



INFORMATION TECHNOLOGY  
RESEARCH INSTITUTE

**SOFTWARE MODERNIZATIONS –  
A QUALITATIVE ANALYSIS OF  
INDUSTRIAL DECISION MAKING**  
**ELTIS-project**

---

Version: 1.1

Authors: Heikki Lintinen, Jussi  
Koskinen, Jarmo Ahonen,  
Henna Sivula, Tero Tilus

Classification: Public

Date: 2004-06-15

Status: Final

# CONTENTS

<b>ABSTRACT .....</b>	<b>1</b>
<b>1 INTRODUCTION .....</b>	<b>2</b>
<b>2 RESEARCH METHOD .....</b>	<b>4</b>
2.1 PREPARATION AND QUESTIONNAIRE .....	4
2.2 THE SAMPLE.....	4
2.3 DATA GATHERING – SEMISTRUCTURED INTERVIEW.....	4
2.4 TRANSCRIPTION .....	5
2.5 CODING (I.E. INDEXING) .....	5
2.6 ANALYSIS .....	5
<b>3 GATHERED DATA .....</b>	<b>6</b>
3.1 CHARACTERISTICS OF THE INTERVIEWEES .....	6
3.1.1 Experience .....	6
3.1.2 Responsibilities in decision-making .....	6
3.2 MODERNIZATIONS.....	7
3.3 THE CURRENT STATE OF MODERNIZATION DECISIONS .....	7
3.4 DECISION CRITERIA .....	13
3.5 QUESTIONS REGARDING THE INTERVIEW.....	13
<b>4 DISCUSSION .....</b>	<b>14</b>
4.1 LIMITATIONS AND WEAKNESSES .....	14
4.2 FURTHER STUDY .....	15
<b>5 CONCLUSIONS .....</b>	<b>16</b>
<b>BIBLIOGRAPHY .....</b>	<b>17</b>
<b>APPENDIX 1 .....</b>	<b>18</b>
<b>APPENDIX 2 .....</b>	<b>20</b>

## **ABSTRACT**

This report describes the results of an interview study carried out in ELTIS project at the Information Technology Research Institute. The goal of the study was to find out different characteristics currently present in software modernization decision-making. For this study 29 persons were interviewed from both software vendor organizations and their client organizations. The interviewees were mostly upper or middle management and responsible either for the modernization decision or for the argumentation behind the decision.

Expert judgment or intuition is a significant factor affecting modernization decision-making. There are very few tools available for modernization decision support that decision-makers would be aware of. In practice the decision is almost always a group decision to some extent even though officially one person were responsible for it.

The most important factor in modernization decision-making is the so-called “imperative factor”, an unavoidable situation, which arises from e.g. changes in legislation or technology platform becoming obsolete. On the software vendors’ side the most influential factors in modernization decision-making are costs, business operations, system usability and technical factors. On the clients’ side the most influential factors are costs, business operations and system usability.

Costs are an important argument and they are calculated to a very large extent but the estimations are in some cases consciously overly optimistic. Part of the interviewees expressed extensive interest in quantification of possible benefits but no tools or methods existed for such quantification.

## 1 INTRODUCTION

Software maintenance is the most expensive phase in software lifecycle. Maintenance costs to software supplier are more than 50% of programs' lifetime costs. Proportional software maintenance costs for its supplier are presented in literature as shown in Table 1.

Year	Proportion	Definition	Reference
2000	>90%	sw cost devoted to system maintenance & evolution / total sw costs	Erlikh (2000)
1993	75%	sw maintenance / information system budget (in Fortune 1000 companies)	Eastwood (1993)
1990	>90%	sw cost devoted to system maintenance & evolution / total software costs	Moad (1990)
1990	60-70%	sw maintenance / total management information systems (MIS) operating budgets	Huff (1990)
1988	60-70%	sw maintenance / total management information systems (MIS) operating budgets	Port (1988)
1984	65-75%	Effort spent on software maintenance / total available sw engineering effort.	McKee (1984)
1981	>50%	Staff time spent on maintenance / total time (in 487 organizations)	Lientz & Swanson (1981)
1979	67%	Maintenance costs / total sw costs	Zelkowitz <i>et al.</i> (1979)

Table 1. Software maintenance costs.

Many legacy systems contain vital information and business logic of organizations. They have been great investments and extending their lifetime may be desirable instead of complete rewrite. (Koskinen & Ahonen, 2003b)

Modernizations carry a great risk and the argumentation for modernization decisions has to be solid in order to convince the decision maker of the benefits of modernization. This is a huge challenge because the software suppliers and clients sometimes have different notions on several aspects of modernizations (Koskinen & Ahonen, 2003b).

In general the purpose of this study was to find out different aspects of software modernization decision-making. In more detail the primary goal in this study was to find answers to the following questions:

1. Who is responsible for modernization decisions?
2. What is the modernization decision process?
3. What is the argumentation behind modernization decisions?
4. What tools are used for decision support?
5. What are the most influential factors in modernization decisions?

This study was conducted in the ELTIS (Extending the LifeTime of Information Systems) project at the Information Technology Research Institute. ELTIS is a research project funded by TEKES (National Technology Agency of Finland) and Finnish software industry.

The data gathering for this study was done by a semistructured interview followed by a qualitative analysis of the data. The interviewees were mainly upper or middle level managers with years of experience in information technology, maintenance and modernizations.

This report consists of five chapters. In chapter 2 we describe the data gathering by interview and data processing. Later in chapter 3 we present the characteristics of the decision-makers and summarize the answers to each question. In chapter 4 we provide some discussion of the results and finally in chapter 5 we summarize the conclusions.

## 2 RESEARCH METHOD

The data was gathered by semistructured interviews. A qualitative analysis of the data followed. The interviews took place between August 25<sup>th</sup> 2003 and February 4<sup>th</sup> 2004.

### 2.1 Preparation and questionnaire

The questionnaire was created in an iterative process of finding relevant subjects from the literature (Koskinen, 2003a) and other sources (e.g. industrial partners), reviewing the questionnaire internally within the project group, reflecting the preliminary formulations to our goals and editorial work. Test-interviews were made to practise and standardize interviewing technique and to ensure that the planned length of the interviews was realistic. While planning the interview the goals were: 1) finding answers to the most relevant questions of modernization decision-making, 2) learning about new emergent aspects of software modernization and 3) keeping the duration of the interview within one hour. However, if the interviewee had no time restrictions, more time could be spent on finding the answers.

On some questions a numerical rating on a scale of 4 to 10 was required in addition to detailed explanation. The scale of these “to what extent”-questions was chosen to be the same as the grading system in Finnish comprehensive school. This choice was made because of the project group’s assumption that this rating system would be the most familiar to the interviewees.

The questionnaire used in the study is shown in APPENDIX 1.

### 2.2 The sample

We chose to use the so called “snowball sampling” which is a commonly used method in qualitative research. “Snowball” starts with a core set of interviewees who are asked to name the best people to answer these questions. The named persons are contacted and with their permission, interviewed and so the “snowball” grows.

The contact persons of ELTIS-project’s partners were asked to find possible candidates for interviews. The interviewees had to be responsible for 1) the modernization, or 2) the argumentation of the modernization decision. Those candidates were used as the core of the “snowball”.

The strategy proved to be very successful and a large number of new potential interviewees were acquired and later interviewed. No one actually refused to be interviewed and only a few were not reached.

### 2.3 Data gathering – semistructured interview

At the beginning of the interview a short description of the project and the purpose of the interview were explained to the interviewee. Next some information about the interviewee was asked. The questionnaire for gathering the interviewee’s information is shown in APPENDIX 2.

The interview was planned to last approximately one hour. The time spent on the interview varied from half an hour to almost two hours. The average duration of an interview was one hour and four minutes.

To minimize the interviewer's influence on the interviewee, special attention was paid to asking the questions as they were written on the question form. This was especially important due to the fact that there were four different interviewers. This procedure was followed in most cases. The deviations from this were partly due to the same reason why a semistructured interview was chosen instead of a rigorously structured interview. There was a set of questions which needed to be answered but there also had to be a chance for additional specifying questions and discussion of other emerging subjects of interest.

Most of the deviation occurred during the last section of the interview. On one hand discussion on decision criteria was prone to rise emergent issues, on the other hand interviewers' use of examples varied.

## 2.4 Transcription

Each interview was audiotaped and transcribed in detail afterwards. Most of the transcription work was done by a research assistant apart from the interviewers. He had previous experience on transcribing. The interviewers also took part in the transcription process.

The required fidelity of transcription was assessed by cross-checking transcriptions of different transcribers. Capturing the interviewees' dialect, tempo and breaks exactly wasn't required since the language itself wasn't the subject of the research.

## 2.5 Coding (i.e. indexing)

The transcribed interviews were coded using Atlas.ti-software (version 4.3), which is a support tool for *grounded theory* (Glaser & Strauss, 1967) methods. Coding helps a great deal in organizing and analyzing a large data set (Seaman, 1999). Using Atlas.ti helped us to verify that each interpretation could be traced back to the original material and new emerging points of view could later be analyzed in more detail. The general and interviewee specific summaries for each question were also written in Atlas.ti as memos which were linked to the corresponding codes and quotations.

## 2.6 Analysis

The answer to each question was searched from the entire transcribed interview and not just from the point where the question was asked. This approach was very successful and a great deal of information was gained from the out-of-context answers of the interviewees. Each of us coded and analyzed a set of questions. That way we were able to balance the workload and still keep the internal coherence of interpretations regarding each question or issue. Due to the variation of interviewing styles and straying of topic in the last section of the interview the depth and point of view of the analysis of decision-making criteria was discussed during the analysis and changed several times towards more interpretation-neutral point of view.

### 3 GATHERED DATA

In this chapter we present general characteristics of the interviewees and the answers to individual questions regarding the modernization decision-making process. The questions were divided into three categories: modernizations, the current state of modernization decisions and factors affecting modernization decisions. The questions in the last category are discussed only briefly in this report.

Two additional questions regarding the relevance of the issues discussed in the interview were also asked.

#### 3.1 Characteristics of the interviewees

The number of interviewees was 29 of which 12 worked within software vendor organizations and 17 were client organizations' representatives. The youngest of the interviewees was 30 and the oldest 63. The average age was 48. The majority of the interviewees were upper or middle level managers. 13 of them were technical managers, others included customer managers (3), account managers (2), senior directors (2), directors (2), a team leader, a director of a day-care center, a key account manager, an application expert and an application consultant.

##### 3.1.1 Experience

Four of the interviewees did not have actual experience in information technology and their participation in the decision-making was related to substance only. Two interviewees had less than 10 years of experience, eleven of them had 10 to 20 years, 10 of them had 21 to 30 years and two persons had more than 30 years.

Experience in software maintenance was not restricted to programming only. It also included decision-making related to maintenance. Four of the interviewees had no experience in maintenance. Eight interviewees' experience was less than 10 years, 12 of them had 10 to 20 years of experience and four persons had more than 20 years. One interviewee had experience in maintenance decision-making but he was unable to say specifically how much.

Experience in modernizations included both decision-making and argumentation. Eight of the interviewees had less than 10 years of experience and nine of them had 10 to 20 years of experience. 12 of them could not specifically say the amount of experience in modernization decision-making.

##### 3.1.2 Responsibilities in decision-making

All the interviewees were responsible for 1) the modernization decision, 2) the argumentation for the modernization decision, or 3) the argumentation and the decision. The number of interviewees in these categories were 3, 16 and 10, respectively.

All of the vendor organizations' representatives and four of the clients' representatives were responsible for the argumentation only. Ten of the clients' representatives were responsible for both the argumentation and the decision and the rest were responsible for the decision only.

## 3.2 Modernizations

*Who decides on modernizations?*

The final decision is always made by the client who purchases the software or product. Software vendors may suggest different implementation methods or explain the benefits and disadvantages of various strategies. The final decision maker can be the client's steering group, individual manager, IT-management or some other expert group.

*To what extent is group decision-making used?*

With one exception the decision is always the result of cooperation to some extent. Even if the decision is officially made by a single individual, the preparatory work is usually made in various expert groups. These expert groups may include both clients' and vendors' representatives. One interviewee considered group decisions to be non-preferable and that group decisions are not made in their organization.

## 3.3 The current state of modernization decisions

*What is the current quality of modernization decisions?*

The numerical average of decision quality is 7,5 (n=24). In general the quality of modernization decisions is seen as average. Most of the interviewees give the quality a score of 7 or 8 with only a few scores below 7 and above 8.

Some interviewees argue that decisions are too much based on technical arguments or intuition.

*To what extent is the modernization decision-making process specified?*

In public administration the modernization decisions follow the minimal statutory rules of acquisition, but apart from that the decision process is not specified. Some organizations have vague guidelines which are used in decision-making. Some interviewees confuse decision process specifications with general software process specifications.

*To what extent are the specifications followed?*

The rules of acquisition are followed in public administration but since there are no other specifications for modernization decision process, they can not be followed. If some general guidelines exist, they are usually followed.

*Where do modernization initiatives come from?*

Modernization initiatives come from various sources. In public administration the most important source is legislation. Sometimes software vendors cease to maintain some system or technology platform becomes obsolete which creates a need for change. In these situations a change is inevitable.

Software vendors sometimes suggest technical changes. Business strategy or changes in business process or organization create the need for modifications in software. Initiatives also come from end-users but it varies greatly, how well these initiatives are taken into account.

*Where do the arguments for modernizations come from?*

As with initiatives, the arguments sometimes come from legislation, at least in public administration. Other sources for arguments are maintenance data and personnel, management, outside consultants, main users, system experts, preliminary investigations, analysts' reports, changes in business process and operative systems. The argumentation is usually done by various groups.

*Is sufficient time spent on decision-making?*

12 interviewees argue that sufficient time is spent on decisions and lack of time is not a problem. Some of them even think that too much time is wasted. The rest of the interviewees see some problems with the lack of time, except for one who doesn't give a coherent answer at all. Problems with time exist especially with changes in legislation. These changes often force to make hasty decisions when there isn't enough time to explore all the alternatives.

*To what extent is the modernization decision based on intuition?*

This is one of the most interesting questions in these interviews. When asked directly, without any hesitation eleven of the interviewees deny the use of intuition.

"I think such [decisions] are hardly done at all."

Yet in some other part of the interview three of them reveal that some decisions have no solid arguments behind them and the decision is solely based on feeling and experience.

"Sometimes, when you have to implement something in haste, you just decide that "let's do it that way" and there's no certainty of whether it's going to work. There's just good experience."

The majority (15) of the interviewees admit the use of intuition to some extent and four of these interviewees state that intuition plays a significant part in decision-making.

*To what extent are quantitative methods used to justify modernization decisions?*

Besides cost estimation quantitative methods are not very widely used at least not systematically. Various calculations are made, but they lack formality.

*What quantitative methods are used to justify modernization decisions?*

Cost estimation was mentioned by 23 subjects. The mentioned systematic methods were return-on-investment, total cost of ownership, capital investment appraisal, total cost estimate, payback period, scoring and operating expenses –calculation. From these methods payback period was the most commonly used (mentioned by eight subjects).

Other factors which were mentioned to be quantified included possible benefits, LOC, working hours, savings in person-workyears, improvement on efficiency, time savings and synergy benefit.

*To what extent previous modernization decisions have been based on formal calculation of return-on-investment (ROI)?*

Only three of the interviewees state that systematic calculation of ROI is used as an argument for decisions. Another three admit the use of ROI-calculation to some extent. Some of the interviewees state that ROI-calculation has been discussed in the organization but it has never been used as an argument in decisions. The majority admits directly that ROI-calculation has never been used in their organization (to their knowledge). Some interviewees admit that the calculation of ROI would be a strong argument in modernization decisions.

*To what extent the quantification of potential benefits has been possible in previous modernization decision cases?*

Vast majority of the interviewees (24) state that quantification of benefits is pursued, and  $\frac{3}{4}$  of them told that quantification had been possible, at least to some extent. Still many of the interviewees (12) had never seen either successful quantification or even a trial. Some of them (7) told that a list of potential benefits is the best they have seen to be actually achieved.

There seems to be a fine line between estimating and “fishing” the benefits of modernization (and the competing options). The pressure towards cost-benefit thinking brings out a clear drawback here. More than elicited, evaluated and quantified the benefits may be assumed or, in the worst case, even “pulled from the hat”.

“It just gotta be done.”

“You must consider and point them out [the benefits] with one way or another.”

*To what extent is there a need for the quantification of potential benefits of modernization?*

The decision makers clearly aim from listing the benefits towards quantitative evaluation. As previously pointed out, achieving it is not a matter-of-course. Pretty much all interviewees (26) recognize the need and nine of them gave it a very high grade (>9).

“Nothing is more valuable than to be able to justify the benefits of an investment.”

Only one of the interviewees argued that there is no actual need to quantify the benefits. Rationale was the precedence of the “imperative factor” (see “*Decision criteria*”, section 3.4).

Additionally a need was pointed out to analyze where the acquired benefits are spent. Will people do something productive during the time saved by streamlining the business process or do they just “lengthen coffee breaks”.

*To what extent the quantification of potential costs has been possible in previous modernization decision cases?*

Here the interviewees diverged a little. A few (3) stated that cost estimation has been possible only weakly (grade under 6). The majority (19) told that it has been possible to some extent (grade between 6 and 9) and the rest (7) gave it a high grade (over 9) and were generally very satisfied with the present situation of cost estimation. No particular

profile of high or low cost-quantification ability was found, which is a bit surprising. All the groups were pretty equally distributed between clients vs. vendors and private companies vs. public sector.

Information about the costs is clearly better accessible to decision makers than that of the benefits. Problems mostly arise from singular failures of the estimation and from the need to break down and classify the costs at a finegrained level. Estimating the costs of maintenance was mentioned.

*To what extent is there a need for the quantification of potential costs?*

Interviewees argue that budgeting and reserving resources necessitates the quantification of costs. The majority of them (17) give a high grade (over 9) to this need. Still two of the interviewees were satisfied with the present cost estimates to the extent that they stated that the need for the quantification of costs is fulfilled.

Two interviewees argued that there's no need to quantify the costs, because of the precedence of the "imperative factor".

Additionally there is a need for vendor to perceive the client's "internal" costs of the modernization undertaking.

*What kind of support do you need for modernization decision-making?*

The following needs were recognized by the interviewees

- General methodological support (7)
- Consultation of an expert or an expert group (6)
- Benefit estimation method (5)
- More information regarding the options in consideration (5)
- Nothing special, present situation is OK (4)
- Cost estimation method (3)
- Checklist of the "top things" to consider (3)
- General systematization of the process (3)
- Information on the lifetimes of technologies in consideration (2)
- Exchange of ideas and experiences between decision makers (1)
- Statistical information on the decisions made previously (1)

In general the needs of decision makers focus to various ways of systematizing the decision-making process and accessing new viewpoints and the expertise inside and outside the organization.

Surprisingly many (4) decision makers were completely satisfied with the present situation with the support they get. Opinions regarding consultants were highly polarized.

*What kind of tools are used in decision-making?*

The vast majority of the interviewees (25) did not mention any supporting tools. That leaves us only four who did. 14 of the interviewees stated clearly that there's no tool support for decision-making whatsoever. Instead of tools the interviewees usually gave a comprehensive list of sources of support. Spreadsheet, operative system and executive reporting systems were mentioned as the tool support for modernization decision-making.

*To what extent is there a need for decision support tools?*

Additional support for decision-making process and its systematization is clearly needed. The need is pointed out by the interviewees' answers to this and the two previous questions. Some of the interviewees stated that the need is high (grade over 9). Still majority (22) of the interviewees was unable to depict what the tool support for decision-making could be. The checklist was mentioned again.

*To what extent the correctness of the decision can be verified (in advance)?*

Frighteningly many (9) of the interviewees stated that verification was a "mission impossible". In those answers a great deal of cynicism towards decision-making process was detectable. Only one of the interviewees argued that the decision could be well verified (grade over 9).

The extent to what the correctness of the decision could be verified was seen by interviewees to be contingent on the quality of the decision-making process and the decision criteria used. If the criteria are not measurable (or in worst case are absent), the ability to verify the decision is greatly lowered.

Opinions at this point were in line with the answers given when earlier asked for the needed support. Decision-making is plagued by a lack of systematization, which complicates the verification of the correctness of the decision.

"It's the same as all other decision-making, solely based on emotion."

*In what ways the correctness of the decision can be verified (in advance)?*

The following issues were mentioned as possible ways to assess the correctness of the decision:

- material collected by experts (2),
- independent expert / consultant (5),
- forecasts of research institutes,
- pilot project (4),
- prototyping (2),
- table test,
- inspection,
- survey (3),
- risk analysis,
- cost-benefit analysis,
- elicitation of the effects of the decision,
- elicitation of potential problems,
- making vendors return directly depending on the result,
- selecting long-life technology (2),
- choosing sustainable vendor,
- checking vendor's references,
- avoiding new technologies.

Selection of ways to verify the correctness gives, especially on the client side, precedence to low-risk conservative decisions. This could reflect the confrontation between the client and the vendor. Proactivity in decision-making was emphasized, due to the known high cost of correcting mistakes after the decision has been made.

The following quote gives a pretty good general grasp of the situation with the verification of decisions.

“If I knew that I would have started up a consultancy.”

*To what extent the correctness of the decision can be confirmed (afterwards)?*

Vast majority (23) of the interviewees stated that the correctness could be confirmed at least to some extent and 8 of them even gave a high grade (over 9) to it. Only two of the interviewees actually stated that confirmation would be an important thing to do. However, immediately after telling that the confirmation could be possible, many of the interviewees (6) pointed out that it's not actually done and gave a multitude of reasons why it's bypassed. Most common of the reasons were the following

- It's not what one wants to do.
- There's no time to do that (which holds a slight contradiction to the answers on the previously asked question regarding time).
- There's no use analyzing the decision because it cannot be reversed.

This is quite natural due to the fact that people normally regard their actions more consistent and rational than they really are. So critical inspection of one's own actions introduces potentially very high cognitive dissonance<sup>1</sup> which people tend to avoid. The very same phenomenon drives one's mind to fabricate a “rational” reason for skipping the inspection to avoid the cognitive dissonance between the fact that one knows the inspection to be important and the fact that one wants to skip it.

*In what ways the correctness of the decision can be confirmed (afterwards)?*

The interviewees stated that the correctness of the decision can be confirmed by the following means:

- experiences gathered by using the new system (12),
- realization of the decision criteria (8),
- user feedback (7),
- user satisfaction (4),
- realization of the project plan (2),
- realization of the budget (2),
- comparison between the current situation and another situation in which a different decision was made (1),
- make an external body (quality assurance -team, steering group, ...) responsible for the confirmation (1).

---

<sup>1</sup> Cognitive dissonance is a psychological phenomenon which refers to the discomfort felt at a discrepancy between what one already knows or believes, and new information or interpretation.

### **3.4 Decision criteria**

*What are the most influential decision criteria affecting modernization decisions?*

The most influential factor in modernization decision is not actually a “factor” in the sense the word is commonly used, but more like a composite factor or family of factors. We call it the “imperative factor”, an unavoidable situation, which can arise for example from legislation or limited lifetime of technologies.

By restricting the review to answers, which were given in context without being prompted with examples the three most influential factors (leaving out the “imperative factor”) in modernization decision-making are costs (22), business operations (11) and system usability (10). When reviewing only customers’ answers, the list of criteria is the same, but from suppliers’ point of view also technology is included.

### **3.5 Questions regarding the interview**

*Did the preceding questions pay attention to relevant issues?*

Without exceptions the interviewees stated that the discussed issues were relevant. One interviewee stated that more emphasis should be put on measuring the benefit. Another wanted to focus more on factors initiating modernizations . One interviewee stated that even though the questions seemed relevant, she still wasn’t sure what their purpose was. One of the interviewees mentioned that it would be interesting to find out methods with which the existing systems could be more efficiently utilized in modernization projects.

*What points of view present in real life decision-making were disregarded?*

One interviewee stated that the long term relationship between the software vendor and the client should be emphasized. Another interviewee would have wanted to discuss more about the substance and procedures of his department in detail but we believe his expectations for the interview were a little fallacious.

## 4 DISCUSSION

When asked about the affect of intuition in decision-making some interviewees instantly replied that no decisions are made on the basis of intuition. Yet in some other context many of them revealed that intuition is used to some extent. Intuition is not necessarily a bad thing since expert judgment generally provides better estimates (for software maintenance and modernization effort) than even the best of the current modeling techniques (Jørgensen, 1995). Not admitting the existence of intuition behind a decision can cause problems in exploiting the data regarding previous decisions. Intuition is problematic also because it is not considered a solid argument. Because of this the decision-makers (or people behind the argumentation) have to come up with some “fake” arguments, preferably numbers, on which the decision can be based. (Parnas, 1998)

For the most part the basis for decision is expert judgment. In addition to a slight portion of history data it is usually the only support for the decision. History data does exist but its usability is weak in general. A few of the interviewees admitted that history data of previous decisions would be very useful.

To some extent the decision is always the result of cooperation even if the decision is officially made by a single individual. The interviewees were almost unanimous about this with one exception: one interviewee considered group decisions to be non-preferable and that they are never used in his organization. This could be due to the complexity of organizational group decision-making, see e.g. (March, 1981). Also another interviewee stated, that “not deciding often costs more than deciding”.

The problems in decision-making seem to be more or less related to non-systematic and narrow-viewed approach. Decision-makers were generally unsatisfied with the informal and non-systematic features of the decision-making process. And when speaking about the support the decision-makers wanted, the issue of viewpoints was brought up. The decision makers wish-list included a variety of means to provide different perspectives to the decision making.

So what is the best direction from here on? Since the modernization decision-making is dealing with very complex issues, creating a comprehensive “decision automaton” is practically impossible. So far the best estimates have been results of expert judgment, so supporting expert judgment is likely to be a good way to improve decision-making.

At this stage the decision makers should be provided with tools to systematize the process and means to widen the scope of thinking and to acquire new perspectives. The latter is likely to address the problem of fabricated arguments and balance the weighting between listed benefits. How the balance between “fishing” the benefits and bypassing the costs could be unbiased remains an open question.

### 4.1 Limitations and weaknesses

The interviewers’ influence on the interviewees is probably the highest concern in this study. The influence may concern the interview itself, where the interviewer can lead the subject or the influence may concern the interpretation of the answers and results. The influence on the interviewee was minimized by test interviews and cross-evaluation of different interviewers.

The influence of interview structure is also an issue of worry. How well different aspects of decision-making were taken into account? The literature was reviewed extensively for the important factors. The interviewees themselves, when asked, suggested that all the relevant issues were covered and no important points of view were disregarded.

## **4.2 Further study**

During the study some very interesting points have emerged from the data. The most interesting areas of further study are:

- Comparing the differences in the argumentation behind modernizations between software vendors and clients with a larger sample.
- Analyzing the data with even more different categories, e.g. categories based on experience and other characteristics of the decision makers.
- Another perspective to modernization could be obtained from actual modernization cases.
- Modeling the actual modernization decision-making process.
- Definition and classification of the criteria. There are two problems with the criteria: 1) the criteria are not clearly defined, and the decision-makers understand them differently, and 2) the criteria are on a different level of abstraction.
- Finding means to balance the arguments of decision so that they wouldn't be overemphasized or underemphasized.
- The weighting of different criteria by the decision makers. We are currently conducting this study and hope to publish some results soon.

## 5 CONCLUSIONS

This report describes the results of an interview study focusing on modernization decision-making. One should be careful making generalizations on the basis of this study, since the sample is not large.

The modernization decision-making process is not specified well in either the clients' or the software vendors' organizations. Some general guidelines exist in some of the organizations but usually decision processes progress case by case.

The most influential factor in modernization decision-making is the so-called "imperative factor", e.g. change in legislation or the ending of support for a technology platform. Besides the unavoidable situation the three most influential factors in modernization decision-making are costs, business operations and system usability. In the case of software vendors, technology is also a strong argument. Both the software vendor and the client require a stable and widely supported technology platform. Neither the software vendor nor the client is eager to adopt new technologies based on hype alone. The mutual trust between software vendor and client was also mentioned as an important factor affecting the decision.

Costs are an important argument behind modernization decisions. Costs are calculated to a very large extent but the estimations are in some cases overly optimistic. Both the vendors and the clients show extensive interest in calculating the possible benefits, but tools and methods for such calculations do not exist. The indirect costs from e.g. training and adoption of modernized system are usually disregarded.

Expert judgment plays a significant part in the decision-making process. Besides some history data there isn't many tools available for decision support and the interviewees did not miss any support tools or couldn't figure out what they could be.

The correctness of the decision could be evaluated with end-user feedback and by reflecting the results against the goals. The decision's economical correctness can be evaluated earlier than the technical correctness, which, in some cases, can be judged in few years time. The correctness of the decision should be evaluated by a third party, not the decision maker. The decision is not usually evaluated afterwards.

## BIBLIOGRAPHY

- Eastwood, A. (1993). "Firm fires shots at legacy systems". *Computing Canada* 19 (2), p. 17.
- Erlikh, L. (2000). "Leveraging legacy system dollars for E-business". (*IEEE*) *IT Pro*, May/June 2000, 17-23.
- Glaser, B. G., Strauss, A. L. (1967). *The Discovery of Grounded Theory: Strategies for Qualitative Research*. Aldine Publishing.
- Huff, S. (1990). "Information systems maintenance". *The Business Quarterly* 55, 30-32.
- Jørgensen, M. (1995). Experience with the Accuracy of Software Maintenance Task Effort Prediction Models. *IEEE Transactions on Software Engineering* 21 (8), 674 – 681.
- Koskinen, J. (2003a). *Bibliografia: ELTIS-projekti*. Information Technology Research Institute, University of Jyväskylä, 21 p.
- Koskinen, J., Ahonen, J. (2003b). *ELTIS (Extending the Lifetime of Information Systems): Estimation of Software Modernizations*. University of Jyväskylä, Information Technology Research Institute, ELTIS-project, Technical report, 8 p.
- Lientz, B.P. & Swanson, E. (1981). "Problems in application software maintenance". *Communications of the ACM* 24 (11), 763-769.
- McKee, J. (1984). "Maintenance as a function of design". *Proceedings of the AFIPS National Computer Conference*, 187-193.
- March, J. (1981). "Decision Making Perspective". In: *Perspectives on Organization Design and Behaviour*. van de Ven, A., Joyce, W. (eds.) John-Wiley, 205 – 244.
- Moad, J. (1990). "Maintaining the competitive edge". *Datamation* 61-62, 64, 66.
- Parnas, D. L. (1998). "Successful software engineering research". *ACM SIGSOFT Software Engineering Notes* 23 (3), 64 – 68.
- Port, O. (1988). "The software trap – automate or else". *Business Week* 3051 (9), 142-154.
- Seaman, C. B. (1999). Qualitative Methods in Empirical Studies of Software Engineering. *IEEE Transactions of Software Engineering* 25 (4), 557 – 572.
- Sommerville, I. (1996). *Software Engineering* (5<sup>th</sup> ed.). Addison-Wesley.
- Zelkowitz, M., Shaw, A. & Gannon, J. (1979). "*Principles of Software Engineering and Design*". Prentice-Hall.

## APPENDIX 1

### **Modernisointipäätökset**

#### **Yhteystiedot**

1. Vastaajan nimi
2. Vastaajan sähköpostiosoite

#### **Modernisoinnit**

3. Ketkä päättävät modernisoinnista?
4. Missä määrin modernisointipäätöksissä käytetään ryhmäpäätöksentekoa?

#### **Modernisointipäätösten teon nykytila**

5. Mikä on mielestänne modernisointipäätösten teon nykyinen laatutaso?
6. Missä määrin modernisointipäätösprosessi on ohjeistettu?
7. Missä määrin ohjeita käytännössä noudatetaan modernisointipäätöksiä tehtäessä?
8. Mistä modernisointialoitteet ovat peräisin?
9. Mistä päätöksien perusteet ovat peräisin?
10. Käytetäänkö päätöksentekoon riittävästi aikaa?
11. Missä määrin modernisointipäätökset tehdään perustuen intuitioon?
12. Missä määrin modernisointipäätösten perusteluun käytetään laskennallisia menetelmiä?
13. Mitä laskennallisia menetelmiä modernisointipäätösten perusteluun käytetään?
14. Missä määrin aiemmat modernisointipäätökset ovat perustuneet ROI:n muodolliseen määrittämiseen?
15. Missä määrin aiemmissa modernisointipäätöksissä on pystytty kvantifioimaan mahdollisia hyötyjä?
16. Missä määrin tähän olisi tarvetta?
17. Missä määrin aiemmissa modernisointipäätöksissä on pystytty kvantifioimaan mahdollisia kustannuksia?
18. Missä määrin tähän olisi tarvetta?
19. Minkätyyppistä tukea kaipaisit modernisointeja koskevaan päätöksentekoon?
20. Mitä valmiita tukivälineitä päätöksenteossa käytetään?
21. Missä määrin päätöksenteon tukivälineisiin olisi tarvetta?
22. Missä määrin modernisointipäätösten oikeellisuus voidaan mielestänne varmistaa?
23. Millä keinoin?
24. Missä määrin modernisointipäätösten oikeellisuus voidaan mielestänne tarkistaa?
25. Millä keinoin?

#### **Päätekijäluokat**

26. Mitkä ovat merkittävimmät tekijät modernisointipäätöstä tehtäessä? (esim. Muutostyön hinta, Ylläpitokustannukset, Uudelleenkirjoitettavuus, Strategiset/kilpailuetuun liittyvät tekijät, Lainsäädäntöön liittyvät tekijät, Tekniset tekijät, Hype, Käyttäjien muutosvastarinta, Käyttäjien tyytyväisyys nykyiseen järjestelmään)

27. Mitä ovat merkittävimmät strategiset/kilpailuetuun liittyvät tekijät? (esim. liiketoimintaympäristö, liiketoimintamallien/prosessien muutokset, yrityskauppa, fuusio, käytänteiden muuttuminen, imagokysymykset, ...)
28. Mitä ovat merkittävimmät lainsäädäntöön liittyvät tekijät? (esim. muutostiheys, tieto valmisteilla olevista säädöksistä, ...)
29. Mitä ovat merkittävimmät tekniset tekijät? (esim. järjestelmätuen loppuminen, uudet tekniset mahdollisuudet, kehityksen “aallonharjalle” pyrkiminen/siellä pysyminen, ...)
30. Laatuksiteerit: tehokkuus, virheettömyys, toimintojen monipuolisuus/hioutuneisuus, käytettävyys

## **APPENDIX 2**

### ***Vastaajan tiedot***

#### ***Yhteystiedot***

1. Etunimi
2. Sukunimi
3. Puhelinnumero
4. Sähköpostiosoite

#### ***Yleistiedot***

5. Ikä
6. Koulutus
7. Organisaatio
8. Yksikkö
9. Asema tai virkanimike
10. Pääasialliset työtehtävät

#### ***Kokemus***

11. Tietotekniikka-alan työkokemus (vuotta)
12. Työkokemus ohjelmistojen ylläpidosta (vuotta)
13. Oletteko vastuussa ylläpitoon liittyvistä päätöksistä tai niiden perustelusta?
14. Työkokemus ohjelmistojen modernisointipäätösten teosta (vuotta)
15. Oletteko vastuussa modernisointiin liittyvistä päätöksistä tai niiden perustelusta?