Pragmatic Approach to Cost Benefit Analysis of User Centered Design

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Abstract. User-centered design (UCD) is an effective method for understanding users' needs and improving usability. Introducing UCD to the existing development process increases new development activities, so it is important to analyze the cost benefits of UCD, but it is not clear how to measure the effectiveness of these benefits for actual projects in companies. It is not clear which analysis is more appropriate, quantitative or qualitative. We propose a pragmatic approach to analyzing the cost benefits of UCD. We analyzed the effectiveness of 22 projects in our company using this approach.

Keywords: UCD, cost benefit, quantitative analysis, qualitative analysis.

1 Introduction

User-centered design (UCD) is an effective method for understanding users' needs and improving usability. Introducing UCD to the existing development process increases new development activities, so it is important to analyze the cost benefits of UCD. Previous research clarified the cost benefits of UCD, such as a reduced need for resources, increased customer satisfaction, reduced product support cost, and increased productivity [1]. However, it is very difficult to measure the effectiveness of these benefits for actual projects in companies. Because it is not clear how to measure this, it is also not clear which analysis is more appropriate, quantitative or qualitative. We propose a pragmatic approach to analyzing the cost benefits of UCD.

2 Important Perspective for Cost Benefit Analysis

2.1 Clarifying Relationship between Activities and Benefits

(Hypothesis 1) Developers and managers generally do not know much about UCD activities. Therefore, it is necessary to clarify the activities, investment in UCD, and kinds of benefits. It is also important to clarify the relationship between activities and benefits, which is an input-output relationship. The benefits should be categorized as those for the customers and end users and those for the company. The following items should be clarified.

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<Activities>

1. What kinds of UCD activities did they do?
2. How much did the UCD activities cost?

<Benefits>

1. Who received the benefits from the UCD activities?
2. What kind of benefits did they obtain?

2.2 Combination of Quantitative Analysis and Qualitative Analysis

Quantitative analysis is important to clearly show the benefits of UCD and make developers and managers recognize the benefits. But not all benefits can be measured quantitatively, and numerical data on its own is not persuasive. Therefore, we think it is important to combine quantitative analysis and qualitative analysis.

(Hypothesis 2) It is difficult to measure and compare the development time and costs of real projects that used UCD and did not use it under the same conditions. Therefore, we think it is important to obtain estimates of development cost benefits.

(Hypothesis 3) We think it is important to make tentative benefit lists in advance and draw out developer's and customer's opinions that they are not aware of.

Quantitative Analysis

1.Benefits to development organization

- Increased sales volume and profits

This benefit is the most attractive for managers. The investment in UCD and the order amount or sales volume of the products can be shown as quantitative data. However, various factors aside from UCD activities contribute to receiving a lot of orders, so qualitative analysis such as interviews should be added.

- Reduced product development cost

Measuring the reduction in the development cost quantitatively is difficult because comparing using UCD and not using it is impossible for the same project. Therefore, we make developers estimate the reduction in the development cost by using UCD. We ask developers questions such as, "How much would the cost be in terms of development time and cost to obtain the same quality of output if you had not used UCD for the project?" and compare the estimate cost and real cost of the project. We also ask developers the reason for the difference. It is a combination of quantitative analysis and qualitative analysis.

- Improved quality of product

Usability is improved by executing UCD. The usability metrics are effectiveness, efficiency, and satisfaction. These metrics can be shown in user test experiments, for example, operation time and number of errors are measurable. Therefore, we can measure the part of benefits that improved product quality as quantitative data.

2. Benefit to user's organization and end users

- Improved operational efficiency

The reduction of operation time and number of errors improves the operational efficiency of the user's organization. The cost of operation can be simulated using the number of people involved in the operation, working hours, unit price, and the reduction of operation time and number of errors. Therefore we can measure the part of benefits that improved operational efficiency as quantitative data.

Qualitative Analysis

We ask project-related people such as developers, planers, UCD professionals, and users about the benefits for qualitative analysis. The contents of the hearing are contribution to receiving a lot of orders, actual feelings about development costs, or feelings of satisfaction about the system, but the project-related people are often not thoroughly aware of the benefit. It is important to make tentative benefit lists in advance and draw out developer's and customer's opinions that they are not aware of by using tentative benefit lists. We selected the benefit items related to IT solutions that are related to our company's area and made specific tentative benefits for every item. The contents of quantitative and qualitative analysis are shown in Table1.

Table 1. Quantitative and qualitative analysis

Benefits		Quantitative analysis	Qualitative analysis
Benefits to development organization	Increased sales volume and profits	Order amount or sales volume	Contribution to successfully receiving orders
	Reduced product development cost	Reduction of development cost (estimated value)	Actual feelings about development costs
	Improved quality of product	Operation time or number of errors	Actual feelings of satisfaction about system
Benefits to user's organization and end users	Improved operational efficiency	Business efficiency (simulated value)	Actual feelings of satisfaction about system and job

3 Proposed Method of Measuring Cost Benefit

3.1 Making Case Sheet and Hearing

This proposal is related to hypothesis 1. To clarify the relationship between activities and benefits, we propose making a case sheet and hearing. In this method, first UCD professionals write what kinds of UCD activities, processes, and tentative benefits occur in their project on a case sheet. It can clarify the activities. Next, a cost benefit

analyst and project- related people such as developers, planers, and UCD professionals share information on the UCD activities and processes using the case sheet, and then a cost benefit analysts asks project related people about the benefit of each UCD activity and process. This can clarify the relationship between activities and benefits.

3.2 Obtaining Estimates About Development Cost

This proposal is related to hypothesis 2. To clarify quantitative data about the reduction in development cost, we propose obtaining estimates. In this method, first a cost benefit analyst asks developers about what development process proceeds smoothly by using UCD compared to not using UCD and then asks about the development time and cost of the relevant development process in some past projects not using UCD. The past projects are simulated ones that require the same output quality. This data consist of estimates. The development process is broken down from the UCD process in order to make estimates close to the correct data. Therefore,. Examples of questions are shown below.

<Examples of questions for quantitative analysis>
Q: What items did you have success with when using UCD?

1. Creating concrete usage scenarios
2. Creating ideas
3. Creating concepts
4. Extracting and organizing customer's needs
5. Setting persona
6. Specifying the context of use
7. Evaluating usability problems
8. Making prototypes
9. Creating UI guidelines, patterns, or templates (software)
10. Creating mockups (hardware)
11. Complying with standards such as accessibility

Q: How much would the cost of the items you checked be if you did not use UCD?

- man-hours ( )
- costs ( )
- Impossible if UCD is not used

3.3 Making Tentative Benefit Lists

This proposal is related to hypothesis 3. To draw out the developer's and customer's opinions that they are not aware of, we propose making tentative benefit lists in advance. We referred to some previous research [1-6] and discussed the benefits of UCD that were shown in our company's past projects. We selected the benefit items

that were related to IT solutions as shown in Table1, and then wrote down the specific benefits for every benefit item. We asked relevant people in the project which benefit lists apply to their project. Examples of questions are shown below.

<Examples of questions for qualitative analysis>
(1)Benefits to development organization
Q: What benefit did you obtain in your project?
i) Increased sales volume and profits

- Proposal support
  E.g. you can meet mandatory requirements such as Section 508 of the US Rehabilitation Act.
- Customer satisfaction
  E.g. you can obtain some positive comments from customers.

ii) Reduced cost in product development

- Drawing out latent user needs
  E.g. you can draw out customer's needs that they are not aware of.
- Reducing agreement process
  E.g. you can adjust opinions and agree goals smoothly among developers.
  E.g. you can adjust opinions and agree goals smoothly with customers.
- Reducing development cost by making standards
  E.g. you can reduce the burden of development by using UI standards.
- Improving developer's motivation
  E.g. you can be motivated to develop functions since you can understand usage situation and need for these functions.
- Reducing backtracking
  E.g. you can reduce serious risks of demanding design changes at last phase because prototype images were agreed with customers.

iii) Improved quality of product

- Differentiation
  E.g. you can create appealing and unique concepts.
- Brand
  E.g. you can create consistent UI.
  E.g. you can create consistent appearance design.
- Usability
  E.g. you can improve usability, and learnability of your products.
  E.g. you can improve usability, and efficiency of your products.
  E.g. you can improve usability, and memorability of your products.
  E.g. you can improve usability, and reduce errors of your products.
  E.g. you can improve usability, and satisfaction of your products.

(2)Benefit to user's organization and end users
Q: What benefits did customers obtain?
i) Improved operational efficiency

- end user's operational efficiency
  E.g. users (end users) can reduce working time.
  E.g. users can reduce learning time.
  E.g. users can reduce number of errors.
- end user's satisfaction
  E.g. users increase job satisfaction.
- user's organization's efficiency
  E.g. user's organization can reduce training costs.
  E.g. user's organization can hire lower-level staff.
  E.g. end user's organization can decrease maintenance costs and inquiries.
- user's organization's satisfaction
  E.g. brand image of user's company is improved by usability or design.

4 Analyzing Actual Projects

4.1 Applied Projects

We analyzed the effectiveness of 22 projects that executed UCD in our company using this approach. The 22 projects were selected from various development processes, and UCD seemed to be effective in these projects. Some projects were selected from the upper phase such as system proposal or product planning, and some projects were selected from the requirement definition phase or development phase. The types of products were selected in accordance with our company's business domain, software, hardware, or IT solutions.

4.2 Procedures

The cost benefits of 22 projects were measured following orders as shown in Fig. 1. First, UCD professionals and cost benefit analysts made a case sheet as shown in Fig.2 in advance. The case sheets include: 1) abstract, 2) purpose of applying UCD, 3) list of UCD processes and related member's role, 4) activities of each UCD process, 5) benefits to user's organization and end users, 6) benefits to development organization, 7) cost and schedule of UCD. The purpose and activities were written in accordance with actual projects. Benefits were written by referring to the benefit list as shown in 3.3, and benefits were also written by referring comments of developers or customers provisionally. The cost and schedule of UCD were written to estimate which UCD costs is worth bearing.

User evaluation experiments were executed for some projects in advance. User interfaces were improved in these projects. The operation time and number of errors before improvement and after improvement were compared in these experiments. The reduction of operational time and cost a year were simulated by using them. We wrote down the reduction data as benefits to the user's organization and end users on a case-sheet.

Next, the UCD professional and cost benefit analysts interviewed project-related persons using the case sheet. Project-related persons mean developers or planners who are in charge of UCD in the development division, and project managers who are person in charge of budget control and progress management.

In the interview, first cost benefit analysts explained the purpose of the interview and confirmed the contents of 1) abstract, and 2) purpose of applying UCD on the case sheet to project-related persons.

Second, the UCD professional explained and confirmed 3) list of UCD processes and related member's role and 4) activities of each UCD process on the case sheet to project related persons. They also asked developers planners, or project managers how they felt about UCD and the different and advanced points of UCD compared to the traditional development process. We could collect the benefits related activities, because we confirmed their UCD activities and asked about the benefits of each activity.

Third, cost benefit analysts confirmed 6) benefits to development organization that were written provisionally to project-related persons, UCD professionals and then corrected the benefits reflected in the early part of the interview under participants' agreement.

For the last part of the interview, cost benefit analysts asked about benefits to project related persons using a questionnaire. The questions in 3.2 and 3.3 were collected in the questionnaire as shown in Fig. 3. Cost benefit analysts asked each question, and if the answer for the question had been determined before, analysts wrote the answers themselves. They asked the rest of the questions and discussed the benefits related to the questions. Before the questions for quantitative analysis, the analysts explained the intention of the questions, which is these questions should be answered in their heads, and it should be assumed the project requires the same output quality as the past project. If the project related persons did not know the numerical value in the interview, these data were supplied later.

The interview took about two hours. The participants were 1-4 developers, planners or project managers, 1-2 UCD professionals, and 1-4 UCD analysts. Case sheets were refined by the result of interview, and they were outputs for cost benefit analysis.

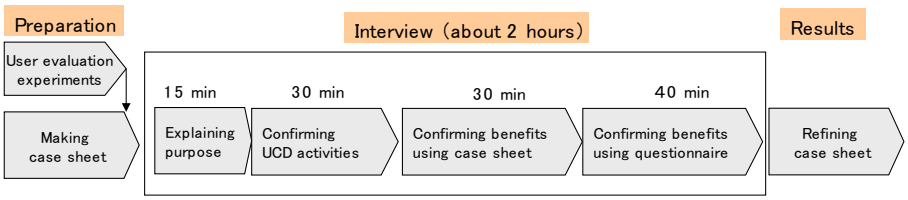

Fig. 1. Procedure for analyzing cost benefits

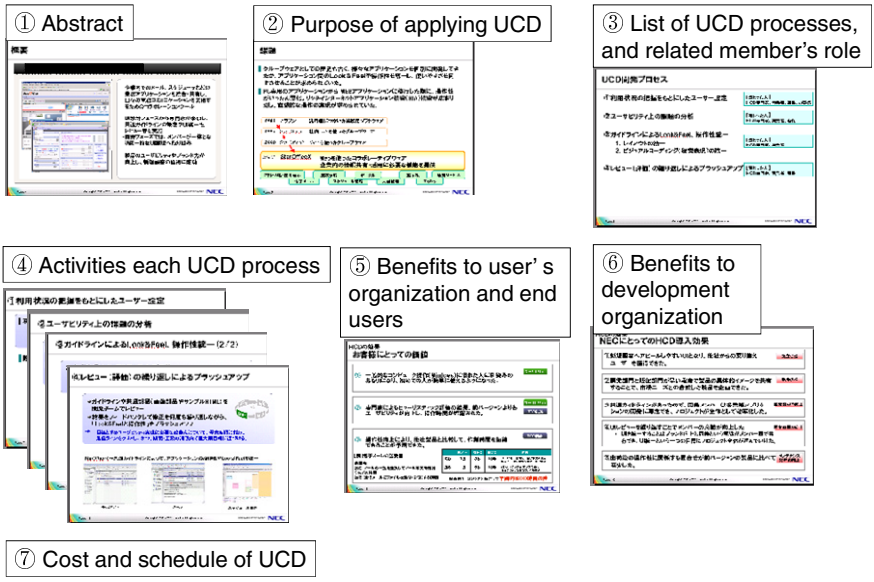

Fig. 2. Example of case-sheet

What benefit did you obtain in your project?

◆ Drawing out latent user needs	Answer	Apply
No.11. You can draw out latent customer's needs that they are not aware of.	☐Yes ☐No	☐Yes ☐No
◆ Reducing the agreement process	Answer	Apply
No.12. You can adjust opinions and agree goals smoothly with customers.	☐Yes ☐No	☐Yes ☐No
No.13. You can adjust opinions and agree goals smoothly among developers, project-related member's role ( )	☐Yes ☐No	☐Yes ☐No
◆ Reducing development cost by making standards	Answer	Apply
No.14. You can reduce the burden of development by using UI standards.	☐Yes ☐No	☐Yes ☐No
◆ Improving developer's motivation	Answer	Apply
No.15. You can be motivated to develop functions since you can understand usage situation and need for these functions.	☐Yes ☐No	☐Yes ☐No
◆ Reducing backtracking	Answer	Apply
No.16. You can reduce serious risks of demanding for design changes at last phase, because prototype images were agreed with customers.	☐Yes ☐No	☐Yes ☐No

Fig. 3. Questionnaire sheet

5 Results and Discussion

We clarified the benefits of UCD for 22 projects. We wrote down several benefits for the user's organization and end users and several benefits for the development organization of each project. Typical benefits that we obtained are shown below. Some concrete numerical data is hidden because it is confidential.

- Increased sales volume and profits
  In one project, which was a system proposal, UCD methods such as observation were used, and then the problems of the end-user's perspective were found. UCD professionals and planners in our company proposed a concept about their customer's facilities and system. Because the concept was a proposal to increase the customer's business value, our company could receive an order. The customer's present system was built by other companies, so the competition was challenging but we won. We wrote the order amount as quantitative benefits and the customer's comments in which they recognize the concept made by UCD activities as qualitative benefits.
- Reduced cost in product development
  In one project which was a user interface development for a major system renewal, UCD methods such as visualization for organizing customer's demand were used. The product development cost was reduced about the cost that 10 people worked for 2~3 months. This number was estimated by developers of this project. We found the developers felt the benefit of reduced cost in development very much.
- Improved quality of product and operational efficiency
  In one project, the user interface of one application was improved by unifying with some other applications and operating it intuitively. The operation time of sending and organizing e-mails of the application was expected to decrease by 8 seconds by our experiment. If 1000 people operate this application, the working time would be decreased by about 800 hours a year in the user's organization. We wrote the reduction of working time for business efficiency as quantitative benefits for the user's organization.

Our proposed method for measuring the benefits of UCD is effective as below.

- Benefits related to UCD activities are very persuasive to developers or managers.
- We could obtain some numerical data on reducing product development cost.
- UCD professionals could describe the benefits that they were not aware by using the questionnaire. We could also obtain various benefits from developers, planners, or project managers through the interview and questionnaire. This approach is effective for thoroughly obtaining benefits.

6 Conclusion

We proposed a pragmatic approach to analyzing the cost benefits of UCD. Our method is the combination of quantitative analysis and qualitative analysis. We described the procedures and results of applying this method to 22 projects in our company. We will study the difference in cost benefits and methods among various types of products in the future.

References

1. Rajanen, M.: Usability Cost-benefit models – Different Approach to Usability Benefit Analysis. In: Proceedings of 26th Information System Research Seminar In Scandinavia (IRIS26), Haikko, Finland
2. Ehrlich, K., Rohn, J.: Cost Justification of Usability Engineering: A Vendor's Perspective. In: Bias, R., Mayhew, D. (eds.) Cost-Justifying Usability, pp. 73–110. Academic Press (1994)
3. Bevan, N.: Cost Benefit Analysis TRUMP report (September 2000)
4. Karat, C.-M.: Cost benefit and business case analysis of usability engineering. In: Tutorial presented at the ACM SIGCHI Conference on Human Factors in Computing Systems, New Orleans, LA, April 28-May 2 (1993)
5. Mayhew, D., Mantei, M.: A Basic Framework for Cost-Justifying Usability Engineering. In: Bias, R., Mayhew, D. (eds.) Cost-Justifying Usability, pp. 9–43. Academic Press (1994)
6. Harrison, M., Henneman, R., Blatt, L.: Design of a Human Factors Cost-Justification Tool. In: Bias, R., Mayhew, D. (eds.) Cost-Justifying Usability, pp. 203–241. Academic Press (1994)