Methodology Choice and Adoption: Using the Diffusion of Innovations Theory (DOI) as the Theoretical Framework

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Abstract

This paper examines method adoption factors in three organisations and their three specific locales over a 43-year-period. The collected data covers the said 43 years, which were divided into four time periods, or phases, that are concurrent with the four computer generations, as described in Friedman and Cronford (1989). A conceptual framework is presented for method choice and adoption with the Rogers's (1995) theory of Diffusion of Innovations (DOI) as a focal point. Analysis is made in accordance with the DOI to identify factors affecting method choice. The results show that DOI characteristics (factors) groups have affected method choice and adoption, and factors specific to different methods explained why a certain method was chosen and adopted. Four method categories were created from the basic method definition in this study. In locale one and two the method categories were almost identical, but in locale three they were different. Phase one (late 1940s until the mid1960s) was different from phases two (mid 1960s to early 1980s), three (early 1980s to the beginning of 1990s) and four (from the beginning of 1990s) due to fewest number of attributes. DOI's innovation, task, individual and environmental characteristics groups in phases two to four were almost the same. In the organisational characteristics group, phases two and four were identical, and phase four did not exhibit some factors previously identified.

Keywords: Diffusion of Innovation, Field study, Empirical research, IS Development methods and tools, Adoption decision

BRT Keywords: DD0502, AIO108, AIO104, FC

Introduction

The paper presents a longitudinal empirical case study involving three different organisations and their three specific locales over a 43-year period to determine what factors as described in the DOI theory were relevant to adoption of a given methodological innovation within the organisation.

Previous research indicates a variety of factors being of importance in adoption of a technological innovation. Kwon and Zmud (1987, pp. 233-241) presented a DOI model. They found organisational characteristics to cover structural factors (specialisation, centralisation, formalisation, informal network); innovation characteristics to cover

technological factors (relative advantage, compatibility and complexity); individual characteristics to cover individual factors (job tenure, cosmopolitanism, education, role involvement); task characteristics to cover task uncertainty, autonomy, variety, responsibility (significance), identity; and feedback and environmental characteristics to cover heterogeneity, uncertainty, competition, concentration/dispersion and inter-organisational dependence. Prescott and Conger (1995, p. 22) enlarged Kwon and Zmud's (1987) DOI model by extending the innovation characteristics to include trialability and observatibility; individual characteristics to include willingness to take risks, motivation, and interested on subject).

Huff and Munro (Huff, Munro, 1985, p. 337) found employee curiosity, repetition factor, other organisations and vendors as possible factors to explain information gathering task in method adoption at the organisational level. Wolfe's (1994, p. 408) study supported Rogers's factors to explain diffusion of innovations: adopter characteristics, the social network to which the adopters belong, innovation attributes, environmental characteristics, the process by which an innovation is communicated and the characteristics of those who are promoting an innovation. March and Simon (1958, pp. 187-188) argued for communication between organisation members and group resource allocation to be important factors. Sauer and Lau (1997, p. 255) observed the business managers' role and influence of business pressures in the strategic environment to be important factors in the method adoption in the task level. Nilakanta and Scamell (1990, p. 24, p. 35) found different information sources (altogether five different major types) and channels of communication to affect method adoption. Fitzgerald (1997, pp. 208-210) found two relevant factors affecting methodology usage and non-usage. For non-usage of commercial methodologies he argues to be based on a position of knowledge, rather than ignorance. The factor concerning developer experience and methodology usage according to him is due to the fact that experienced developers do not object to methodological guidelines that make sense and they used a methodology if it was logical and made sense. Kozar (1989, pp. 77-78) studied if the three factors, the method itself, the organisation or project that is to adopt the method, and the personal characteristics of the individuals, who are potential adopters, are important in adoption of new system development methods. He argued for personal rewards and organisation sanctions to be most critical factors in use of a new method and he found out that personal characteristics of the individuals who are potential adopters were important factors in method adoption.

Our goal is to identify what factors affect system development method adoption in practice. The study is motivated by the fact that system development deploys different methods whilst new methods are suggested all the time. But how they are chosen and adopted is not known very well. We also know little about the factors, which affect method adoption and why the methods have been adopted. This research question is important, because a lot of money is invested in method use and development, but we know little about how people are using the methods, what factors, for example novelty or somebody knowing the method, affect use of methods. Currently we do not have any theoretical models to be used for explaining why given methods are adopted. And when do not have any models, we can not help people in managing method adoption. In this study both problems are addressed. We wanted to study empirically factors that effect why methods are adopted using DOI (Diffusion of Innovations theory) (Rogers, 1995) as a theoretical framework. Our general research problems were:

- What are the general factors affecting method adoption decisions.
- To what extent the method category and/or different locales affect what

factors are significant.

- To what extent the Roger' characteristics/factors change in time in adoption decisions.

The structure of the article is the following. We first represent the conceptual framework of the research, diffusion of innovations theory (DOI) and adoption decision model. Then the research problems, related research and research methodology are represented. The validity and reliability of the data is shown; case organisations and locales are briefly discussed; method categories and adoption decision-maker categories are presented. The way the data is adapted into the Adoption Decision Model is shown and analysed and the results of the analysis are discussed. The last paragraph presents the conclusions.

Conceptual Framework

We study factors that affect method adoption in organisations, in specific locales. Because of this the basic concepts are methods, adoption and locale.

> IEEE (1991, p. 13-14) defines methods as follows:
> "They specify the computing system(s), development methodology(s), team structure(s), programming language(s) and other notations, tools, techniques, and methods to be used to specify, design, build, test, integrate, document, deliver, modify or maintain or both (as appropriate) the project deliverables. In addition, technical standards, policies and procedures governing development or modification or both of the work products, and project deliverables shall be included, either directly or by reference to other document."

Accordingly methods are normative rules, which exist beforehand and state how the system work should be done. The definition we use covers tools, phase studies and notations. Because the definition is so general, phasing, programming methods, system design methods, strategic planning methods, "home-grown" or invented methods, project instructions, standards etc. are included in the definition.

The adoption decision is made normally in one or some organisational units or locales and because of this locale is defined as the adoption place. A single designer is also relevant because a designer in the organisations can make the decision to adopt a method.

According to Giddens (1984, p. 375) the term locale means "a physical region involved as part of the setting of interaction, having definite boundaries which help to concentrate interaction in one way or another".

In this paper the locale is defined as a certain physical environment, where people interact with each other and this affects people's thinking. In some circumstances it can be an organisation unit, in some cases several units, in some cases only a half of the unit, if the unit is distributed physically. We will define the locale as the unit, which has developed methods and used them.

According to Rogers the adaptation of an innovation is a process of social construction and adoption is the decision to use an innovation (1995, p. 389). How method adoption in locales occurs is described in figure 1. Figure 1 depicts relationships between method choice, the locale practice, for an individual method and locale, and the theoretical discourse of methods (the academic community, consultants, etc.) interacting with each other in time. The theoretical level offers several optional methods to be

discussed but the choice of a method occurs in locales. The theoretical discourse of methods and the locale practice interact with each other, and between them exist method transfer mechanisms. These can be education, communication channels, consulting practice, etc. There is also a feedback from locale practice to the theoretical discourse. These two levels, locale practice and theoretical discourse of methods both affect method adoption. In the theoretical discourse the academic community and consultants exchange views on what the methods actually are, how you could use them, etc. In the locale practice internal experience and learning can affect method choice. The internal experience and learning are experience based. According to Tolvanen (1998, p. 172) experience-based feedback occurs when developers face situations in which they feel that a constructed method is, or is not, applicable. If the method is considered inapplicable, they may rely on their experience more than on the use of the method. “A requirement to modify a method arises when the method does not meet the situational requirements. These requirements can be collected while adapting a method to a tool, while introducing a method into an organisation (adoption decision stage), or while using the method. The method modifications can also occur while selecting or constructing the method” (Tolvanen, 1998, p.172).

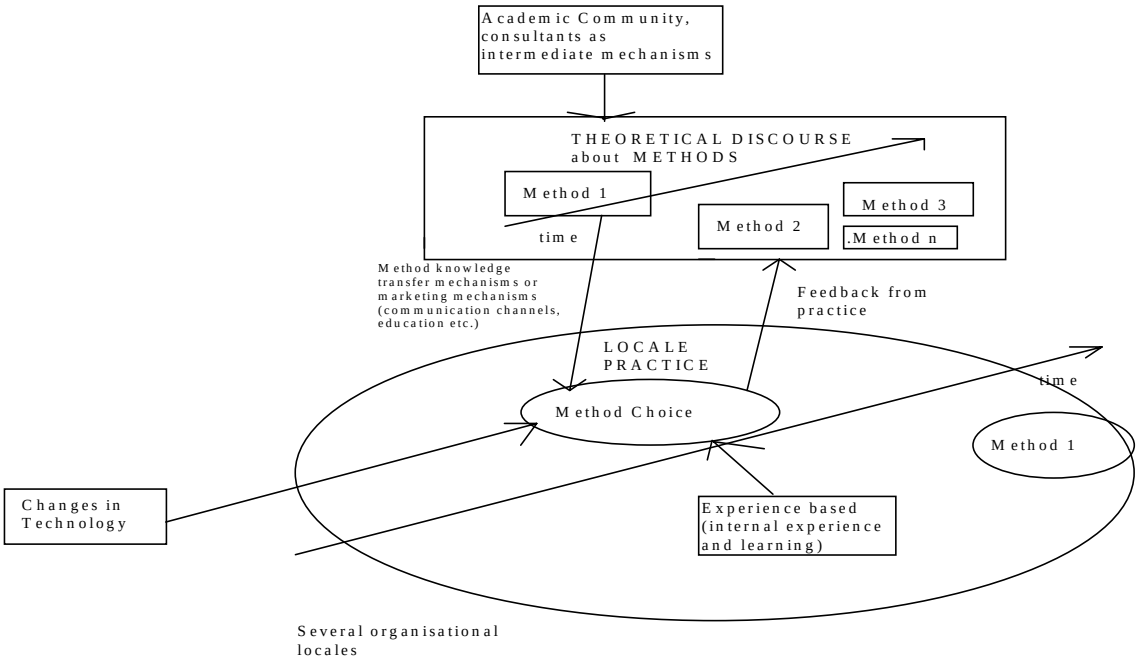

Figure 1: The theoretical framework of the research: method adoption in locales.

In figure 1 the method choice occurs in time and the drivers, which lead to method choice, are changes in technology, knowledge evolution, method marketing and evolution in local practice and theoretical discourse. Allison (1971, p. 30) defines the choice as “rational”: a choice, which consists simply of selecting that alternative whose consequences rank highest in the decision-maker’s payoff function. Allison (1971, p. 22) defines rational decision-making as a “logical assessment of desired goals and available means and as being implemented in a manner calculated to make the gains outweigh the costs”. Rogers`s (1995) theory of Diffusion of Innovations (DOI) is instrumental in explaining the factors leading to method choice in this context. Attewell (1992) suggests that knowledge or learning burden of end users must be innovated in developing novel institutional mechanisms. The innovations are a burden to “would-be adopters”, because

users must gain the knowledge to use an innovation to understand, implement and assimilate it. The mediating institutions, consulting and service firms, which are specialised in creating and accumulating technical know-how will help to lower the knowledge burden (Attewell, 1992). Fichman and Kemerer (1994) argue that new factors (sponsorship, standardisation, expectations, adopter heterogeneity, institutions for lowering knowledge barriers) are needed to understand the adoption and knowledge barriers.

Lyytinen and Robey (1998, pp. 6-7) argue that all ISD methodologies are theories-in-use and they are derived from absorbing both external and internal knowledge in a relatively uncontrolled and random fashion. Tolvanen (1998, p. 173) argues that experiences can lead to organisational knowledge if they are collected and shared in some way with other participants.

Friedman and Cronford's (1989) four phases, four computer generations, were chosen to divide the historical data into four phases. Friedman and Cronford`s division was chosen because it is so well established and concerns the system work. The first phase was from the late 1940s until the mid 1960s. It was called "hardware constraints". The second phase was from the mid 1960s until the early 1980s and was called "software problems constraints". The third phase was from the early 1980s and according Friedman & Cornford it is still continuing. The phase is called "user relationships constraints". The writers do mention the fourth phase, called "organisation environment constraints", but they do not give any detailed year for it. We suggest that the end of the third phase and the start of the fourth phase would fall at the end of the 1980s or the beginning of the 1990s. The reason for this separation is that EDI, etc. was first mentioned at that time and there are articles in Friedman & Cornford, which date from the end of the 1980s and the beginning of the 1990s (Friedman, Cornford, 1989). We do believe that no fatal mistake is made, if the end of the third phase and the start of the fourth phase are placed at the beginning of 1990s. The fourth phase can be considered as "still continuing". Our data covers the end of 1997.

Diffusion of Innovations Theory (DOI)

Methods can be treated as innovations and the diffusion of innovations theory (Rogers, 1995) is applied in this study. Rogers (1995) distinguishes five stages in the innovation process and the process consists of two broad activities called initiation and implementation. The decision to adopt divides initiation from implementation (Rogers, 1995, page 392). DOI includes characteristics of compatibility, complexity, relative advantage, trial and observability, which originally were considered product characteristics (Rogers, 1995).

Innovation studies have employed different sets of characteristics such as innovation, individual, task, environmental, technological, and organisational, each further composed of several attributes, affecting the willingness to adopt an innovation (Rogers, 1995; Prescott, Conger, 1995; Kwon, Zmud, 1987; Huff, Munro, 1985; Wolfe, 1994; March, Simon, 1958; Sauer, Lau, 1997; Nilakanta, Scamell, 1990; Bouchard, 1993; Chin, Gopal, 1995; Kozar, 1989; Westin, Mundorf, 1995; Attewell, 1992; Parnisto, 1995; Giddens, 1984; Tolvanen, 1998; Premkumar, Potter, 1995).

We first search for adoption decisions, the very point that divides initiation from implementation and then study what characteristics are important concerning the method adoption. The model in figure 2 incorporates the five characteristics as presented in Prescott and Conger (1995, p. 22) plus a set of additional of attributes, from Rogers

(1995) for each characteristic. The attributes from Rogers derive from three different sets of cases: 27 case examples in which an innovation adoption and diffusion were successful; 11 case examples in which an innovation failed; and finally four case examples which first proved successful but which eventually failed. The final model then incorporated a total of 30 attributes. The attributes for consequences and process attributes also to be found in Rogers were excluded.

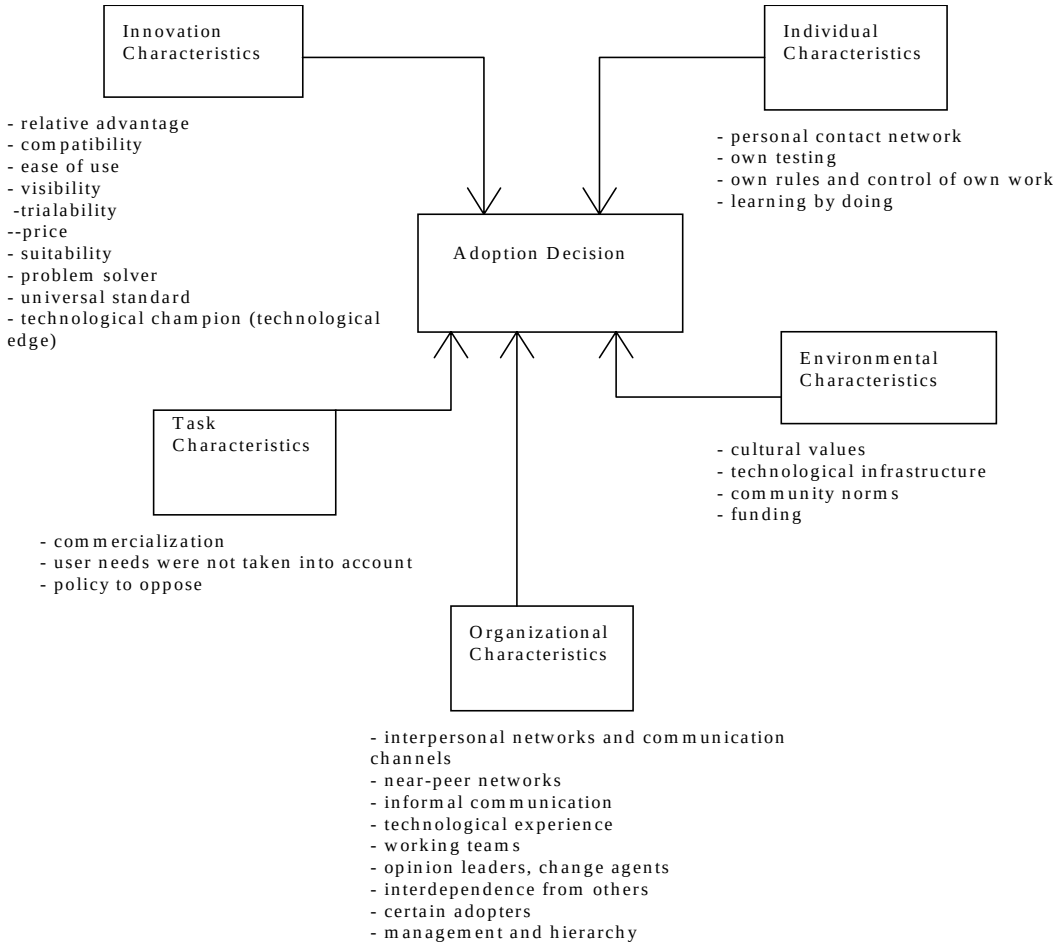

Figure 2: DOI factors affecting method adoption decision: the Adoption Decision Model.

Research problems

Our general research problems are:

- What are the general factors affecting method adoption decisions.
- To what extent the method category and/or different locales affect what factors are significant.
- To what extent the Rogers's characteristics/factors change in time in adoption decisions.

Related research for method adoption and method adoption decisions

In an effort to standardise system development work (SDW) and help companies to adopt methods, official committees in Finland have issued standards for use in SDW (SFS Handbook, 1988; SFS Handbook, 1983; SFS Handbook, 1992). Normally, however, each company and organisation will adopt such methods as will suit their needs.

Tolvanen`s (1998) findings suggest that organisations will develop their own methods and such local methods were developed on account of the limitations found in the existing methods used, inadequate tool support, and the lack of knowledge about other methods.

The way organisations actually adopt methods, how they really use them has been largely neglected as a subject for study (Smolander, Tahvanainen, Lyytinen, 1989). Wynekoop and Russo (1993) also point to several unanswered questions in method selection.

An example of related research of interest is the adoption of the SSADM (Structured Systems Analysis and Design Method) in an Australian government agency (Sauer and Lau, 1997). It highlights business managers' role in methodology adoption and the influence of the business pressures originating in the strategic environment. This study was used as a model how to adapt data to our own theoretical model. But as opposed to the present study, however, Sauer and Lau`s (1997) horizontal study involved one single organisation and one single methodology, and did not address the past history, which also affects how an organisation makes decisions.

Wynekoop and Russo (1997) in their study of 127 existing studies set themselves to establish how many of the system development methods (SDM) were indeed selected, adapted, used and developed in an empirical manner. Wynekoop and Russo (1997) suggest that SDMs will as a rule be adapted, but there is little knowledge about the process by which these SDMs are selected, developed or adapted and some companies even use ad hoc for selection.

Bouchard (1993) in her study of EDI adoption decisions argues that such decisions are based on business partners actions, an environmental attribute, even though it is not the only reason for adoption.

Premkumar and Potter's (1995, p. 105) findings from adoption of CASE technology show the importance of existence of a product champion, strong top management support, lower information systems (IS) expertise, perception that CASE technology has greater relative advantage over other alternatives, and a conviction of the cost effectiveness of the technology.

Research methodology

The research problems can be searched as one shot research horizontally through one or several organisations (Sauer, Lau, 1997) or vertically in time in several organisations. Unfortunately in horizontal research the organisation's previous history is neglected. Current and future adoption decisions are largely determined by the decisions enacted in earlier times.

Owing to the above reasons, we chose qualitative research methodology (Laudon, 1989, p. 7) and field study approach (Johnson, 1975). Further, a single case study

approach was chosen due to the fact that there were three organisations and their three specific locales as subjects. Following Yin's (1993) arguments our study is a descriptive case study (Yin); it has time, history and context aspects.

Laudon (1989, p. 7) argues that qualitative research almost always involves studying a phenomenon over a substantial period of time. Longitudinal study supports our time aspect (Barley, 1990; Heiskanen, 1994; Pettigrew, 1990). Our research problems change in time (Pettigrew, 1989). The research is bound to the organisations` history (Copeland, McKenney, Mason 1988; Mason, McKenney, Copeland, 1997a; Mason, Kenney, Copeland, 1997b; Kalela, 1976). Context aspects refer to the inner and outer context of the Automatic Data Processing (ADP) department within companies XX Oy and YY Oy. The inner context takes into consideration the structural, cultural and political environment and the outer context economical, social, political and lines of business environment (Järvinen, Järvinen, 1995, pp. 63-64; Pettigrew, 1990, p. 268).

Due to research problems it is meaningful additionally to conduct research vertically through time. Unfortunately time dependent vertical research is difficult to conduct in several organisations and the collection of data becomes increasingly difficult to carry out.

Due to this reason we chose only three organisations and their three specific locales. In the locales there can be different social groups, structures, different cultures, different technologies, etc. The interviewees were involved in the situations and events under study, with working careers in ADP extending over periods of 10 to 30 years. The empirical data contained tape-recorded semi-structured interviews dealing with experiences of the method use and changes in the organisations' environments. The interviews (primary data) and archival files included data from 1960 until December 1997. The archival material included the interviewees` private and public files. Archive materials served as a primary and a secondary data (Järvenpää, 1991). The suggestions of Pettigrew (1985) were used in deciding what kind of data was worth gathering and also in organising the data. The collected data covered 43 years, which were divided into four time periods, or phases, that are concurrent with the four computer generations, as described in Friedman and Cronford (1989).

The data was analysed with historical methods (Copeland, McKenney, 1988; Mason, McKenney, Copeland, 1997a; Mason, McKenney, Copeland, 1997b) and using synchronic analysis (Barley, 1990). We chose historical methods because we were not able to go back to the past and make the interviews with the people dealing with method adoptions in a specific time and context, but as Mason, McKenney and Copeland put it (1997, p. 272) "the effects of technological decisions unfold over long periods of time, typically measured in decades. We believe that historical methods are appropriate for studying strategically motivated IT-based innovations in firms." In his synchronic analysis Barley (1990, p. 223) highlighted the differences and similarities in tasks, roles and role relationships of the two different people groups working together with the new technologies. In our analysis we searched for differences and similarities between method categories and locales and their significance to factors affecting method adoption decisions.

The validity and reliability of the data

The interviews were first transcribed on paper and the interviewees were then allowed to check them for mistakes, which were corrected accordingly by the author. Recognised historical events were arranged in a chronological order. At this stage archival material

was also utilised to improve the reliability of the data: the dates and the events. The resultant manuscript, the Baseline Story Data (Mustonen-Ollila, 1997) consisted of the interviews and archival material relevant to the research subject. The data for the manuscript was gathered between February 1995 and December 1997; it was then translated into English, and further arranged chronologically and topically.

The first version of the Baseline Story Data manuscript (Mustonen-Ollila, 1997) was sent in May 1997 to company XX Oy's IT director and was corrected according to his instructions. In November 1997 the manuscript was divided into two different sets of data, the first set covering the years 1954 to 1990, and the second set covering the years 1984 to 1997. The division was warranted by the fact that the present IT director of company XX Oy, had previously held important positions both in company XX Oy (1963-1984) and in company YY Oy (1984-1990, giving him an overall view of all relevant developments within and outside of company XX Oy.

The second set included data from 1984 until 1997 and it was sent to the managing director of company YY Wood Oy for an overall review. As with the first reviewer, company YY Wood Oy`s managing director was considered to be qualified to review the latter set of data owing to his senior position in the company YY Oy, YY Wood Oy, MM Development Oy and his working career. The division was made because of reasons of confidentiality and, obviously, to improve the reliability of the data.

Case organisations and locales

The paper focuses on three Finnish-based case organisations, all companies, XX Oy, YY Oy and YY Wood Oy. XX Oy is a big paper-producer whereas YY Oy is specialised in designing, implementing and maintaining IS. In 1984 XX Oy chose to outsource its ADP functions into a newly formed company, YY Oy, set up by the former ADP employees at XX Oy. Since 1993 YY Oy has belonged to the KK Oy (YY Oy, 1993), a large Finnish software corporation. In 1995 YY Oy was divided into sister companies, one of them being YY Wood Oy. Until the end of 1997, YY Wood Oy was a division within YY Oy. Ever since their respective inceptions, 1984 for YY Oy and 1995 for YY Wood OY, the two companies have been in close cooperation with XX Oy on ADP.

The three companies' subject locales are all three situated in the cities of Imatra, Helsinki and Lappeenranta respectively. XX Oy in Imatra housed ADP functions in the years 1954-1969. The year 1969 saw the establishment of a separate ADP department, which continued until 1984. In 1984 the ADP department was outsourced. XX Oy in Helsinki also had in-house ADP functions in the years 1961-1969. 1969-1984 it belonged to the ADP department in XX Oy. Despite having separate locations, we chose to treat both Helsinki and Imatra as a single locale, locale one, due to the fact the two were working intimately together and belonged to the same ADP department within XX Oy. After the 1984 outsource decision until 1995, Imatra was treated as locale two. For 1995-1997, Imatra continued to be treated as locale two although its forest section was set up as a separate company in 1995 as YY Wood Oy. The Lappeenranta locale, the third research subject, was established in 1989 within YY Oy and continued until 1995 under the authority of YY Oy. From 1995 until 1997 it was part of YY Wood Oy. In 1989 YY Oy established MM Development Oy, terminated in 1990, but it was considered as belonging to the Lappeenranta locale, because it was situated in Lappeenranta and was under the authority of YY Oy. (For the organisational structures of the locales see figures 3-6 in the appendix.)

Method categories and adoption decision maker categories

For the purposes of this study the term method is considered to cover team structures, programming languages and other notions. According to Tolvanen (1998, p. 38) concepts defined as part of the conceptual structure can be discussed and represented only by using some kind of notation. Our definition of method formed the basis for the interviews and collection of archival material. A total of 208 different methods (Mustonen-Ollila, 1998) were identified in the data.

Our four method categories are based on the definition of method. They are project management and controlling principles (M); description techniques (D); tools (TO); and technology (T). Project management and controlling principles category included phasing, system work instructions, in-house system design methods, project instructions, ADP (Automatic Data Processing) in-house and Hewlett Packard standards (XX-AA Osakeyhtiö, 1977; XX-AA Oy, 1972; TK-65 ohjausosa, 1966; Johdatus Tietojenkäsittelyyn, 1996; Tietotekniikan alkuvuodet Suomessa, 1993; XX-AA Oy, 1981; Kerola, Rautiainen, 1969; XX-AA Oy, 1984; Kostamo, 1965, p. 46; Automaattisten Tietojenkäsittelysysteemien Suunnittelu, 1964, p. 118). Description techniques category included wall technique and end user activities. Tools category included home-grown applications generators such as the IDEA code generator (XX ATK, 1983) for information search from IDMS (Integrated Data base Management System) databases (XX-AA Oy, 1982a; XX-AA Oy, 1982b), CAREL tools in DOS environment (KK-konserni, 1996), commercial methods like Information Systems Work and Analysis of Changes (ISAC) (Lundeberg, Goldkuhl, Nilsson, 1981) and ADW (Application Development Workbench) (Tietokoneavusteisen systeemityön työsuunnitelmat YYssa, 1991; YY Oy, 1990; TTP/Ke/Yrjö Utti, 1991), data communication and network handling tools such as CARELLINK for connecting the IBM and HP3000 environments in accounting information systems (XX-AA Oy, 1991), and ROSCOE terminal computing software (Kivistö, 1974; YY, 1993). Technology category included database and platform technology and programming languages, C++, the ObjectCycleModel (OCM) method by Lehto and Nokso-Koivisto (Taipale, 1992; Aalto, 1992), OQL (Online Query language for IDMS databases), the EPOK packet system for accounting information system (Hiltunen, 1997; XX ATK, 1982). The number of adoption decisions for the four method categories is shown in table 1.

Table 1: The number of adoption decisions in the four method categories (M= project management and controlling principles, D= description techniques, TO = tools, T= technology).

category	M	T	TO	D	sum
	72	97	59	35	263

The adoption decision-makers included 67 different decision-makers and are categorised by the decision authority, resulting in a total of ten categories: “company”, “board of directors in the company or executives of the paper group”, “business unit inside a company”, “department inside the business unit”, “IS project group”, “IS working group inside a project group or a development group in the chosen IS project area or inside a department”, ”project controlling group”, “project manager”, “staff in the IS project area (automatic data processing, administrative, bookkeeping, order handling, salary payment, wood and paper, personal administrative, internal and external accounting, material, transport control, maintenance, factory accounting)”, and “designer”. Table 2 shows the number of adoption decisions for the four

method categories taken by the respective decision-maker body or individual.

Table 2: The number of adoption decisions for the four method categories, (M= project management and controlling principles, D= description techniques, TO = tools, T= technology), taken by the respective decision-maker body or individual.

Decision made by	M	T	TO	D	sum
Company (YY Oy, YY Wood Oy, XX Oy, KK Oy, MM Development Oy)	7	7	6	1	21
Board of directors in the company or executives of the paper group	2		2		4
Business Unit inside a company	3	1	3		7
Department inside the business unit	20	45	19	2	86
IS project group	32	35	25	27	118
IS working group inside a project group or a development group in the chosen IS project area or inside a department	3	9		1	13
Project controlling group				4	4
Project manager	1				1
Staff in the IS project area	3				3
Designer	1		4		5
Total number	72	97	59	35	263

Adapting the data into the Adoption Decision Model

The Baseline Story Data (Mustonen-Ollila, 1997) included methods, events and their dates, method decision-makers, locales' names and locations, organisational structures, technological development, changes in business line of units, etc. First, using the information retrieved from the Baseline Story Data, an entry was made into a table for each occurrence of a method; its locale; the year when the adoption decision was made; and the decision-maker(s) (Mustonen-Ollila, 1998). (For a description of the three locales, see above.) At the second stage, we searched the data for references to attributes as presented in the Adoption Decision Model in figure 2. A tabulation example for one method is presented in table 3 in the appendix.

Thirdly the methods were sorted into the four method categories and three locales. Then within the method categories the methods were sorted according to the year the adoption decision was made. The number of attributes was counted together for each year the decision was made. As a result there were attributes, and a total occurrence number of attributes in a certain year. The years were sorted and placed into the four time phases according to Cronford and Friedman (1989). This procedure was repeated for all the four method categories. The sum totals were counted for the attributes under five characteristics of the Adoption Decision Model.

The final results are presented in tables 4-13 in appendix, where the five characteristics had sum totals of attributes for the four phases, for the three locales and for the four method categories. Table 14 is the sum of tables 4,7, 10, and 13 and we notice that attributes were mentioned 522 times in the four phases. The adoption decision-makers, amount of adoption decisions, four method categories, and Adoption Decision Model's characteristics groups according the four phases are shown in the table 15 in appendix.

Analysing the problems of method choice and adoption

The first research problem "What are the general factors affecting method adoption decisions" was investigated by analysing table 14. The results showed that Rogers's Adoption Decision Model's attributes in characteristics/factors group had affected method adoption decisions. Innovation characteristics was the largest group in terms of adoption decision affected, the second largest one was environmental characteristics and the third largest one was organisational characteristics; task and individual characteristics were almost identical.

The second research problem "To what extent the method category and/or different locales affect what factors are significant" was investigated by analysing tables 4-13 and table 15. The results showed that in the technology category in the second, third and fourth phase, all the Rogers's Adoption Decision model's characteristics/factors have affected method adoption decisions. For phase one no characteristics were recorded. In the project management and controlling principles category, the number of characteristics were on the decline starting from phase two. Organisational and task characteristics had disappeared in the fourth phase. In the tools category, in the first phase, there were no characteristics to be found, in the second and third phases all the five characteristics were represented, but in the fourth phase individual characteristics were not present. In the description techniques category, in the first phase no characteristics were recorded, in the second phase all the five characteristics were there, in the third and fourth phase individual characteristics had disappeared. The effect of different locales in the project management and controlling principles category, locale one exhibited more attributes in the characteristics groups than locales two and three. In the technology category, the number of attributes and characteristics was almost identical for locales one and two, but different for locale three. In the tools category, it was difficult to observe any major difference between the locales; in the description techniques category, locale one had more attributes than locale two and locale three did not have any.

The last research question: "To what extent the Rogers's characteristics change in time in adoption decisions" was addressed by comparing the different phases with each other in the characteristics' groups as seen in table 14. We found that innovation, task, individual and environmental characteristics groups in phases two to four were almost identical, but phase one was different. In the organisational characteristics group phases two and three were identical, but phase four was different, as it was lacking some factors previously important, and phase one was different due to its fewest amount of attributes.

Conclusions

The general conclusion of the analysis is that attributes for Adoption Decision Model's characteristics/factors (Rogers's characteristics/factors) have affected method adoption decisions. Adoption decisions falling under the four method categories have been affected by Rogers's factors. However, only phase two, that is, mid 1960s to early 1980s, displays all the factors for all the four method groups. For the technology and tools category, locales one and two displayed almost identical sets of Rogers`s factors. In project management and controlling principles, and the description techniques category, locale one had more factors than locale two or locale three. Locale three was different from locales one and two, which were almost identical. Phase one was different from all

other phases, having the lowest number of attributes. As to the number of attributes, four out of the five characteristics groups, innovation, task, individual and environmental, were almost identical in phases two to four. In the organisational characteristics group, phases two and four were almost identical; interestingly, however, phase four was lacking some factors previously important. Finally, attributes for Rogers's characteristics groups were almost identical in locales one and two, but somewhat different in locale three.

A major difficulty encountered in the course of the study concerns the large number of different adoption decisions (263) and methods (208). Moreover, the Adoption Decision Model incorporates a large number of attributes for each of the character groups, 30 in total, and attributes receiving evidence 522 times altogether. Also, we should have at the outset taken greater care in defining what is the content of an attribute, instead of relying solely on Rogers for attributes. Thus, future research should try to concentrate on a more restricted number of attributes that are also better adapted to our research context. The attributes could be taken from the data, from Rogers and from other diffusion literature. For example, Nilakanta and Scamelli (1990, p. 29) have defined the content or meaning for a restricted number of attributes.

The first limitation concerns division into method categories. The division had to be made roughly, because there were 208 different methods to be classified into the four method categories. The second limitation concerns cases where several factors having bearing on the decision were identified to be present simultaneously. Weighing the relative importance of a single factor against each of the rest of the factors proved at this stage next to an overwhelming task. The third limitation concerns the comprehensibility and thus reliability of the data: despite our efforts through in-depth interviews and use of archival material to identify exhaustively all the relevant factors affecting method adoption, we obviously have to contend to accept the limitations of such a study as this. Despite its obvious shortcomings, the present Adoption Decision Model was, however, considered best suited to this research context.

In future research the theories of Actor-Network (ANT) and Organisational Learning could provide us with new frameworks and theoretical insights especially into how to identify potential additional factors. The ANT deals with ways of affecting people's thinking and it could be applied to a context where actors are obliged to choose between alternative methods. Organisational learning could be used to investigate how organisations learn from their experience and use this knowledge when selecting a method. The locales have organisational structures, and certain roles for actors, be they individuals or groups. For example, an adoption decision taken by an actor may result in method adoption in a given locale; yet again, the locale might fail to do so. Who, then, really makes the decisions? Was delegation used?

Reality is that we can not go back in time to make the interviews in a specific situation and time in the past and make the interviews at that particular moment when a decision was made. This study is a historical study, whose accuracy may be limited, but as Mason, McKenney and Copeland (1997, p. 307) point out, the historical method identifies the solutions that worked in the past and those that did not. We hope this study has given even a slight glance at least the great number of methods, factors, decisions and decision-makers involved in method adoption over a long period of time.

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Appendix

-54	-60	-63	1969	1984
ADP function began in 1954 in Imatra			ADP department was established in 1969	outsourcing 1984

Figure 3: XX Oy's Imatra locale in 1954-1984.

-54	- 60	-61	1969	1984
		ADP functions expanded to Helsinki in 1961	ADP department was established in 1969	outsourcing 1984

Figure 4 : XX Oy's Helsinki locale 1961-1984.

-84	-86	-87	-89	-91	-93	-95	- 97
						YY Wood Oy (Wood industry) 1995	
						YY Base Industry Oy (metal industry) 1995	
						YY International Oy 1995	
						D Team Oy (metal industry) 1995	
						YY Power Oy (energy industry) 1995	
YY Oy 1984-1993 (before 1984 XX Oy's ADP department)						TT KK Oy bought YY Oy in 1993. Five units were created 1995.	
	Information Data Services Unit 1986-1987: IBM- line	Information Data Services Unit 1987-1993: IBM line. HP line called XXnet department was transferred to it 1988					

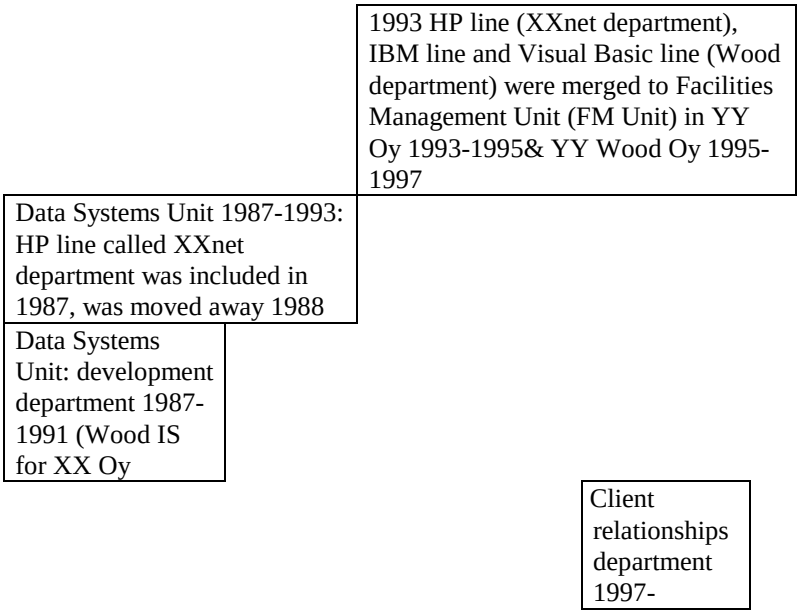

Figure 5: YY Oy's Imatra locale in 1984-1997.

								YY Wood Oy (Wood industry) 1995			
								YY Base Industry Oy (metal industry) 1995			
								YY International Oy 1995			
								D Team Oy (metal industry) 1995			
								YY Power Oy (energy industry) 1995			
							TT KK Oy bought YY Oy in 1993. Five units were created 1995.				
					MM Development Oy 1989-1990 (belonged to YY Oy)						
					Data Systems Unit 1989-1993 in YY Oy		Data Systems Unit was merged to Facilities Management Unit 1993 in YY Oy				
YY Oy 1984-1993. In 1993 TT KK Oy bought YY Oy and it became TT KK Oy's industrial division							YY Oy 1993-1995&YY Wood Oy 1995-1997				
-84					-89	-90	-93	-95		-97	

Figure 6 : YY Oy's Lappeenranta locale in 1989-1997.

Table 3: Reference example of Adoption Decision Model's attributes for CARELIA COBOL generator. Method belongs to the Tools category (T). The rest of the references to each of the methods is in the data table (Mustonen-Ollila, 1998).

Method: CARELIA COBOL generator, 1983-, implementers: Turkulainen, Ovaska H.
Locale: XX Oy's ADP department in 1983. Decision-maker: OHS (order handling IS) project group

Rogers's attributes in	**evidence**
Innovation Characteristics group	
relative advantage	gave good productivity easily, simplicity essential
compatibility	-
ease of use	COBOL generator was easy to use by programmers
visibility	-
trialability	-

price	-
suitability	There were lots of records in programs, which had the same structure and no query language was available. The data from data dictionaries had to be read with the ASSEMBLER C COBOL language. IDMS's OLQ (Online Query Language) was not proper for this purpose. Carelia COBOL code generator was proper.
problem solver	automated matters that took a lot of time and work in projects
standard	-
technological champion (technological edge)	-
Task Characteristics group	
commercialisation	-
user needs were taken into account	-
policy to oppose	-
Individual Characteristics group	
personal contact network	-
own testing	was used in massive IDMS information systems for controlling the functions in Savonlinna machine shop
own rules and control of own work	-
learning by doing	-
Environmental Characteristics group	
cultural values	-
technological infrastructure	IBM environment
community norms	-
funding	-
Organisational Characteristics group	
interpersonal networks and	-
communication channels	-
near-peer networks	-
informal communication	-
technological experience	-
working teams	-
opinion leaders and change agents	-
interdependence from others	-
certain adopters	Turkulainen and Ovaska implemented the tool
management and hierarchy	-

Table 4: Project management and controlling principal category (M) (sum table). Locale one (XX Oy's ADP department in 1961-1984 in Helsinki and in 1954-1984 in Imatra). Locale two (1984-1997 YY Oy and YY Wood Oy, Imatra) and locale three (1989-1997 YY Oy and YY Wood Oy, Lappeenranta) are included here, but shown also separately in tables 5-6.

PHASE GENERATIONS	PHASE 1.			PHASE 2.								PHASE 3.				PHASE 4.			
Rogers's factor (characteristics) groups/years	60-62	63-64	65-66	67-68	69-70	71-72	73-74	75-76	77-78	79-80	81-82	83-84	85-86	87-88	89-90	91-92	93-94	95-96	-97
Innovation Characteristics: the sum	1	1	3	3	4	2	-	3	3	1	1	-	-	-	1	-	-	-	2
Task Characteristics: the sum	-	-	-	-	1	2	-	-	1	-	-	1	-	-	1	-	-	-	-
Individual Characteristics: the sum	-	-	1	-	4	1	-	2	4	-	3	1	-	-	2	-	-	1	1
Environmental Characteristics: the sum	1	-	1	-	-	-	3	3	1	1	2	-	-	-	1	-	-	1	2
Organisational Characteristics: the sum	2	-	2	2	1	-	1	-	-	1	1	1	-	-	-	-	-	-	-

Table 5: Project management and controlling principal category (M). Locale two (YY Oy in 1984-1995 in Imatra and YY Wood Oy in 1995-1997 in Imatra).

PHASE GENERATIONS	PHASE 1.			PHASE 2.								PHASE 3.				PHASE 4.			
Rogers's factor groups/years	60-62	63-64	65-66	67-68	69-70	71-72	73-74	75-76	77-78	79-80	81-82	83-84	85-86	87-88	89-90	91-92	93-94	95-96	-97
Innovation Characteristics: the sum													-	-	1	-	-	-	1
Task Characteristics: the sum													-	-	1	-	-	-	-
Individual Characteristics: the sum													-	-	1	-	-	1	1
Environmental Characteristics: the sum													-	-	1	-	-	1	2

Table 6: Project management and controlling principal category (M). Locale three (YY Oy in 1989-1995 in Lappeenranta and YY Wood Oy in 1995-1997 Lappeenranta).

PHASE GENERATIONS	PHASE 1.			PHASE 2.								PHASE 3.				PHASE 4.			
Rogers's factor groups/years	60-62	63-64	65-66	67-68	69-70	71-72	73-74	75-76	77-78	79-80	81-82	83-84	85-86	87-88	89-90	91-92	93-94	95-96	-97
Innovation Characteristics: the sum													-	-	-	-	-	-	1
Individual Characteristics: the sum													-	-	1	-	-	-	-

Table 7: Technology category (T) (sum table). Locale one (XX Oy's ADP department in 1954-1984 in Imatra and in 1961-1984 in Helsinki). Locale two (1984-1997 YY Oy and YY Wood Oy, Imatra) and locale three (1989-1997 YY Oy and YY Wood Oy, Lappeenranta) are included here, but shown also separately in tables 8-9.

PHASE GENERATIONS	PHASE 2.								PHASE 3.				PHASE 4.			
Rogers's factor groups/years	67-68	69-70	71-72	73-74	75-76	77-78	79-80	81-82	83-84	85-86	87-88	89-90	91-92	93-94	95-96	-97
Innovation Characteristics: the sum	1	13	4	1	3	3	17	6	2	1	9	1	4	11	8	
Task Characteristics: the sum	1	2	-	-	-	-	1	3	1	1	-	-	1	4	2	
Individual Characteristics: the sum	-	-	-	-	2	-	2	3	-	1	3	-	-	6	1	
Environmental Characteristics:the sum	-	-	-	1	-	-	11	3	-	4	6	1	5	6	5	
Organisational Characteristics: the sum	1	1	-	-	1	1	3	5	1	2	2	-	1	2	3	

Table 8: Technology category (T). Locale two (YY Oy in 1984-1995 in Imatra and YY Wood Oy in 1995-1997 in Imatra).

PHASE GENERATIONS	PHASE 2.								PHASE 3.				PHASE 4.			
Rogers's factor groups/years	67-68	69-70	71-72	73-74	75-76	77-78	79-80	81-82	83-84	85-86	87-88	89-90	91-92	93-94	95-96	-97
Innovation Characteristics: the sum										2	1	8	1	4	11	8
Task Characteristics: the sum										1	1	-	-	1	4	2
Individual Characteristics: the sum										-	1	3	-	-	6	1
Environmental Characteristics:the sum										-	4	3	1	3	6	5
Organisational Characteristics: the sum										1	2	2	-	1	2	3

Table 9: Technology category (T). Locale three (YY Oy in 1989-1995 in Lappeenranta and YY Wood Oy in 1995-1997 in Lappeenranta).

PHASE GENERATIONS	PHASE 2.								PHASE 3.				PHASE 4.			
Rogers's factor groups/years	67-68	69-70	71-72	73-74	75-76	77-78	79-80	81-82	83-84	85-86	87-88	89-90	91-92	93-94	95-96	-97
Innovation Characteristics: the sum												1				
Environmental Characteristics:the sum												3	2			

Table 10: Tools category (TO) (sum table). Locale one (XX Oy's ADP department in 1954-1984 in Imatra and in 1961-1984 in Helsinki). Locale two (1984-1997 YY Oy and YY Wood Oy, Imatra) and locale three (1989-1997 YY Oy and YY Wood Oy, Lappeenranta) are included here, but shown also separately in tables 11-12.

PHASE GENERATIONS	PHASE 2.								PHASE 3.				PHASE 4.			
Rogers's factor groups/years	67-68	69-70	71-72	73-74	75-76	77-78	79-80	81-82	83-84	85-86	87-88	89-90	91-92	93-94	95-96	-97
Innovation Characteristics: the sum			-	1	5	2	6	2	9	1	5	4	19	2	4	7

Task Characteristics: the sum	-	1	2	1	-	-	2	-	1	3	4	2	2	1
Individual Characteristics: the sum	-	-	2	2	2	1	5	-	-	1	7	3	-	-
Environmental Characteristics: the sum	-	4	4	4	3	1	5	-	4	4	10	3	9	5
Organisational Characteristics: the sum	-	1	2	3	1	-	6	-	4	2	1	5	1	3

Table 11: Tools category (TO). Locale two (YY Oy in 1984-1995 in Imatra and YY Wood Oy in 1995-1997 in Imatra).

PHASE GENERATIONS	PHASE 2.								PHASE 3.				PHASE 4.			
Rogers's factor groups/years	67-68	69-70	71-72	73-74	75-76	77-78	79-80	81-82	83-84	85-86	87-88	89-90	91-92	93-94	95-96	-97
Innovation Characteristics: the sum										1	5	3	19	2	4	7
Task Characteristics: the sum										-	1	1	4	1	2	1
Individual Characteristics: the sum										-	-	-	7	-	-	-
Environmental Characteristics: the sum										-	4	3	10	3	9	5
Organisational Characteristics: the sum										-	4	-	1	4	1	3

Table 12: Tools category (TO). Locale three (YY Oy in 1989-1995 in Lappeenranta and YY Wood Oy in 1995-1997 in Lappeenranta).

PHASE GENERATIONS	PHASE 2.								PHASE 3.				PHASE 4.			
Rogers's factor groups/years	67-68	69-70	71-72	73-74	75-76	77-78	79-80	81-82	83-84	85-86	87-88	89-90	91-92	93-94	95-96	-97
Innovation Characteristics: the sum												1		-		
Task Characteristics: the sum												2		1		
Individual Characteristics: the sum												1		3		
Environmental Characteristics: the sum												1		-		
Organisational Characteristics: the sum												2		1		

Table 13: Description technique category (sum table) (D). Locale one (XX Oy's ADP department in 1954-1984 in Imatra and in 1961-1984 in Helsinki). Locale two (1984-1997 YY Oy and YY Wood Oy, Imatra) is included here. The years 1967-1984 cover the locale one, and the years 1985-1997 cover the locale two. YY Oy's part begins at 1985 and ends 1997.

PHASE GENERATIONS	PHASE 2.								PHASE 3.				PHASE 4.			
Rogers's factor groups/years	67-68	69-70	71-72	73-74	75-76	77-78	79-80	81-82	83-84	85-86	87-88	89-90	91-92	93-94	95-96	-97
Innovation Characteristics: the sum	1	-	-	10	4	2	-	1	-	-	-	1	-	8	-	
Task Characteristics: the sum	1	-	-	2	3	2	-	-	1	-	-	2	-			
Individual Characteristics: the sum	-	-	-	6	3	-	-	-	-	-	-	-	-	-	-	
Environmental Characteristics: the sum	-	1	-	2	-	-	-	-	1	-	-	2	-			
Organisational Characteristics: the sum	-	-	-	7	8	4	-	-	-	-	-	1	-			

Table 14: Rogers's attributes and characteristics/factors groups (Adoption Decision Model's attributes and characteristics/factors in figure 2) in four phases.

PHASE GENERATIONS	PHASE 1.	PHASE 2.	PHASE 3.	PHASE 4.	
years	1960-1966	1967-1982	1983-1990	1991-1997	
Rogers's attributes in characteristics/factors groups					**total number**
Innovation Characteristics:					
relative advantage		14	2	3	19
compatibility			2	2	4
ease of use	1	20	10	16	47
visibility		7	2	4	13
trialability		4	3	2	9
price	1	4	1	4	10
suitability	1	5	8	7	21
problem solver	1	7	2	3	14
universal standard	1	28	1	12	42
technological champion (edge)		3	7	12	22
Task Characteristics:					
commercialisation			1	2	3

user needs were considered		17	11	13	41
policy to oppose		3	1	3	7
Individual Characteristics:					
personal contact network					
own testing		13	10	7	30
own rules and control of own work	1	13	2	7	23
learning by doing		8	3	5	16
Environmental Characteristics:					
cultural values			1		1
technological infrastructure	2	29	13	41	85
community norms		4	12		16
funding		8	2	6	16
Organisational Characteristics:					
interpersonal networks and communication channels			2		2
near-peer networks		1	1	2	4
informal communication			2		2
technological experience	2	12	13	11	38
working teams		11	4		15
opinion leaders, change agents		2	3	2	7
interdependence from others		1	1		2
certain adopters	1	4	3	2	9
management and hierarchy	1	4			5
Innovation Characteristics: the sum	**5**	**92**	**38**	**65**	**200**
Task Characteristics: the sum	**-**	**20**	**13**	**18**	**51**
Individual Characteristics: the sum	**1**	**34**	**15**	**19**	**69**
Environmental Characteristics: the sum	**2**	**41**	**27**	**47**	**117**
Organisational Characteristics: the sum	**4**	**35**	**29**	**17**	**85**
total number	**12**	**222**	**123**	**166**	**522**

Table 15: Sum results.

PHASE GENERATIONS	PHASE 1.	PHASE 2.	PHASE 3.	PHASE 4.		
Years	1960-1966	1967-1982	1983-1990	1991-1997	**Decision makers**	**Number of decisions**
Project management and controlling principles category (M)	Inno, Indi, Envi, Orga (4)	Inno, Task, Indi, Envi, Orga (5)	Inno, Task, Indi, Envi (4)	Inno, Indi, Envi (3)	**project group, department, company**	**72**
Technology category (T)	-	Inno, Task, Indi, Envi, Orga (5)	Inno, Task, Indi, Envi, Orga (5)	Inno, Task, Indi, Envi, Orga (5)	**department, project group, company, working group**	**97**
Tools category (TO)	-	Inno, Task, Indi, Envi, Orga (5)	Inno, Task, Indi, Envi, Orga (5)	Inno, Task, Envi, Orga (4)	**project group, department, company**	**49**
Description techniques category (D)	-	Inno, Task, Indi, Envi, Orga (5)	Inno, Task, Envi, Orga (4)	Inno, Task, Envi, Orga (4)	**project group**	**35**