Different Approaches to Usability Cost-Benefit Analysis

Mikko Rajanen
Department of Information Processing Science, University of Oulu, Finland
mikko.rajanen@oulu.fi

Abstract: There are few development organizations that have integrated usability activities as an integral part of their product development projects. One reason for this might be that the costs and benefits of usability activities are not visible to the management. In this paper the author analyses some of the characteristics of the published usability cost-benefit analysis models. These models have different approach for identifying the costs and benefits of usability and identifying the interest groups of the usability cost-benefit analysis. The models also vary in identifying the empirical research the models are based on.

Keywords: Usability, usability cost-benefit models

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 a few product development organizations reportedly having incorporated usability activities 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 fifty years ago (Ohnemus 1996, 46). 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).

This paper is a conceptual-analytical study based on literature reviews. The usability cost-benefit models can be and have been analysed from many different points of view (Rajanen & Jokela 2004, Rajanen 2003). The purpose of this paper is to categorise the usability cost-benefit analysis models based on their approach for the usability cost-benefit analysis and identifying the conductor of the analysis. This broad topic is approached through following research questions:

- How do the usability cost-benefit models approach the usability cost-benefit analysis?
- What kind of empirical background do the models identify and document?
- What interest groups do models indentify for usability cost-benefit analysis?

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.

The method has three steps and it proceeds as follows (Burrill and 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 project even when customers and end users identify the usability as important products attribute (Rajanen 2006). 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 is achieved if the benefits of better usability can be identified and calculated. Better usability can for example speed up the products market introduction and acceptance (Conklin 1991) and increase revenues (Wixon & Jones 1991). 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).

There are many 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. There has been some discussion in publications about the potential business benefits of usability, but most of them are focused on case studies of usability benefits or the overall aspects of usability cost-benefit analysis. In this research, the author analysed the differences and characteristics between some of the published usability cost-benefit models.

Calculating the cost of better usability is fairly straightforward if the necessary usability tasks are identified (Mayhew and Mantei 1994). The actual cost of usability can be divided into initial costs and sustaining costs (Ehrlich and Rohn 1994). How the usability cost-benefit models identify and calculate the costs is not discussed in this paper.

2. Overview of usability cost-benefit models

There are surprisingly few published models for analysing the benefits of usability in development organizations. Bias and Mayhew selected most of the existing usability benefit models analysed in this paper from the book Cost-Justifying Usability. This book was published in 1994, but it is still the best source of different usability cost-benefit models. The analysed models taken from *Cost-Justifying Usability* were selected for this report because they represent the overall variety of different views for usability benefit analysis.

Bevan and Donahue have published two of the latest usability cost-benefit analysis models. (Bevan 2000, Donahue 2001). These models were selected for this analysis because they have a slightly different point of view on different benefits of usability. The Bevan's model also estimates potential usability benefits in four different product life cycles while other analysed models do not have such a clear point of view about benefits in product life cycles.

2.1 Ehrlich and Rohn

Ehrlich and Rohn analyse the potential benefits of better usability from the point of the view of the Vendor Company, corporate customer and end user (Ehrlich and Rohn 1994). 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 and 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 and 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 a role usability has in the buying decision.

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 and 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 Bevan

Bevan estimated the potential benefits of better usability for an organization to be during 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.

2.3 Donahue

Donahue's usability cost-benefit analysis model (Donahue 2001) is based on the model of Mayhew & Mantei (Bias & Mayhew 1994). In this model the costs and benefits of better usability are analysed through costs for development organisation and benefits for customer organisation. According to Donahue the most important aspect of usability cost-benefit analysis is calculating the savings in development costs.

2.4 Karat

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

- Increased sales
- Increased user productivity
- Decreased personnel cost 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).

2.5 Mayhew and Mantei

Mayhew and Mantei 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 (Mayhew and Mantei 1994). 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:

- Increased sales
- Decreased customer support
- Making fewer changes in a late design life cycle
- 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.

3. The characteristics of usability cost-benefit models

Every model is compared against three categories to identify the different characteristics. The categories are based on the collection and categorisation of usability cost-benefit models and reported usability benefit cases from literature (Rajanen 2004, Rajanen 2003, Jokela and Rajanen 2002). These three categories are:

- The approach for usability cost-benefit analysis
- Empirical background behind the usability cost-benefit model
- Interest groups identified in the usability cost-benefit model

3.1 The approach of usability cost-benefit analysis

Two different categories of usability cost-benefit analysis are identified from the analysed usability cost-benefit models: user-centered design approach and usability task approach. From the analysed usability cost-benefit analysis models the models of Ehrlich & Rohn and Donahue have the user-centered design approach where the costs and benefits of user-centered design activities are identified. From the analysed usability cost-benefit analysis models the models of Ehrlich & Rohn, Bevan, Karat and Mayhew & Mantei have the usability task approach where costs and benefits of individual usability tasks are identified. The models of Ehrlich & Rohn and Bevan identify the need of analysing the costs and benefits of some of individual usability tasks in addition to user-centered design costs and benefits. Since the user-centered design can be done with wide variety of individual usability tasks it can be argued that the user-centered desing approach for usability cost-benefit analysis may be more comprehensive than the usability task approach. New usability cost-benefit models should therefore primarily have an user-centered design approach and maybe also identify some important usability tasks for cost-benefit analysis.

Table 1: The approach for usability cost-benefit analysis

	Ehrlich & Rohn	**Bevan**	**Donahue**	**Karat**	**Mayhew & Mantei**
Approach	UCD/UT	UCD/UT	UCD	UT	UT
UCD = User-centered design approach UT = Usability task approach					

3.2 The empirical background

User-centered design and usability activities are very down to earth and practical methods. Therefore the usability cost-benefit analysis model should have a strong empirical background (Mauro 2002).The usability cost-benefit models are based on empirical research or empirical research has been used to verify the model. The models vary in identifying the empirical background of the model. From the analysed usability cost-benefit analysis models only Karat documents all the empirical background of the model in detail. Ehrlich & Rohn and Mayhew & Mantei document some of the empirical background but not in the same amount of detail as Karat. Bevan and Donahue do not identify the empirical background of their models. New usability cost-benefit models should identify and document their strong empirical backgrounds fully.

Table 2: The empirical background behind the models

	Ehrlich & Rohn	Bevan	Donahue	Karat	Mayhew & Mantei
Identified empirical research	XX	-	-	XXX	XX
XXX = The model has a well identified empirical background XX = The model has an identified empirical background X = The model has an empirical background but the empirical research is not identified further - = The model does not mention empirical background of the model at all					

3.3 Interest groups

The usability cost-benefit analysis can have a different focus depending of the conductor and the target group of the analysis. 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 (Rajanen 2003). Therefore it can be argued that the usability cost-benefit analysis has more impact and results if the target group of the analysis is the organisational management. New usability cost-benefit models should therefore identify the organisational management as the primary target group for the cost-benefit analysis.

Table 3: The identified interest groups for usability cost-benefit analysis

	Ehrlich & Rohn	Bevan	Donahue	Karat	Mayhew & Mantei
Conductor of analysis	U	-	-	U	-
Target group of the analysis	O, P	P	-	O	O
U = Usability team member O = Organisational management P = Project management - = The mode does not identify the conductor or the target group					

4. Discussion

The analysed models have different approaches for identifying the costs and benefits of usability and identifying the interest groups of the usability cost-benefit analysis. The models also vary in identifying the empirical research the models are based on. Therefore, it can be assumed that they are built upon a different basis and that they are made to fit different specific purposes (Rajanen 2002). The models also have differences in who does the usability cost-benefit analysis and what is the target group of the analysis.

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 (Rajanen 2006, 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 (Rajanen 2006). 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 of the usability cost-benefit models, the benefits are seen from the point of view of a starting development project and identified by a member of usability team. 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 or usability team (Rajanen 2006). 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. When the usability cost-benefit analysis is done 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.

The author argues that 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 either 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.

4.1 Limitations

There are some limitations to be taken into account when making conclusions about this report. First, how the usability cost-benefit models identify and calculate the costs is not discussed in this paper when analysing the characteristics of the existing models.

Second, one important function of the usability benefit analysis is to gain management support for usability activities in development projects. This function was not included in this analysis.

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 the author discussed this with representatives of various development organizations it was clear 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, the existing models do not take into account that product support can be an important 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 the usability cost-benefit analysis is 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.

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 might be that the costs and benefits of usability activities are not visible to the management. In this paper the author analysed some of the characteristics of the published usability cost-benefit analysis models. The usability cost-benefit analysis models have two different approaches for identifying the costs and benefits of usability. Two of the models (Ehrlich & Rohn and Bevan) approach usability cost-benefit analysis through identifying the costs and benefits of user-centered design activities. Four of the models (Ehrlich & Rohn, Karat, Donahue and Mayhew & Mantei) approach usability cost-benefit analysis through identifying the costs and benefits of individual usability tasks.

The usability cost-benefit analysis models also vary in identifying the empirical research the models are based on. One of the models (Karat) identifies the empirical background of the model in detail. Two of the models (Ehrlich & Rohn and Mayhew & Mantei) identify some of the empirical background behind the models. Two of the models (Karat and Donahue) do not identify the empirical background behind the models. The usability cost-benefit models also vary in identifying the interest groups of the usability cost-benefit analysis. Two of the models (Ehrlich & Rohn and Karat) identify a member of the usability team as the conductor of the analysis. Three of the models (Bevan, Donahue and Mayhew & Mantei) do not identify the conductor of the analysis at all. Three of the models (Ehrlich & Rohn, Karat and Mayhew & Mantei) identify the organisational management as the target group of the usability cost-benefit analysis. Two of the models (Ehrlich & Rohn and Bevan) identify the project management as the target group of the usability cost-benefit analysis. One model (Donahue) does not identify the target group of the usability cost-benefit analysis.

References

Bevan, N. (2000) "Cost Benefit Analysis", [online], *TRUMP report*, September 2000. http://www.usability.serco.com/trump/methods/integration/costbenefits.htm

Bosert, J. (1991) "Quality Functional Deployment: A Practitioner's Approach", *ASQC Quality Press*, New York

Bulkeley, W. M. (1992), "Study finds hidden costs of computing", *The Wall Street Journal*, 2 Nov.

Burrill, C. and Ellsworth, L. (1980), *Modern Project Management: Foundations for Quality and Productiv*ity, Burrill-Ellsworth, New Jersey.

Conklin, P. (1991), "Bringing Usability Effectively into Product Development", In *Human Computer Interface Design*: Success Cases, Emerging Methods, and Real-World Context, Boulder, Co., July

Donahue, G. M. (2001), "Usability and the Bottom Line", *IEEE Software*, 18, 1, pp 31-37.

Ehrlich, K., Rohn, J. (1994), "Cost Justification of Usability Engineering: A Vendor's Perspective", In Bias, R., Mayhew, D. *Cost-Justifying Usability*, Academic Press, pp 73-110.

ISO 13407 (1999), "Human-centered design processes for interactive systems", *International standard*.

ISO/IEC 9126-1 (2001), "Software Engineering, Product quality, Part 1: Quality model", *International Standard*.

Jokela, T., Rajanen M. (2002), "Usability Business Benefits – literature review 2, v0.2", *KESSU Project Report*, University of Oulu, Oulu, Finland.

Karat, C-M. (1994), "A Business Case Approach to Usability Cost Justification" In Bias, R., Mayhew, D. *Cost-Justifying Usability*, Academic Press, pp 45-70.

Mauro, C. (1994) "Cost-Justifying Usability in a Contractor Company." In Bias, R., Mayhew, D. *Cost-Justifying Usability*. Academic Press. pp 123-142.

Mayhew, D., Mantei, M. (1994), "A Basic Framework for Cost-Justifying Usability Engineering", In Bias, R., Mayhew, D. *Cost-Justifying Usability*. Academic Press. 1994. pp 9-43.

Ohnemus, K. (1996) "Incorporating Human Factors in the System Development Life Cycle : Marketing and Management Approaches", *IPCC96*.

Rajanen M. (2002), "Assessing the Business Benefits of Usability in the Product Development Project - Analysing the Existing Models", *25th Information Systems Research Seminar In Scandinavia (IRIS25)*, Bautahøj, Denmark.

Rajanen, M. (2003), "Usability Cost-Benefit Models – Different Approaches to Usability Benefit Analysis", *26th Information Systems Research Seminar In Scandinavia (IRIS26)*, Haikko, Finland.

Rajanen, M., Jokela, T. (2004), "Analysis of Usability Cost-Benefit Models", *European Conference on Information Systems (ECIS2004),* Turku, Finland.

Rajanen, M. (2006), "Applying Usability Cost-Benefit Models to Nanotechnology Tools Development", TNT project report, Oulu, Finland.

Schneider, M. F. (1985), "Why ergonomics can no longer be ignored", *Office Administration and Automation*, vol. 46(7), pp 26-29.

Wixon, D., Jones, S. "Usability for fun and profit: A case study of the design of DEC RALLY version 2. " Internal report, Digital Equipment Corporation. 1991.