may be an additional user interface architect who oversees the higher-level conceptual and strategic issues.
- E. Some projects use a few discount usability methods, although the methods are applied too late in the development process. The projects that do use usability often have managers who have experienced that applying usability early in the development process is beneficial.
- F. Most projects involve simple usability methods, and some projects use usability methods in the early stages of system development.
Stage 4: Partnership
In this stage we can classify an organization where the user centered design group is charged with exploring ideas for innovative products to a stage of advanced prototype development, at which ideas can be communicated throughout a group. This type of partnership is often seen in an advance-development group.

Features of this stage are:

- A. The project team is a seamless entity with a single clear product vision and purpose, high level of communication, and a deeply held commitment to providing products that are not only more usable but also more useful.
- B. Much time is spent by everyone getting customer input early in the process and often throughout the development.
- C. The user centered design people are not only part of the project team but are likely to be “driving” some or all of the project.
- D. A usability group and / or usability lab is founded.
- E. Usability is deep rooted in the life cycle of a product. Even companies with a usability group does not reach this stage due to a lack of usability resources to employ all methods one could wish for at all the stages in the development life cycle.

Levels within the organization

As said by Ehrlich and Rohn it can be so that the people at various levels in an organization are at different stages, as described above. The levels of a company consist of upper management, middle management, and individual contributors. It is said that all levels must be in either at the acceptance or the partnership stage in order to have an efficient user centered design organization that can make a significant difference in the products.

Question 2:
In what level can you place Baan management?

- The first level that is described is the “grassroots effort”. In this level companies have user centered design champions among some individual contributors and perhaps some middle management. To gain support in these companies for usability, low-cost methodologies are all that can be employed.

- The second level that is discussed is called the “high-level champion”. If one or more people in the upper management decide that usability engineering is useful and that is should be funded.
Appendices G: Activity Based Costing

In this appendix the data that were needed to fill in ABC is shown. The product names that are used are fictitious and show no relation to Baan products. The numerical data shown here is fictitious and shows no relation to Baan figures.

Because the descriptions in the hour registration program were most of the time too general to know which product the usability consultant had worked on, the usability consultant had to make a division for the hours made of ThinBaan. Table 45 shows the division the usability consultant made. An X means that the activity is not done for the corresponding ThinBaan. The usability consultant had worked for ThinBaan1.0 from January 2000 through February 2001. After that the usability consultant started with ThinBaan1.1.

When the hours where divided over the different tasks for ThinBaan, the tasks had to be divided in the activities that were explained in Chapter 3. This is done in Table 46 by the usability consultant of ThinBaan. At last the hours had to be divided over the different products. The different products and the division of the hours were made also by the usability consultant. The end result can be found in Table 24 Chapter 7.

<table>
<thead>
<tr>
<th>Tasks from Time Wizard</th>
<th>Task exists of x% time used for ThinBaan</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ThinBaan1.0</td>
</tr>
<tr>
<td>PDU coding</td>
<td>X</td>
</tr>
<tr>
<td>ERP Usability</td>
<td>50</td>
</tr>
<tr>
<td>Project meetings</td>
<td>40</td>
</tr>
<tr>
<td>Design review</td>
<td>X</td>
</tr>
<tr>
<td>General UC consult</td>
<td>0</td>
</tr>
<tr>
<td>Knowledge Transfer</td>
<td>0</td>
</tr>
<tr>
<td>Team/Group Meetings</td>
<td>0</td>
</tr>
<tr>
<td>Training</td>
<td>0</td>
</tr>
<tr>
<td>Travel hours</td>
<td>0</td>
</tr>
<tr>
<td>Usability design BIS</td>
<td>0</td>
</tr>
<tr>
<td>General review &amp; ad hoc UI consult</td>
<td>0</td>
</tr>
<tr>
<td>E-BOKS proof of concept</td>
<td>100</td>
</tr>
</tbody>
</table>
### Table 45: Dividing hours from Time Wizard Tasks over ThinBaan

<table>
<thead>
<tr>
<th>Tasks from Time Wizard</th>
<th>Task exists of x% time used for ThinBaan</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ThinBaan1.0</td>
</tr>
<tr>
<td>Proof of concept</td>
<td>X</td>
</tr>
<tr>
<td>Customer review prototypes</td>
<td>X</td>
</tr>
<tr>
<td>High Level CUID</td>
<td>X</td>
</tr>
<tr>
<td>NGUI Documentation</td>
<td>X</td>
</tr>
</tbody>
</table>

Table 45: Dividing hours from Time Wizard Tasks over ThinBaan

<table>
<thead>
<tr>
<th>Tasks from Time Wizard</th>
<th>Task can be split up in the following activities</th>
<th>X% time used per activity per task</th>
</tr>
</thead>
<tbody>
<tr>
<td>PDU coding</td>
<td>Task analysis</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>Task design</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>Prototyping</td>
<td>70</td>
</tr>
<tr>
<td>PDU coding</td>
<td>Is the same as ERP Studio</td>
<td></td>
</tr>
<tr>
<td>PDU inspection</td>
<td>Visual Design</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>Logging change requests</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>Testing bugs</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Ad hoc consultancy</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>Preparation FD</td>
<td></td>
</tr>
<tr>
<td>ERP Usability</td>
<td>Prototyping</td>
<td>17</td>
</tr>
<tr>
<td></td>
<td>Usability testing</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Visual design</td>
<td>17</td>
</tr>
<tr>
<td></td>
<td>Icon design</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Logging change requests</td>
<td>22,5</td>
</tr>
<tr>
<td></td>
<td>Testing bugs</td>
<td>7,5</td>
</tr>
<tr>
<td></td>
<td>Ad hoc consultancy</td>
<td>22,5</td>
</tr>
<tr>
<td></td>
<td>Preparation FD</td>
<td>7,5</td>
</tr>
<tr>
<td>Project meetings</td>
<td>Visual design</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ad hoc consultancy</td>
<td>70</td>
</tr>
<tr>
<td></td>
<td>Preparation FD</td>
<td>20</td>
</tr>
<tr>
<td>Design review</td>
<td>Visual design</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Ad hoc consultancy</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Preparation FD</td>
<td>80</td>
</tr>
<tr>
<td>Usability Consult ThinBaan</td>
<td>Id the same as ERP Studio</td>
<td></td>
</tr>
<tr>
<td>E-BOKS proof of concept</td>
<td>Prototyping</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Usability testing</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Visual Design</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Icon Design</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Logging change requests</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Testing bugs</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ad hoc consultancy</td>
<td></td>
</tr>
</tbody>
</table>

159
<table>
<thead>
<tr>
<th>Tasks from Time Wizard</th>
<th>Task can be split up in the following activities</th>
<th>X% time used per activity per task</th>
</tr>
</thead>
<tbody>
<tr>
<td>NGUI usability consultancy ThinBaan</td>
<td>Preparation FD</td>
<td>20</td>
</tr>
<tr>
<td>Proof of concept</td>
<td>Task analysis</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>Task design</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>Prototyping</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>Ad hoc consultancy</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Preparation FD</td>
<td>5</td>
</tr>
<tr>
<td>Customer review prototypes and Prototype ThinBaan</td>
<td>Prototyping</td>
<td>100</td>
</tr>
<tr>
<td>High level CUID</td>
<td>Visual Design</td>
<td>90</td>
</tr>
<tr>
<td></td>
<td>Icon Design</td>
<td>10</td>
</tr>
<tr>
<td>NGUI Documentation</td>
<td>Preparation FD</td>
<td>100</td>
</tr>
</tbody>
</table>

Table 46: Dividing hours of tasks over activities

<table>
<thead>
<tr>
<th>Activities</th>
<th>Product</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ThinBaan</td>
</tr>
<tr>
<td>Task Analysis</td>
<td>80</td>
</tr>
<tr>
<td>Task Design</td>
<td>80</td>
</tr>
<tr>
<td>Prototyping</td>
<td>80</td>
</tr>
<tr>
<td>Usability testing</td>
<td>50</td>
</tr>
<tr>
<td>Visual design</td>
<td>80</td>
</tr>
<tr>
<td>Icon design</td>
<td>90</td>
</tr>
<tr>
<td>Assisting in realization: Logging change requests</td>
<td>80</td>
</tr>
<tr>
<td>Assisting in realization: Testing bugs</td>
<td>90</td>
</tr>
<tr>
<td>Assisting in realization: Ad hoc consultancy</td>
<td>60</td>
</tr>
<tr>
<td>Assisting in realization: Preparation FD</td>
<td>70</td>
</tr>
</tbody>
</table>

Table 47: Dividing hours of activities over products