

ANALYSIS OF USABILITY COST-BENEFIT MODELS

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Abstract

There are few development organizations that have fully integrated usability activities as an integral part of their product development projects. One reason for this is that the benefits of better usability are not visible for the management. In this paper, the characteristics of selected published usability cost-benefit models are analyzed. These models have different approaches for identifying, approaching and categorizing the costs and benefits of usability. The analyzed models provide general guidelines for estimating the costs and benefits of usability but in most cases provide only little details. It is proposed that the business type of development organization and the type of the developed product as variables could be taken into account when analyzing the benefits of better usability.

Keywords: Usability, Usability Cost-Benefit Models, Usability Benefits.

1 INTRODUCTION

Usability is defined as one of the main product quality attributes for the international standard ISO 9126. It means the capability of the product to be understood by, learned, used by and attractive to the user, when used under specified conditions (ISO 9126). Another usually referred to definition of usability is in standard ISO 9241-11, where usability is 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” (ISO 13407).

Usability has many potential benefits for a development organization such as increased productivity and customer satisfaction. But even today there are quite few product development organizations having incorporated usability activities largely in their product development process. Bringing usability activities into the product development life cycle has been a challenge since the beginning of usability activities over twenty years ago. One reason for this is that the benefits of better usability are not easily identified or calculated. Usability engineering has been competing for resources against other project groups who do have objective cost-benefit data available for management review (Karat 1994).

The topic of this paper is to analyse the different cost-benefit analysis models that are used for estimating the cost-benefits of better usability. There exist a number of different cost-benefit models related to usability. In our knowledge, however, there is not much work reported on contrasting and comparing the different models. The aim of this paper is to partially fill this gap.

Generally, the cost-benefit analysis is a method of analysing projects for investment purposes (Karat 1994). It embodies the idea that decisions should be based on comparing the advantages and disadvantages of an action. Technical and financial data is gathered and analysed about a given business situation or function. This information assists in decision making about resource allocation. A general cost-benefit method identifies three steps and it proceeds as follows (Burrill & Ellsworth 1980):

1. Identify the financial value of expected project cost and benefit variables.
2. Analyse the relationship between expected costs and benefits using simple or sophisticated selection techniques.
3. Make the investment decision.

Development management often sees usability activities as a potential risk to the deadline of their projects. It is difficult to implement usability activities in development projects without the support of the business management. Management level support for usability activities in development projects could be achieved if the benefits of better usability can be identified and calculated. In the usability cost-benefit analysis of usability activities, expected costs (e.g., personnel costs) and benefits (e.g., lower training costs) are identified and quantified (Karat 1994).

The benefits and costs of usability are different at the different stages of product life-cycle. Therefore, in this paper, the different usability cost-benefits are examined through the different phases of product life cycle. Our research question is: To which extent do the usability cost-benefit models identify the benefits and costs related to usability at the different phases of product life-cycle: development of the product, the sales phase, introduction of the product into use, and everyday use?

There exist some published models for calculating usability benefits, and as many ways of identifying the benefits. A business benefit is a positive return that the development organisation expects to obtain as a result of an investment. In this research, the differences and characteristics between some of the published usability cost-benefit models and their approach to costs and benefits of better usability are compared.

The analysis of this paper covers four models. Three of them are ones presented in the book of Bias & Mayhew (1994). Although the book is rather old, it still is the benchmark book in cost-justifying

usability. The fourth model included in the analysis – the one by Bevan – is a more recent one, a result of European research projects.

2 OVERVIEW OF THE SELECTED USABILITY COST-BENEFIT MODELS

Most of the existing usability benefit models analysed in this paper is selected from the book, *Cost-Justifying Usability* by Bias & Mayhew (1994). This book was published in 1994, but it is still the most referred source of usability cost-benefit models. The analysed models taken from *Cost-Justifying Usability* were selected for this report because they represent a variety of different views on usability cost-benefit analysis.

Bevan has published a usability benefit analysis model in a report of the European TRUMP project (Bevan 2000). The model was selected for this analysis because it is a recent usability cost-benefit model and it has a slightly different point of view on different benefits of usability.

2.1 Ehrlich & Rohn

Ehrlich & Rohn (1994) analyse the potential benefits of better usability from the point of the views of vendor company, corporate customer and end user. They state that by incorporating usability activities into a product development project, both the company itself and its customers gain benefits from within certain areas. When compared to the other usability benefit models analysed in this paper, Ehrlich & Rohn present the most comprehensive discussion about different aspects of usability cost-benefits. However, they do not clearly present an overall formula for calculating the value of usability benefits.

According to Ehrlich & Rohn, a vendor company can identify benefits from three areas:

1. Increased sales
2. Reduced support costs
3. Reduced development costs.

In some cases, a link between better usability and increased sales can be found, but usually it can be difficult to relate the impact of better usability directly to increased sales. One way to identify the impact of usability on sales is to analyse how important role usability has in the buying decision.

According to Ehrlich & Rohn, the cost of product support can be surprisingly high if there is a usability problem in an important product feature, and the product has lots of users. Better usability has a direct impact on the need for product support and therefore, great savings can be realized through a reduced need for support. By focusing on better product usability and using usability techniques, a vendor company can cut development time and costs. The corporate customer can expect benefits when a more usable product reduces the time that end users need for training. And in addition to official training, there are also hidden costs for peer-support. End users often seek help from their expert colleagues, who therefore suffer in their productivity. It is estimated that this kind of hidden support cost for every PC is between \$6.000 and \$15.000 every year (Bulkeley 1992).

End users are the final recipients of a more usable product. According to Ehrlich & Rohn, increased usability can result in higher productivity, reduced learning time and a greater work satisfaction for the end user. The end-user can benefit from higher productivity when the most frequent tasks take less time.

2.2 Karat

Karat (1994) approaches usability benefits through a cost-benefit calculation of human factors at work. This viewpoint is different from other analysed usability benefit models. There are some examples of identified potential benefits. The benefits are identified as:

1. Increased sales
2. Increased user productivity
3. Decreased personnel costs through smaller staff turnover

A development organization can gain benefits when better usability gives a competitive edge and therefore increases product sales. A customer organization can gain benefits when end user productivity is increased through reduced task time and when better usability reduces staff turnover. Karat describes a usability cost-benefit analysis of three steps. In the first step, all expected costs and benefits are identified and quantified. In the second step, the costs and benefits are categorized as tangible and intangible. The intangible costs and benefits are not easily measured, so they are moved into a separate list. The third step is to determine a financial value for all tangible costs and benefits. Karat also links the usability cost-benefit analysis with business cases. Business cases provide an objective and explicit basis for making organisational investment decisions (Karat 1994).

2.3 Mayhew & Mantei

Mayhew & Mantei (1994) argue that a cost-benefit analysis of usability is best made by focusing attention on the benefits that are of the most interest to the audience for the analysis. The relevant benefit categories for the target audience are then selected, and the benefits are estimated. Examples of relevant benefit categories are given for a vendor company and internal development organization. The vendor company can benefit from:

1. Increased sales
2. Decreased customer support
3. Making fewer changes in a late design life cycle
4. Reduced cost of providing training.

The benefits for an internal development organization can be estimated from the categories of increased user productivity, decreased user errors, decreased training costs, making fewer changes in a late design life cycle and decreased user support. To estimate each benefit, a unit of measurement is chosen for the benefit. Then an assumption is made concerning the magnitude of the benefit for each unit of measurement. The number of units is then multiplied by the estimated benefit per unit.

2.4 Bevan

Bevan estimates the potential benefits of better usability for an organization in terms of development, sales, use and support (Bevan 2000). A vendor can gain benefits in development, sales and support. A customer can benefit in use and support. When a system is developed for in-house use, the organization can identify benefits for development, use and support. In each category, there are a number of possible individual benefits where savings or increased revenue can be identified. The total amount of benefits from better usability can be calculated by adding all the identified individual benefits together. Bevan mainly discusses usability benefits derived from increased sales, a lower need for training and increased productivity. Benefits accruing due to decreased development time are identified but they are not discussed in detail.

3 RESULTS OF THE ANALYSIS: COMPARING THE USABILITY COST-BENEFIT MODELS

Our analytical framework is based on product life-cycle. It makes possible a systematic analysis which takes account the different roles that usability has in different phases. We identify the following main phases of product life cycle:

1. Product development phase
2. Product sales phase
3. Introduction phase

4. Daily use

In the first phase – product development – the benefits are actually not based on usability as a product attribute but user-centred design as a development paradigm. Usability as a product attribute becomes important at the phase when the product gets touch with end users.

In the following, we analyse each of the selected models from the viewpoints of the four different phases of product life cycle. We examine specifically:

- What kinds of aspects of benefits each model covers at each phase
- To which extent each model provides concrete guidance for estimating the benefits.

As a last topic, we examine the related costs. As we will see, the costs are mainly related to the first product life cycle, development phase.

3.1 Benefits in the development phase

Overall, the existing models identify three different kinds of usability benefits that user-centred design can provide in the development phase: reduced development costs, prioritisation of product features and less need of future redesign.

By focusing on better product usability and using usability techniques, a vendor company can reduce development costs. Ehrlich & Rohn, Bevan, and Mayhew & Mantei identify reduced development costs as one potential benefit. Mayhew & Mantei provide a sample calculation for analysing this benefit. They calculate the benefits through comparing the difference between the costs of changes detected early and ones detected late. Ehrlich & Rohn have descriptive discussion but no concrete guidelines or example calculations. Bevan mentions these benefits only briefly, and Karat does not discuss them at all (table 1).

Ehrlich & Rohn and Bevan discuss to some extent the benefit of prioritisation the functionality that is important for customers. In one case three key features were deliberately added to the product to make it more appealing but 95% of the respondents to a survey never used the features because they didn't know the features existed, didn't know how to use the features or didn't understand the features (Ehrlich & Rohn 1994). Karat and Mayhew & Mantei do not address this point specifically.

In addition to these benefits, Bevan identifies the reduced need for architectural redesign to make future versions of a product easier to use as a potential benefit.

Benefit category	Ehrlich & Rohn	Karat	Bevan	Mayhew & Mantei
Reduced development costs	XX	-	X	XX
Prioritisation of product features	XX	-	X	-
Less need for future redesign	-	-	X	-
XXX = The benefit is identified and well documented, concrete guidelines, examples etc XX = There is some discussion about the benefit, no concrete guidelines X = The benefit is identified - = The benefit is not identified				

Table 1. The extent to which usability cost-benefit models identify and document benefits for product development.

None of the analysed models takes into account the potentially different benefits depending on whether the product is tailored or mass-produced. It would be interesting to see whether there are some differences in estimating the benefits of better usability when the product is tailored or mass-produced. It is known that different requirements and principles are applied for developing tailored

products and mass products. Because none of the models under this study offer different analysis for these two approaches, it would be interesting to see the extent to which the usability benefits are different in these cases. One research study identified user-centred design as having a key role in differentiating product and human factors improvements (Harrison et al 1994, 223).

3.2 Benefits in the sales phase

Generally, the models identify two categories of usability benefits in the sales phase: gaining a competitive edge, and increased customer satisfaction. It is very difficult to estimate the impact of better usability on product sales. However, there are some reported cases, where a link between better usability and increased sales can be established. In one reported case, the revenues grew by 80% when the most serious usability problems were fixed in the second release of a product (Wixon, Jones, 1991). Poor usability may have a serious effect on a company's reputation and market share, especially when the market is tightly controlled (Mauro 1994, 136). Also, product development usability can speed up a product's market introduction and acceptance (Conklin, 1991).

The benefits of gaining a competitive edge by claiming a product as easier to use than other products is identified and discussed in all models (table 2). Ehrlich & Rohn have a detailed discussion about this benefit and Mayhew & Mantei have an example calculation where the number of systems sold due to enhanced usability is multiplied with the profit margin per product.

Increased customer satisfaction can result in more repeat customers and therefore increased sales. Ehrlich & Rohn and Bevan identify the benefits of customer satisfaction and have descriptive discussion about the benefit. Ehrlich & Rohn estimate that satisfied customers influence four other people to buy the same brand and dissatisfied customers influence ten other people to avoid the brand. Karat and Mayhew & Mantei do not identify this benefit explicitly.

Benefit category	Ehrlich & Rohn	Karat	Bevan	Mayhew & Mantei
Gaining a competitive edge	XX	XX	XX	XX
Increased customer satisfaction	XX	-	XX	-
XXX = The benefit is identified and well documented, concrete guidelines, examples etc XX = There is some discussion about the benefit, no concrete guidelines X = The benefit is identified - = The benefit is not identified				

Table 2. *The extent to which usability cost-benefit models identify and document benefits for marketing and sales.*

One observation is that none of the analysed models take into account the benefits of better usability in terms of sales depending on whether the product is as a business-to-business or a business-to-consumer product. None of the models discusses this although it could be possible that there may be differences in estimating the benefits of better usability in the case of business-to-business products vs. business-to-consumer products.

3.3 Benefits in the introduction phase

There are two categories of usability benefits for product support: a reduced cost of product support and less need for end user training. The difference in training time between a usability-engineered system and a system designed without usability engineering can be as much as several days (Karat 1993). Training the end user includes official training conducted by the development organization or a customer organization and unofficial training by skilled peers.

Ehrlich & Rohn, Bevan, and Mayhew & Mantei identify and discuss the reduced cost of product support and less about the need for end user training to some extent. Karat identifies the reduced cost of product support as a potential benefit but does not provide further discussion or examples on it. Karat does not identify the reduced cost of end user training as a potential benefit (table 3).

Mayhew & Mantei, on the other hand, provide sample calculations for these benefits. To calculate the benefits in product support, they use the number of customers, reduced number of calls per year per customer, the length per call and the hourly wage of the customer support. To calculate the savings in end user training, they use the number of customers, number of training classes per customer, the length of training per class and the hourly wage of the trainer.

Benefit category	Ehrlich & Rohn	Karat	Bevan	Mayhew & Mantei
Reduced cost of product support	XX	X	XX	XXX
Reduced cost of end user training	X	-	XX	XXX
XXX = The benefit is identified and well documented, concrete guidelines, examples etc XX = There is some discussion about the benefit, no concrete guidelines X = The benefit is identified - = The benefit is not identified				

Table 3. *The extent to which usability cost-benefit models identify and document benefits for customer support.*

None of the analysed models suggest different approaches for estimating the benefits for customer support in different cases: whether the product is a product tailored for a particular customer or whether the product is mass produced as a shelf product. For example, a development organization may be more likely to provide customer support for users of a tailored product than when the product is sold in shrink-wrap off the shelf. It can also be argued that estimating the benefits of better usability is somewhat different when the customer is internal in a development organization or when the support is part of the business of the development organization.

3.4 Benefits in the daily use

Two categories of usability benefits are identified during a product's use: increased productivity and less need for end user support. The end user can benefit from higher productivity when the most frequent tasks take less time. It is estimated that productivity within the service sector would raise 4-9% annually if every product were designed for usability (Landauer, 1995). This benefit is also the most identified in literature according to the report of Jokela and Rajanen (2002). Productivity is increased when using more usable products through decreased task time, less rework and greater work satisfaction.

All models identify increased productivity as one benefit. Karat provides couple of examples how to calculate it. Some savings can be made if there is less need for active product support in a development or customer organization. Ehrlich & Rohn, Bevan and Mayhew & Mantei identify the lesser need for end user support as a potential benefit (table 4). According to Ehrlich & Rohn a product that is not easily used or well explained can reduce profits by millions of dollars if the company has a low profit margin or a large customer base. Mayhew & Mantei have an example about calculating the increased productivity but they do not give a concrete guideline and there is little discussion about this benefit in general. Karat has some discussion about this benefit and a very brief guideline. Ehrlich & Rohn identify the increased productivity as a possible benefit but there is no further discussion about it.

One possible benefit could be the indirect effect of better usability when its effect on a mission critical system reduces the problems of other systems using it. The analysed models do not, however, identify this benefit.

Benefit category	Ehrlich & Rohn	Karat	Bevan	Mayhew & Mantei
Increased productivity	X	XX	XX	XX
Less need for end user support	XX	-	X	XX
XXX = The benefit is identified and well documented, concrete guidelines, examples etc XX = There is some discussion about the benefit, no concrete guidelines X = The benefit is identified - = The benefit is not identified				

Table 4. *The extent to which usability cost-benefit models identify and document benefits for customers and end users.*

3.5 Costs

Two main categories of the usability costs in development phase can be identified: one-time costs and sustaining costs. The sustaining costs include cost of usability activities and cost of redesigning the prototype. Ehrlich & Rohn have detailed discussion about one-time costs and examples of sustaining cost but the cost of prototype redesign is not identified. The sustaining cost of usability activities is identified in all models. Mayhew & Mantei have some examples of calculating the sustaining cost of usability activities but there is no further discussion or guidelines about the calculations. Bevan mentions this benefit only briefly and makes a reference to Bias and Mayhew for further information. The sustaining cost of prototype redesign is identified by Karat. Mayhew & Mantei also identify that benefit and have a simple example calculation (table 5). None of the models identify the costs after the development phase.

	Ehrlich & Rohn	Karat	Bevan	Mayhew & Mantei
One time costs	XX	X	-	XX
Sustaining cost of usability activities	XX	X	X	XX
Sustaining cost of prototype redesign	-	X	-	XX
XXX = The benefit is identified and well documented, concrete guidelines, examples etc XX = There is some discussion about the benefit, no concrete guidelines X = The benefit is identified - = The benefit is not identified				

Table 5. *The extent to which usability cost-benefit models identify and document the costs.*

3.6 Summary

The results of the analysis show that the different models generally represent a significant contribution - they cover the benefits and costs at different phases of product lifecycle rather extensively. The results of the analysis show that the different models discuss the benefits at different level of coverage and details. The model of Bevan is probably the most covering one. However, it lacks details. Mayhew & Mantei, on the other hand, provide exact formula on calculating the benefits of some specific aspects but lack in discussion and concrete guidelines. Generally, however, the models provide general guidance but little details.

4 DISCUSSION

The analysed models have a slightly different approach for identifying, categorizing and assessing the benefits of usability. All the models addressed the increased sales of a more usable product as one of the benefits, but none of the models distinguish between these benefits for business to business and business to consumer products. Only Ehrlich & Rohn and Bevan include increased customer satisfaction as a potential business benefit. From all the analysed models, only Bevan identifies savings from a reduced cost of future redesign of the architecture by fixing usability problems for future versions of the product. An easier tailoring of the product through human-centred design as a potential benefit is not explicitly discussed in any of the models.

All the analysed models approach usability benefits through some sort of cost-benefit analysis. The identified benefits of better usability are measured against the estimated costs of usability activities. Every model analyses the costs and benefits of using user-centred design and not the overall benefits of better usability of the product.

Analysing the business benefits of better usability is not an easy task. Some of the potential benefits can be estimated quite easily. For example, the benefit of a lessened need of product support is rather straightforward to calculate. Some of the potential benefit areas are, however, quite abstract and therefore it is difficult to estimate those benefits. For example, it is very difficult to estimate what impact better usability has on improved company reputation, even when it is clear that poor usability hurts company reputation (Mauro 1994).

Some of the existing models also analyse the benefits of better usability from the end user's viewpoint. The potential benefits for end users are much more difficult to calculate than benefits for development or customer organizations. Also, the potential benefit areas for end users are harder to assess economically, even when there is a link between poor usability and higher rates of absenteeism, less job satisfaction and increased turnover (Schneider 1985). Some of the analysed models include increased work productivity as a benefit for end users. It can be argued that the benefits from increased productivity can be calculated more easily from the viewpoint of the customer organization.

In some existing usability cost-benefit models, the benefits are seen from the point of view of a starting development project. This approach does seem to be a bit problematic, because some of the potential benefits are clearly directed to a whole organization, and it may not be very useful to estimate those benefits from the point of view of a development project. For example, it is not very important to reduce support costs for a development project because they are not directly affected by the cost of product support. The models also have differences in who does the usability benefit analysis and what is the target group of the analysis (Rajanen 2002). When the potential usability benefits are analysed from an organizational point of view and the business type of the development organization is identified as a necessary variable in usability cost-benefit analysis, all possible benefits can be fully taken into account.

4.1 Limitations

There are some limitations to be taken into account when making conclusions about this report. First, the analysis is of interpretive nature, and is mainly based on analytical literature study by one of the authors. Carrying out cost-benefit analysis in a real situation would probably provide much more insight to the models. Second, the report does not cover systematically all usability cost-benefit models. Third, the analytical framework – examination of the models through different phases of product life-cycle – does not cover all potentially interesting aspects.

4.2 New research topics

There are some new research topics that were found during this research. First, one very interesting challenge is to identify the indirect effect of better usability when better usability in a mission critical system reduces problems in other systems using it. The analysed models do not identify such benefits, but when one of the authors discussed this with representatives of various development organizations it became possible that this kind of benefit could be identified in many cases.

Second, another interesting area for future research is to find formulas to measure the impact of better usability to development time and resources. The reduction of development time through better usability is reported in some case studies, but the analysed usability benefit models did not bring up any clear formula for calculating that impact.

Third, product support can be a profitable part of the business of a development organization. If the development organization can gain profit by providing product support for end users, the benefit of better usability in product support area is not that straightforward. The published literature does not contain example cases where product support is part of the business of a development organization.

Fourth, the best time for and conductor of a business benefit analysis are not quite clear. The analysis should be conducted before or during the early phases of a development project, because later it is difficult to include the usability activities into an already running project and the potential usability benefits for development are smaller. The analysis can be conducted either by a usability person, project member or organizational management. Each of them has a slightly different interest about usability and that can have some effect on the results. It can be argued that the best effect of introducing usability activities into a development project is achieved when the requirements for better usability are handed down to a development project by an organizational management.

Fifth, the business type of the development organisation and the product should be taken into account when estimating the costs and benefits of better usability. First, benefits of better usability for product development may be different when the product is tailored or mass-produced. Second, there can be differences in benefits of better usability when comparing between business-to-business (B2B) products and business-to-consumer (B2C) products. Third, the identified and calculated benefits of better usability could be different when the customer is internal in a development organization and when the support is part of the business of the development organization. The existing usability benefit models do not take the business type of the development organisation and the product into account. The business type could be used as a context dependent modifier when calculating a certain usability benefit. For example, the benefit of less need for product support could be given a higher benefit rating if the product is mass-produced rather than tailor made to a specific organisation.

5 CONCLUSIONS

There are few development organizations that have integrated usability activities as an integral part of their product development projects. One reason for this is that the benefits of better usability are not visible to the management. In this paper, the characteristics of selected published usability cost-benefit models were analysed. These models have somewhat different approaches for identifying, approaching and categorizing the benefits of usability. All of the analysed models approach usability benefits through a general cost-benefit estimation of user centred design, but none of the models provide concrete guidance for all aspects required in cost-benefit analysis. The authors propose that the business type of development organization or developed product as a variable could be taken into account when analysing the benefits of better usability.

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