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Abstract

This paper identifies mechanisms that affected over 200 Information System Process Innovation (ISPI) unlearning decisions in three organisational environments over a period that spanned four decades. The analysis is based on previous unlearning studies. Four distinct generations analysed are early computing (1954-1965); main frame era (1965-1983); office computing era (1983-1991), and distributed applications era (1991-1997). These follow roughly Friedman's and Cornford's categorisation of IS development eras. We also distinguish four types of ISPI's: base line technologies, development tools, description methods, and managerial process innovations.

Our analysis shows that the most important unlearning mechanisms were new knowledge creation, poor performance, react to changing environment, changes in management, and too complicated to use. In the organisations the unlearning mechanisms varied significantly according to the ISPI category, and time generation. The variation can be thus partly explained by the fact that the technological development and the rapid diffusion of microcomputers in the beginning of 1980s changed IS development (ISD) work, and new skills and ISPIs were needed. In the beginning of 1990s technological platforms, operating systems, databases, tools, and working procedures changed to object orientation, and the previous ISPIs had to be unlearned.

Keywords: IS process innovation, Unlearning decision.

1 INTRODUCTION

The ability to find out innovations and to distribute the new innovation knowledge to organisations has become an important promoter for organisational learning. According to Hedberg (1981), however, understanding involves both learning new knowledge, and discarding obsolete and misleading knowledge. Unlearning is as a fundamental change in understanding and perception, where previous knowledge structures are obliterated, and it refers to the removal or rejection of a previously adopted innovation or practices from the organisation (Kimberly, 1981, 1985; Rogers, 1995; Wagemans; 2001; Yin, 1981; and Clark and Staunton, 1989).

Previous studies indicate that that decision-making routines in organisations decrease the capability of directing organisational action towards the crucial resources required for renewal (Clark and Staunton, 1989). Hedberg et al. (1976) argue unlearning to be the greatest barrier of learning. External knowledge transfer mechanisms do not change the previously learned practices in organisations, and internal learning is possible only in the existence of the present knowledge, and its conformance to the present knowledge. The discarding activity- unlearning- is as important a part of understanding as is adding new knowledge. On the organisational level unlearning is concerned with the dominant organisational logic as reflected in strategies, visions and management's actions (Gustavsson, 1999). Diaper (2001) argues that if one is designing a method then one should develop at the same time a software tool to support it. The primary basis for this advice is not to enhance the delivery of the method, vital though this is, but to analyse the method as a product itself. According to Yin (1979) the problem of the unlearning of existing practices may be illustrated of the introduction of new practices into local service organizations, such as the police or the fire service. Unlearning may occur almost silently as when corporate ideologies are revised.

Organisations have increased their interest in seeking, and distributing new innovations in respond to the fundamental changes in their environments (Swanson, 1994). The one type of innovations, called here information system (IS) process innovations have become important for organisational effectiveness. We shall define **IS process innovation (ISPI)** as a *new way of developing, implementing, and maintaining information systems in an organisational context* (Swanson, 1994). ISPIs cover not only changes in the technological core of the development activity like the use of new programming languages or operating systems; but also organisational or administrative innovations like new project management methods, participative modes of interactions, or new forms of contracting development work outside the organisation. In Swanson's terminology ISPIs thus cover technological process innovations (Type Ia) and administrative process innovation (Type Ib) (Swanson, 1994). We can classify **ISPIs into four categories** based on their scope, purpose and content in how they align with technological and administrative innovations. These are project management and control procedures (M), which are administrative innovations; description methods (D), which are also administrative innovations; development tools (TO), which are technological innovations; and base line technology innovations called here technology innovations (T). The first category includes rules and administrative procedures that help control, manage and co-ordinate development activities (Swanson, 1994). Innovations of type D include notational systems and standards, which help to describe the development product or process and/or its relationships to the environment. Such innovations include well-known standardised modelling techniques like data flow diagrams, and complete methodologies like Unified Modelling Language. The innovations of type TO include all "productivity tools" for systems development covering application generators, CASE tools, documentation tools, data dictionaries, or tools to configure, or manage software components. Innovations of type T consist of developed technical platforms like programming languages, database management systems and middleware components.

Giddens (1984, p. 375) defines unlearning units as "regions involved as part of the setting of interaction, having definite boundaries, which help to concentrate interaction in one way or another".

Our definition is purposefully loose in that in our study an unlearning unit may comprise of a single formal organisational unit, or several units; or a half of a unit, if such a unit is the target of the unlearning behaviour.

Kwon and Zmud (1987) define unlearning as the disappearance of an implemented information technology. After Kwon and Zmud (1987) we define **ISPI unlearning** as disappearance of an ISPI.

One aspect in **ISPI unlearning** is the dynamics in the development practices, i.e. how the set of ISPIs used changes over time in unlearning units (Friedman and Cornford, 1989). Based on Friedman and Cornford (1989) **ISPIs** can be classified **into several generations**. Friedman and Cornford (1989) point out- based on an extensive empirical analysis of the historical evolution of IS development- that the four categories of innovations discussed above are often closely "horizontally" related, and they can be accordingly classified into a set of evolutionary generations. Shifts between generations in Friedman's and Cornford's analysis are caused by: 1) changes in hardware and software (T/TO innovations), 2) changes in types of systems being developed i.e. harnessing computing capability into untried organisational domains and tasks (what Swanson (1994) calls type II and type III IS innovations, respectively); and resulting 3) changes in types of users. The latter two form external pull factors that drive the content and scope of ISPIs within each generation.

We will recognise accordingly **four ISPI generations**. The first generation (from the late 1940s until the mid 1960s) is largely hampered by "hardware constraints", i.e. hardware costs and limitations in its capacity and reliability (lack of T innovations). The second generation (from the mid 1960s until the early 1980s), in turn, is characterised by "software constraints", i.e. poor productivity of systems developers and difficulties of delivering reliable systems on time and within budget (lack of D, M, and TO innovations). The third generation (early 1980s to the beginning of 1990s), was instead driven by the challenge to overcome "user relationships constraints", i.e. system quality problems arising from inadequate perception of user demand and resulting inadequate service (lack of M, D, and TO innovations). Finally, the fourth generation (from the beginning of 1990s) was affected by "organisational constraints" (lack of M and D innovations). In the latter case the constraints arise from complex interactions between computing systems and specific organisational agents including customers and clients, suppliers, competitors, co-operators, representatives and public bodies (Friedman and Cornford, 1989).

Despite huge research interest in mechanisms in the past we have not found studies that focused on ISPI unlearning mechanisms involving a longitudinal perspective with several organisational environments and mechanisms. In this longitudinal case study our goal is to study strategies that organisations deploy while unlearning ISPI knowledge. We apply previous unlearning studies in the field because a coherent theory of unlearning in IS related area is missing. The reminder of the paper is organised as follows. We first introduce our unlearning research model based on the past studies. Then research goals and the research approach are briefly introduced. Thereafter, we analyse over 200 ISPI unlearning decisions in the light of our research model.

2   UNLEARNING MODEL

While the past research does not help to analyse changes in unlearning mechanisms over time, we developed our own unlearning research model, and chose five specific mechanisms from the past studies that effect innovation unlearning. The reason for choosing these five specific mechanisms was that they were the only mechanisms supported by our empirical data (see table 1).

Mechanism	Definition	Source
New knowledge creation	Unlearning is to create new knowledge structures in the organisation.	Gustavsson, 1999
React to changing environment: competitors and other outsider forces threat the survival	Organisations scan only the parts of their environments where competitors and other outsider forces threaten their survival.	Terreberry, 1968; Gustavsson, 1999; Rogers, 1995
Changes in management: slack or redeployment or allocation of resources, departure of the key decision-makers	Reallocations of slack resources, the departure of the key decision-makers. Removing people is an important way in which organisations get rid of the past and unlearn.	Wolf, 1971; Sarason, 1972; Cyert and March, 1963; Hedberg, 1981; Yin, 1979; Smith et al. 1990; Hirschman, 1970
Poor performance	Unlearning occurs because of poor performance.	Kimberly, 1981; Downs, 1976
Too complicated to use	Unlearning occurs because the tool is too difficult to use.	Diaper, 2001

Table 1.   Unlearning mechanisms.

In the context of ISPIs based on the earlier studies we can formulate thus our main research question based on our unlearning research model (see figure 1): "Why and how do unlearning mechanisms change over time across different ISPI categories and time generations?"
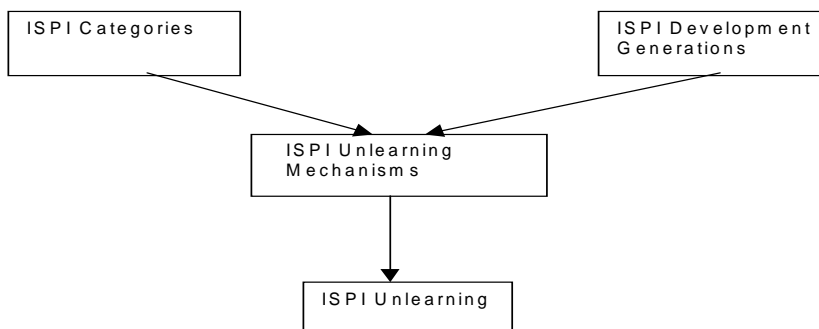

Figure 1.   An ISPI unlearning research model.

3   FIELD STUDY ON ISPI UNLEARNING

Because not much is known of ISPI unlearning over time and across different types of innovations a qualitative case study was deemed applicable (Laudon, 1989; Johnson, 1975; Curtis et al., 1988). We followed a multi-site case approach, as we wanted understand the role of the organisational environment in unlearning behaviour. Unfortunately, collecting a representative data set by following a time dependent vertical research design that involves several organisations is difficult to carry out due to resource and access limitations. Therefore, we limited our sample to three Finnish organisational environments that were or had been at some point, part of the same company. Their origins were in the same company, though the company was divided into two separate Finnish companies (where the other was further divided into two separate Finnish companies. These three organisational environments (units) were the data collection sites. (For further information about the companies see appendix).

We followed a descriptive case study (Yin, 1993) approach in that the collected data set embodied time, history and context of the sites. Being a longitudinal study it involved multiple time generations (Barley, 1990; Heiskanen, 1994; Pettigrew, 1989, 1990). Because the bulk of the gathered data was

qualitative consisting of interviews and archival material, we followed historical research methods, when necessary (Copeland and McKenney, 1988; Mason et al., 1997a, 1997b) in that the suggestions of Pettigrew (1985) were mostly used when gathering and organising data.Our definition of ISPI unlearning issues formed the basis for interviews and collecting data on unlearning behaviours using archives. The archival data encompassed a period between 1960 and 1997, and included interviewees' private and public documents about ISPI unlearning decisions. They served as primary and secondary sources of data (Järvenpää, 1991). Other empirical data contained tape-recorded semi-structured interviews dealing with the experiences of unlearning behaviours of ISPIs. Interviews covered project managers, IS department managers, and systems analysts who had worked at the companies at that time. We also gathered published news about changes in organisations' environments and examined documents of developed systems, system development handbooks, etc. We thus used triangulation to verify veracity of data by using multiple data sources. The first round of data was gathered between February 1995 and May 1997. The obtained data set was arranged in a manuscript, which included descriptions of all ISPI events in unlearning, participating companies, their organisational structures, technological platforms, and changes in their business organization, or strategy. These events were arranged into chronological order and written into a baseline description that identified all ISPI unlearning events in the companies. This manuscript was sent in May 1997 to company A's senior vice president of IT who had worked in this organisation for the whole period of study. We asked him to read the manuscript and find mistakes in facts. Because the base line history did not include any analysis of unlearning decisions or their success we did not ask him for explanations or reasons for these events. This was done to minimise bias in our interpretation of the data. This manuscript was corrected for multiple mistakes and omissions. Because the analysis had several important omissions more data was gathered until November 1997, and a second version of the manuscript was written in December 1997. This manuscript was divided into two parts. The first part covered the years 1954-1990 (in companies A and B), and the second part years 1984-1997 (in companies B and C), and these were sent to senior vice president of IT in company A and managing director of company C, respectively. The above division of data set was justified in that the senior vice president of IT in company A had previously held important positions both in company A (1963-1984), and in company B (1984-1990) giving him an overall view of all developments within and outside of company A until 1990. The second manuscript was sent to the managing director of company C who considered to be qualified to review the second manuscript, because he had held several senior positions in companies B, and C between 1984 and 1997. This division was necessary to retain confidentiality of some of the data. The new manuscript was again corrected for omissions and mistakes. Using the information retrieved from the manuscript, we arranged into a table each observed incidence of an ISPI, its unlearning unit, and the year when the unlearning decision was made. When there were several ISPIs included in the same initiative these were separated into separate innovation events based using the type as a distinguishing criterion. At the data categorisation stage, the ISPI unlearning decisions were further divided into four time generations, four ISPI categories, and three unlearning units (see figure 1). We, however, omitted time generation one because it did not have any data.

We analysed each unlearning decision made in term of how it would match with identified list of unlearning mechanisms. Thus our analysis, due to the data collection approach analysed only those events *where an unlearning decision* had been made already. We matched individual mechanisms with actual decision-making behaviours (in situ) by conducting content analysis of the unlearning cases. Thus for each case we could identify a certain number of mechanisms that were likely to influence the decision at that point. For a single ISPI unlearning decision the maximum number of unlearning mechanisms was five. These analyses of situations and associated documents acted thus as surrogates to actual decision-making behaviours and intentions, which are not any more accessible due to the nature of our data set. For each mechanism identified under a specific category we also inferred that the specific mechanisms had influenced the positive outcome of the unlearning decision. Thus the external validity of the data is higher than in many other unlearning studies, but our internal validity and reliability of the data and its analysis is lower. Therefore some caution must be exercised when interpreting the results.

4   RESEARCH FINDINGS AND ANALYSIS

By studying the unlearning mechanisms we can observe the following (see table 2): 1) new knowledge creation mechanisms were identified 152 times, 2) react to changing environment mechanisms are identified 109 times, 3) changes in management mechanisms were identified 112 times, 4) poor performance mechanisms were mentioned 84 times, and 5) too complicated to use mechanisms were identified 78 times. The total number of mechanisms recognized in 227 unlearning decisions was 535 (in average 2 mechanisms per unlearning decision).

Our main research problem was to investigate why and how do unlearning mechanisms change over time across different ISPI categories and time generations. We therefore classified the data in terms of the four innovation categories as shown in table 2. At the same time we normalised the data by diving the total number of mechanisms with total number of unlearning decisions in each of the four ISPI categories. Table 2 was analysed with the chi-square test to detect differences between how mechanisms influenced unlearning decisions in four ISPI categories. The test (χ^2=21.26, α=0.05) showed statistically significant differences. This suggests that ISPI categories are different, and consequently they are influenced by different unlearning mechanisms. A single mechanism affected unlearning decisions in project management and control procedures category (M) and description techniques category (D). In technology and tools category unlearning decision was influenced normally by three mechanisms. (See table 2). This shows that in different ISPI categories the unlearning decision may depend on varying set of mechanisms.

Mechanism	M	T	TO	D	Total Number
New knowledge creation	36	48	55	13	152
React to changing environment…	10	31	65	3	109
Changes in management…	20	37	54	1	112
Poor performance	10	46	20	8	84
Too complicated to use	5	47	24	2	78
Total number of observations	81	209	218	27	535
Total number of unlearning decisions/mechanism	57	72	74	24	227
Total number of mechanisms affecting an unlearning decision	1	3	3	1	2 (in average)

Table 2   The frequency of mechanisms affecting ISPI unlearning in four innovation categories. M is denoted as managerial process innovation;T is denoted as technology innovation; TO is denoted as development tools innovation; and D is denoted as description innovation.

We sorted the unlearning data into the four innovation categories and three unlearning units to investigate possible variation of the mechanism influence over unlearning units. Unlearning events were also sorted according to the year of unlearning decision to map unlearning decisions into different generations. The frequencies of mechanisms were summed up. The sum totals were counted for each of the five mechanisms. The results of this analysis are presented in figures 2-6. They depict sum totals for each mechanism, for each time generation, and for each ISPI category. The number of observations for each of the time generation, were the following: generation one 1 observation, generation two 238 observations, generation three 102 observations, and generation four 194 observations (see figures 2-6).
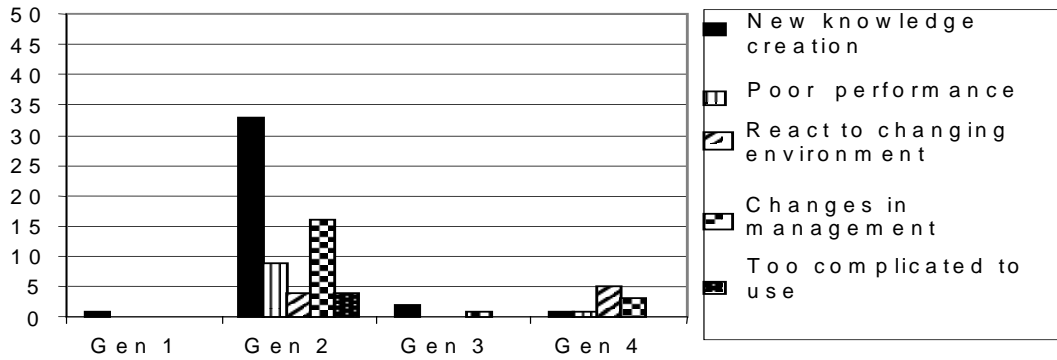
Figure 2.   *Unlearning mechanism influences on project management and controlling category (M) innovations[1]. Time generation is denoted as Gen.*
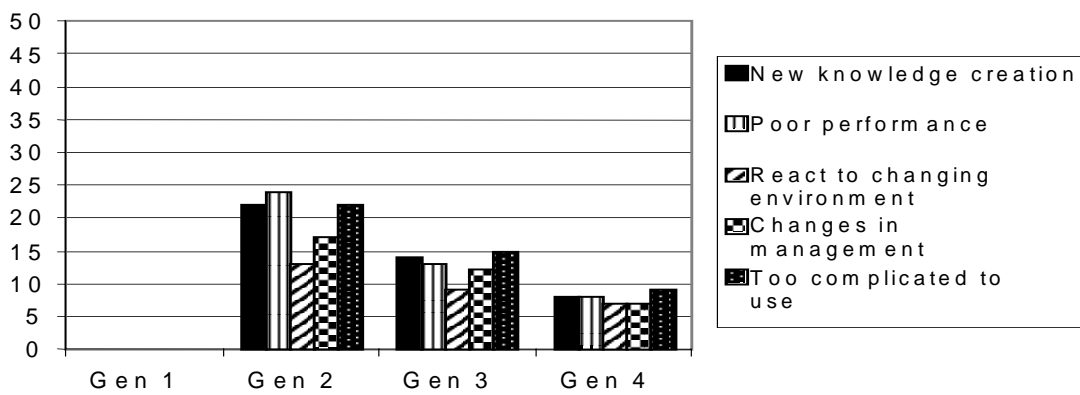

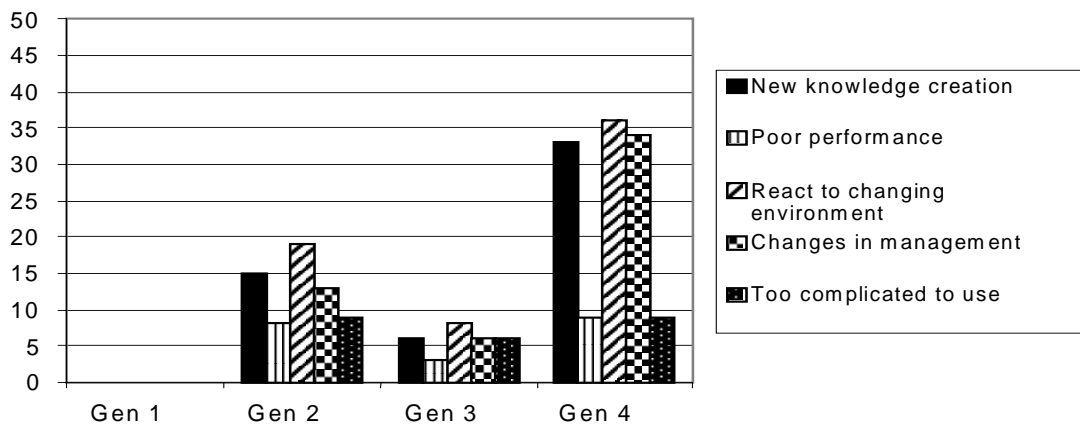*Figure 3.*   *Unlearning mechanism influences on technology T innovations. Time generation is denoted as Gen.*

Figure 4.   *Unlearning mechanism influences on tools (TO) innovations. Time generation is denoted as Gen.*

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[1] The unlearning units over time generations 1, 2, 3 are different as units two and three existed only during generations 3 and 4. Unlearning unit three did not have any data in generation three. Thus, time generation 1 and 2 include unlearning unit one, and time generation 3 and 4 include unlearning unit two.
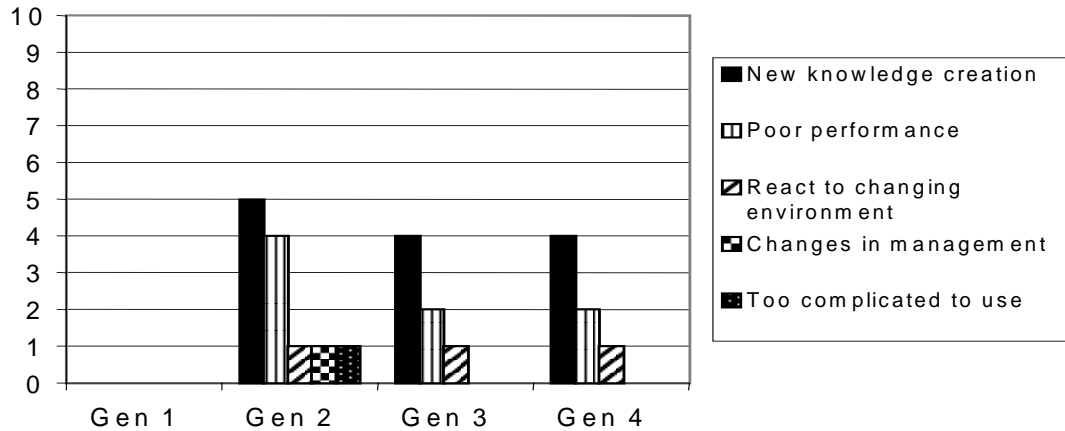
Figure 5.   *Unlearning mechanism influences on description techniques (D) innovations. Time generation is denoted as Gen.*
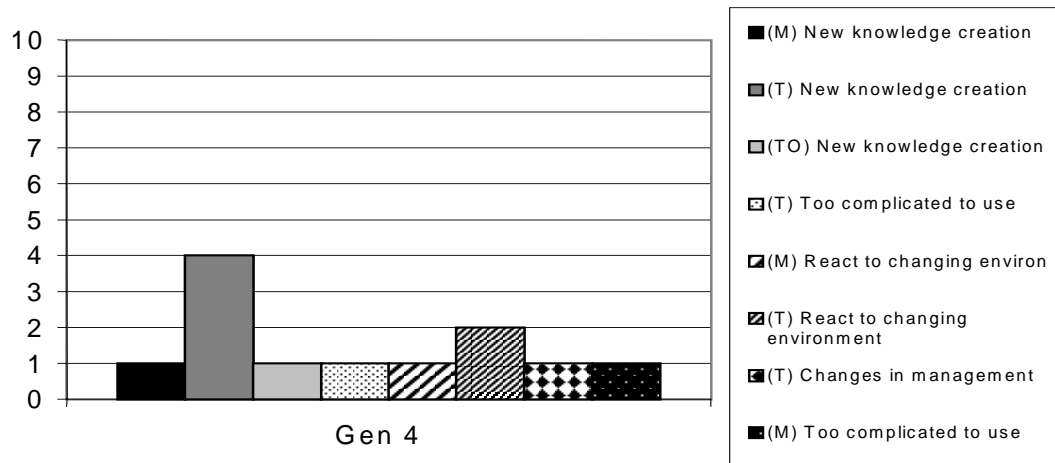

Figure 6.   *Unlearning mechanism influences on project management and controlling procedures (M) innovation, technology (T) innovations, tools (TO) innovations, and description techniques (D) innovation in unlearning unit three.*

If we examine further figures 2-6 we can discover that in the first time generation in project management and control procedures M, technology (T), tools (TO), and description techniques category (D) no prominent mechanisms could be recorded due to a low number of observations. For the project management (M) category, the second generation was most significantly influenced by unlearning mechanisms. After the second generation the unlearning mechanisms decreased in importance as the whole area decreased in popularity. For example poor performance and react to changing environment mechanisms did not exist at all. After second generation the influence of the client-vendor relationships became significant. Shortened projects were important for both parties due to economic reasons. Though, the largest amount of unlearning mechanisms in this category was found during the second generation.

Description techniques (D) were used during project specifications with the client and as an education tool for clients. This innovation became important when these problems surfaced but their importance declined after this issue was solved. We believe that because of this a large number of unlearning fell into category (D). Unlearning mechanisms were also significant and "new knowledge creation", "poor performance" and react to changing environment" were almost the same in D innovations in generations two, three, and four. The mechanisms "changes in management" and "too complicated to

use", however, disappeared in generations three and four. One reason for this is that the existing process technologies were found adequate and an available method was chosen to serve also started projects.

In technology category (T) the importance of all the five mechanisms were steadily decreasing. For example, the data base management and programming tools belonged to this category. Normally they required no modifications and were taken in use directly. The previous knowledge need not to be unlearned, because new knowledge as base on previous knowledge.

In the tools category (TO) unlearning mechanisms were the most important in the fourth generation. Especially the mechanisms "new knowledge creation", "react to changing environment: competitors and other outsider forces threat the survival", and "changes in management: slack or redeployment or allocation of resources, departure of key decision-makers" became the most important of all mechanisms. The reason for unlearning was that new technologies were emerged very rapidly because of the Internet technology and telecommunications and old tools had to be abandoned and unlearned.

In time generation three the importance of mechanisms decreased when comparing to time generation two. This can be explained by the fact that there was no need to unlearn tools, because the same tools were taken in use after outsourcing in time generation three. Throughout all four time generations technologies including the application generators, and network management tools and the like were results of in-house engineering, as there were no suitable tools in the market due to varying computer platforms used in the organisation, rendering the technological infrastructure difficult to manage.

Figure 6 represents the unlearning mechanisms in unlearning unit three in time generation four. Time generation three did not have any data and was therefore left out from the analysis. The reason that there were no mechanisms is that unlearning unit three was established in time generation three and thus no unlearning was needed. The small number of observations, however, does not give a proper idea of the mechanisms. "New knowledge creation" in technology T category had the largest number of observations, and even that mechanism had the maximum of 4 observations.

5   DISCUSSION AND CONCLUSIONS

This study developed an ISPI unlearning research model (figure 1) and analyses longitudinal data set of ISPI unlearning mechanisms in three organisational environments over four decades. The most important unlearning mechanisms discovered were new knowledge creation, poor performance, react to changing environment, changes in management, and too complicated to use. The reason for being the most important was that they were the only mechanisms supported by our empirical data. The study shows that in the three organisations the unlearning mechanisms varied significantly according to ISPI category, and time generation. Unlearning decisions within IPSI categories were influenced by different sets of mechanisms.

We observed that a single mechanism affected unlearning decisions in project management and control procedures category (M) and description techniques category (D). In technology (T) and tools (TO) category unlearning decision was influenced normally by three mechanisms. Unlearning unit one in time generation two used new knowledge creation in managerial process innovations and description methods categories. Unlearning unit two in time generation three used all the five unlearning mechanisms in base line technologies category. Unlearning unit two in time generation four used new knowledge creation, react to changing environment, and changes in management in development tools category. The variation can be thus partly explained by the fact that the technological development and the rapid diffusion of microcomputers in the beginning of 1980s changed IS Development (ISD) work and new skills and ISPIs were needed. In the beginning of 1990s technological platforms, operating systems, databases, tools, and working procedures changed to object orientation, and the previous ISPIs had to be unlearned. The client was neither willing to buy Information Systems if they were implemented with the old fashioned tools. Our results were in line with Gustavsson's (1999), Terreberry's (1968), Rogers (1995), Wolf's (1971), Sarason's (1972),

Cyert's and March's (1963), Hedbers's (1981), Yin's (1979), Smith et. al. 's (1990), Hirschman's (1970), Kimberly's (1981), Downs's (1976), and Diaper's (2001) findings. Our unlearning model, however, should be extended to incorporate new unlearning mechanisms, such as price including license fees and user support fees, and outsourcing. In this typical case an outsourcing occurred in 1984, and we believe this has had a great impact to unlearn the previous ISPIs. One of the major difficulties was encountered during the study concerning our research model. Our model suggests only five unlearning mechanisms, because it was difficult to observe more of them with the recall method we followed. Another limitation is the limited number of organisations studied. The third limitation concerns analysis of cases where several mechanisms had a bearing on a decision. The fourth limitation concerns the comprehensiveness and thus reliability of the data: despite our efforts to obtain through in-depth interviews and extensive use of archival material all relevant facts that affected unlearning, we have to accept the limitation of a historical method. The fifth limitation concerns the obtained results, which may not be applicable to other organisations since the phenomena studied in this study can be atypical. However, if it were possible to collect the same kind of data from other organisations, the analysing methods used in this study would be applicable. On the other hand one of the most important requirements to study ISPI unlearning phenomena in other organisations is that their ISPI evolution, use of Information System Process Innovations, is based on the Friedman and Cronford's (1989) categorisation of the four time generations. If this requirement is fulfilled the research question in this study could be tested in any organisation. Use of ISPIs covers the technological evolution. Business and organisational changes can be different, but it does not prevent to study ISPI unlearning phenomena in other organisations. On the other hand, the research question discovered should be tested separately in every organisation under study.

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Appendix Short description of the three case companies

Three Finnish organisations (units) called here companies A, B and C, respectively, were the data collection sites. Company A is a big global paper-producer. Company B designs, implements, and maintains information systems mostly for company A but also for other companies in paper industry. The origin of company B is that in 1984 company A transferred its Information Systems (IS) department into a newly-formed company, company B that was owned partly by company A and partly by the employees of company B. In 1995 company B was further divided into five separate companies. One of them is company C which was located close to the headquarters of company B and continued to serve mainly company A. These three companies' unlearning units have been situated in three separate Finnish cities. Company A was located in city in Eastern part of Finland and housed several IS activities between 1954-1969 in its separate functional departments (accounting, engineering etc.). In 1969 a separate IS department was established, and it was continued until 1984 when the department was transformed into a separate profit center. Company A had also in-house IS activities in Helsinki between 1961-1969. During 1969-1984 these belonged to the IS department of company A. Despite having separate locations, we chose to treat both sites as an unlearning unit, named company A, due to the fact the two were working intimately together and belonged to the same IS department and also followed the same formal development guidelines. After the 1984 company B's site in the eastern part of Finland is treated as a separate unlearning unit. Between 1995-1997, this site continued to operate separately. The third company -company C- was established in 1989 as a separate division which was located in a different city in Eastern Finland within company B. It continued its existence until 1995 under the formal management of company B. We treat it as a separate unlearning unit because it had totally independent IS development functions. Operated on a different technological platform and it was treated as a separate profit center in company B. The IS and business knowledge within company A's IS department was inherited through outsourcing to company B. Not surprisingly, company B continued the same organisation structure as before the outsourcing, and company A recognised company B easily as its main IS vendor. Considerable organisational development and internal changes, as a result of ISPIs and market changes however, have taken place in fast pace since 1984.