

# WORK DISTRIBUTION IN INFORMATION SYSTEMS DEVELOPMENT, MAINTENANCE AND EVOLUTION

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## Abstract

*The kind of information systems in use today is at first sight very different from those that were developed 20 years ago. On the other hand, it seems that we are still struggling with many of the same problems as before, including late or abandoned projects and unfilled customer demands. In this article we present selected data from survey investigations performed by us in 1993, 1998, 2003, 2008 and 2013 among Norwegian organizations on how they conduct information systems development and maintenance. In particular we compare the data from 2008 and 2013. A major finding is that even if we witness large changes in the underlying implementation technology and methods used, a number of aspects such as overall percentage of time uses for maintaining and evolving systems in production compared to time used for development and the distribution of time on different maintenance activities is remarkably stable, although some trends can be witnessed. On the other hand, because of the more complex infrastructures supporting the application portfolio, and the increasing number of in particular external users an increasing amount of resources is used for other tasks such as operations and user-support than in the first investigations, although also this seems to have stabilised.*

## 1 INTRODUCTION

Large changes in how we develop information systems and the underlying technology for information systems have been witnessed over the last decades. For instance, over this period the prevalent development methods, programming languages and general technological infrastructure have changed substantially. In the early nineties, one went from mainframe solutions to a client-server, and then to an internet and multi-channel architecture for many applications. Year 2000 and the dot.com situation had large impact temporarily on the development and maintenance of systems. More lately SOA, outsourcing, cloud computing, mobile technologies and agile development have been introduced and would be expected to have impact. According to (Jones 2006) one of the impacts on the state of IS-development is the increasing amount of time used for maintenance of systems (instead of developing new systems). On the other hand, many of the intrinsic problems and aspects related to information systems support in organizations are similar now to what they were 20 years ago. Application systems are valuable when they provide information in a manner that enables people to meet their evolving objectives more effectively (Boehm & Sullivan 1999). Many have claimed that the large amount of system work that goes into maintenance is a sign on poor use of resources to meet these demands. On the other hand, as stated already in (Brooks 1987), it is one of the essential properties of application systems that they are under a constant pressure of change. Given the intrinsic evolutionary nature of the sources of system demands, it should come as no surprise that specifications and the related information system must evolve as well (Boehm & Sullivan 1999).

The goal of both development activities and maintenance activities is to keep the overall information system support of the organization relevant to the organization, meaning that it supports the fulfilment of organizational goals. A lot of the activities labelled ‘maintenance’, are in this light value-adding activities, enabling the users of the systems to do new task. On the other hand, a large proportion of the ‘new’ systems being developed are replacement systems, primarily replacing the existing systems without adding much to what end-users can do with the overall application systems portfolio of the organization.

Based on this argumentation we have earlier developed the concept application portfolio evolution (Krogstie 1995) as a more meaningful high-level measure to evaluate to what extent an organization is able to evolve their application system portfolio efficiently. How application portfolio evolution is different from traditional maintenance is described further in the next section.

In this paper, we present descriptive results from two survey-investigations performed in Norwegian organizations during the end of 2013/early 2014, comparing with similar investigations done in Norway in 2008, 2003, 1998 and 1993. These investigations are also comparable to similar investigation by Lientz and Swanson going back to the late 70ties, thus are able to act as replication studies (Brooks et al. 2008) giving us a way of tracking the developments over the last 30 years in this area.

We will first give definitions of some of the main terms used within software development and maintenance, including the terms application portfolio upkeep and application portfolio evolution. We describe the research method, before the main descriptive results from our investigations are presented and compared with previous investigations from earlier years. Section 5 discusses threats to validity of the results. The last section summarizes our results and presents current investigations based on the data and possible future work.

## 2 BASIC CONCEPTS

Maintenance has traditionally been divided into three types: corrective, adaptive and perfective (IEEE 1999) inspired by e.g. (Swanson 1976). This vocabulary is well established both in theory and practice, and we here use the IEEE terms with some clarifications and further division:

Maintenance is defined as the process of modifying a software system or component after delivery.

1. Corrective maintenance is work done to correct faults in hardware and software.
2. Adaptive maintenance is work done to make the computer program usable in a changed environment
3. Perfective maintenance is work done to improve the performance, maintainability, or other attributes of a computer program. Perfective maintenance has been divided into enhanceive maintenance (Chapin 2000) and non-functional perfective maintenance. *Enhanceive* maintenance involves changes and additions to the functionality offered to the users by the system. Non-functional perfective maintenance implies improvements to the quality features of the information system and other features being important for the developer and maintainer of the system, such as modifiability. Non-functional perfective maintenance thus includes what is termed preventive maintenance, but also such things as improving the performance of the system.

In addition to the traditional temporal distinction between development and maintenance, we have introduced the concepts application portfolio evolution and application portfolio upkeep (originally termed functional development and functional maintenance when originally introduced in (Krogstie 1995)).

1. Application portfolio evolution: Development or maintenance where changes in the application increase the functional coverage of the total application systems portfolio of the organization. This includes:
  - a) Enhanceive maintenance.

- b) Development of new systems that cover areas, which are not covered earlier by other systems in the organizations
2. Application portfolio upkeep: Work made to keep the functional coverage of the information system portfolio of the organization at the current level. This includes:
- a) Corrective maintenance
  - b) Adaptive maintenance
  - c) Non-functional perfective maintenance
  - d) Development of replacement systems.

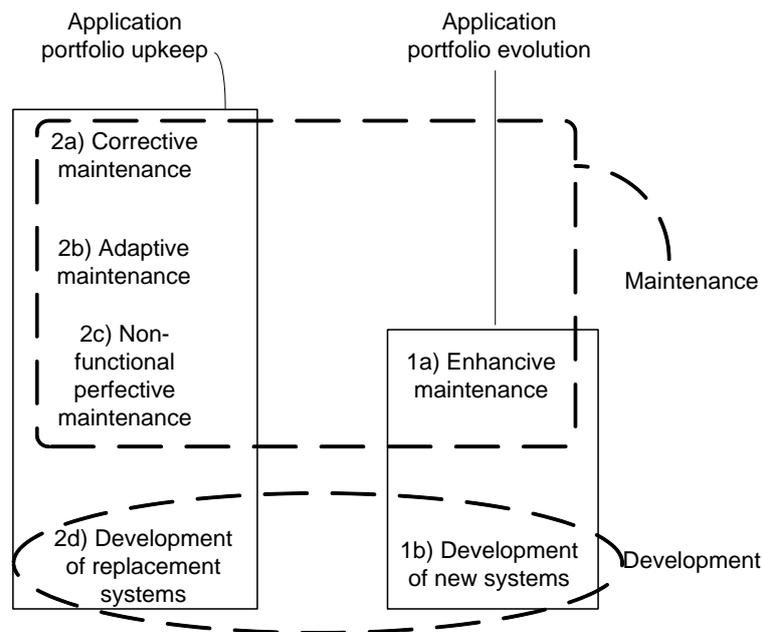


Figure 1. Different types of development and maintenance activities

The relationships between the different concepts are illustrated in Figure 1.

We note that some writers provide more detailed overview of maintenance tasks (Chapin et al 2001, Jones 2006). Jones (2006) has in total 21 categories: This includes user-support as a part of maintenance (a view shared with e.g. Dekleva (1992)), an area usually looked upon as belonging to ‘other work’ in other investigations, including ours.

### 3 RESEARCH METHOD

In connection to this work, we have performed two studies. One is our main replication study covering a large number of topics matching the ones we have investigated 4 times earlier. The other is in connection to the yearly ‘IT i praksis’ (Rambøll 2014) investigation done early 2014, where we have included the questions relative to work distribution from our replication study, to compare this with e.g. the benefit of IT, alignment of IT and business strategy etc. We present these investigations individually below.

Our main replication survey was implemented in the SurveyMonkey web-tool and invitations were distributed by e-mail to 388 Norwegian organizations. The organizations were randomly selected from the list of member organizations of DnD (The Norwegian Computer Society - NCS) (NCS has currently around 1000 member organizations primarily in the private sector) and OSDF - the public sector IT-forum, to have also respondents from the public sector. IT i praksis was sent out to more than 500 or-

ganizations, equally divided between public and private sector, and we made sure to avoid overlap between the respondents.

The form in our replication study contained 41 questions including demographic data. The contents of the form were based on previous investigations within this area; especially those described in (Davidsen & Krogstie 2010, Holgeid, Krogstie & Sjøberg 2000, Krogstie & Sølvberg 1994, Krogstie, Jahr & Sjøberg 2003, Lientz & Swanson 1980, Nosek & Palvia 1990, Swanson & Beath 1989). The full survey form is available on request (main parts of this are available in (Davidsen & Krogstie 2010)). In this paper, only responses to questions shared with the IT i Praksis study are reported.

On some of the questions, we were interested in the quality of the answers, recognizing that some of the information called for might not be easily obtainable for all. It was also room for issuing open-ended remarks.

Galtung (1967) regards that the least size that is meaningful in a survey is 40 units. Since survey-investigations in the area of development and maintenance of application systems toward the same population earlier had given a response rate in the area of 22%-28% (Davidsen & Krogstie 2010) and the response rate of similar surveys has been around 20-25% (e.g. (Lientz & Swanson 1980, Nosek & Palvia 1990)), an answer ratio of approximately 20% was expected. This would have resulted in around 77 responses. 87 responses were returned, giving a response rate of 22%. Out of these 68 responses could be used for the analysis. The additional responses were not complete, and in particular did not include responses to the questions relative to distribution of work.

Although this provides sufficiently many responses to provide grounds for doing statistical analysis, it would obviously be better to have a larger number of responses, based on a higher response rate. Our other investigation, linked to 'IT i praksis' supported this goal. Out of 533 distributed survey forms in this investigation, 272 responded (i.e. 51%), although only 208 provided responses to the questions matching our main investigation. When we put the results together, we had a total response-rate of 39%.

The forms in our main investigation were filled in using the web-form by people with long experience with application systems related work (average 21, 3 years), typically filling the role as IT director in the company. Judged on the responses, all organizations were doing work on all support-line levels (1-3) (Kajko-Mattson 2004), but with different emphasis on different types of support, and different patterns of (out) sourcing of activities. Because of this we will be cautious in our interpretations of the results.

### **3.1. Previous investigations**

Being a replication study, we will compare some of the results with the results of similar investigations done before. The most important of these investigations are:

1. The investigation carried out by Davidsen and Krogstie in 2008 reported in (Davidsen & Krogstie, 2010a)
2. The investigation carried out by Jahr, Krogstie, and Sjøberg in 2003 reported in (Krogstie, Jahr & Sjøberg 2006).
3. The investigation carried out by Holgeid, Krogstie and Sjøberg in 1998 reported in (Holgeid, Krogstie & Sjøberg 2000).
4. The investigation carried out by Krogstie in 1993 reported in (Krogstie & Sølvberg 1994).
5. The Lientz and Swanson investigation (LS) reported in (Lientz & Swanson 1980): That investigation was carried out in 1977, with responses from 487 American organizations on 487 application systems.

6. The Nosek and Palvia investigation (NP) reported in (Nosek & Palvia 1990): A follow-up study to Lientz/Swanson performed in 1990 asking many of the same questions as those of LS. Their results are based on responses from 52 American organizations.

The four first surveys in the list are the main Norwegian investigations in the Lientz/Swanson tradition. They contain the results from investigations of 77, 54, 52 and 53 Norwegian organizations, respectively. Special papers have in addition investigated specific aspects, including use of methodology and tools (Krogstie 1996), differences between private and public sector (Krogstie 2012), and comparisons of long-term trends (Krogstie 2006, Davidsen & Krogstie 2010b). In addition to these investigations, a number of later investigations have been done, but they typically focus on the distribution of maintenance tasks only (Gupta et al. 2006, Lee & Jefferson 2005, Mohaghegdi & Conradi 2004, Schach et al 2003), many only looking on the situation in one organization or on one application.

Several of the organizations that received a survey-form in the 1993, 1998, 2003 and 2008 studies also received the invitation to fill out the form in 2013, and many of the same questions have been asked. The methods that are used are also similar, enabling us to present a replication study, although the overlap among actual respondents to the survey is limited to only a few organizations across different instalments of the survey. Even if the population selection process was similar, the actual organizations in these populations have changed a lot over the period of twenty years, both because of changed focus on IT, and because of the volatile business environment, with a number of acquisitions, mergers and bankruptcies.

### **3.2 Hypothesis**

The following main hypotheses were formulated to investigate the development of the different measures for distribution of work.

- H1: There is no difference between the percentage of time used for maintenance reported in our survey and what are reported in previous surveys. Rationale: When comparing the percentage of time used for maintenance activities in organizations earlier, we have found this to be stable on close to 40 percent of the overall time in our last three investigations (1998, 2003, and 2008), slowly declining. We would not expect this to be different in this survey.
- H2: There is no difference between the percentage of time used on development reported in our survey and what are reported in previous surveys. Rationale: When comparing the percentage of time used for development activities in organizations earlier, we have found this to be stable on close to 20 percent of the overall time in investigations both in the seventies, eighties, and nineties in both USA and Norway. We would not expect this to be different in this survey.
- H3: There is no difference between the breakdown of maintenance work (in corrective, adaptive, and perfective maintenance) in our survey and what are reported in previous surveys. Rationale: A number of investigations (also from the later years) reporting on the distribution of time among maintenance tasks as summarized in (Gupta et al, 2006) reports very different numbers for these distributions. On the other hand the scope of the investigations varies greatly. Whereas some look on single systems of numerous organizations and the whole portfolio of numerous organizations, other look only at one or a few applications in one organization. Since this distribution naturally will differ according to where the individual system is in the lifecycle (development, evolution, servicing, phase-out, closed (Rajlich & Bennett 2000)), this difference should be expected when only looking on individual systems. When averaging across a large number of application portfolios, each consisting of a number of systems of different maturity on the other hand, we would expect a more stable distribution. We will investigate this relative to the percentage of corrective, adaptive, and perfective maintenance reported.
- H4: There is no difference between the distribution of work among maintenance and development in our survey and what is reported in previous surveys when disregarding other work than development

and maintenance. Rationale: Since the amount of other work than development and maintenance is taking up more time now than earlier, we found it beneficial also in the surveys in 1993, 1998, 2003 and 2008 to look at only the proportion between development and maintenance time. When only taking development and maintenance into account, the amount of time used for maintenance has been shown to be stable on 65-70% (i.e., 30-35% for development) since the late 90ties, raising from around 60 % in earlier investigations.

- H5: There is no difference between the distribution of application portfolio upkeep and application portfolio evolution in our survey and what are reported in previous surveys. Rationale: Since these numbers had been investigated only in our own investigations, we were eager to find if also they had the same stable distribution as the maintenance figure. They were significantly higher in 1998 than in 1993, but on the same level in 2008, 2003 and 1998, a pattern we would expect to continue.

## 4 INVESTIGATING DISTRIBUTION OF WORK

Work on application systems was in the survey divided into the six categories presented in section 2. The same categories were also used in 1993, 1998 and 2003 and 2008. We also asked for the time used for user-support and for systems operations which took up the additional time for the work in the IS departments. For these figures we have numbers both from the main replication study and the IT i praksis-study, and we present here the aggregated numbers from these studies below. Note that in the surveys, we do not ask for numbers of our specific figures on application portfolio evolution and upkeep, but calculate them from figures of the more well-known types of maintenance and development.

Table 1 shows the distribution of work in previous investigations, listing the percentage of maintenance work, the study reported, and the year of the study. Based on this we find that in most investigations, between 50% and 70% of the effort is done to enhance and adapt systems in operation (maintenance) when disregarding other work than development and maintenance, although with a slightly increasing trend. An exception from this was our study in 1998 that was influenced particularly by the amount of Y2K-oriented maintenance (Holgeid et al. 2000). The numbers reported by Jones (2006) were also higher than this, but these also include user support as part of maintenance contrary to what we have done in our surveys. Dekleva (1992) also include user support as part of maintenance.

*Table 1: Result on percentage of maintenance from previous investigations*

<b>%maintenance</b>	<b>Investigation</b>	<b>Year</b>
49	Arfa, Mili & Sekhri (1990)	1990
53	Lientz & Swanson (1980)	1980
56	Jørgensen (1994)	1994
58	Yip (1995)	1995
59	Krogstie & Sølvsberg (1994)	1993
62	Nosek & Palvia (1990)	1990
66	Daidsen et al (2010a)	2008
66	Krogstie et al (2006)	2003
66	Dekleva (1992)	1990
73	Holgeid et al (2000)	1998
73	Capers Jones (2006)	2000
79	Capers Jones (2006)	2010 est.

Table 2 summarizes the descriptive results on the distribution of work in the categories in our investigation, comparing to previous investigations.

Table 2: Distribution of the work done by IS-departments

Category	2013	2008	2003	1998	1993	LS
Corrective	10.2	8.2	8.8	12.7	10.4	10.6
Adaptive	9.7	6.3	7.3	8.2	4	11.5
Enhancive	12.9	11.3	12.9	15.2	20.4	20.5
Non-functional perfective	8.0	9.1	7.6	5.4	5.2	6.4
<b>Total maintenance</b>	<b>40.7</b>	<b>34.9</b>	<b>36.6</b>	<b>41,5</b>	<b>40</b>	<b>48.8</b>
Replacement	8.3	9.7	9.9	7.7	11,2	NA
New development	8.3	11.4	12.5	9.5	18,4	NA
<b>Total development</b>	<b>16.6</b>	<b>21.1</b>	<b>22.4</b>	<b>17.1</b>	<b>29.6</b>	<b>43.3</b>
Technical operation	23.4	23.8	23.6	23	NA	NA
User support	19.2	20.1	17.2	18.6	NA	NA
<b>Other</b>	<b>42.6</b>	<b>43.9</b>	<b>40.8</b>	<b>41.6</b>	<b>30.4</b>	<b>7,9</b>

40.7% of the total work among the responding organizations is maintenance activities, and 16.6% is development activities. When disregarding other work than development and maintenance of application systems, the percentages are as follows: maintenance activities: 73%, development activities: 27 %. This is a bit more skewed towards maintenance than in the previous investigations. 65% of development and maintenance work was application portfolio upkeep, and 35% was application portfolio evolution. This is almost the same as in 2008, 2003 and 1998, which in turn was significantly different from the situation in 1993 where application portfolio upkeep- and application portfolio evolution respectively amounted to 44% and 56% of the work (see table 4).

Table 3 summarizes the results on the breakdown of maintenance activities from our investigations where we look upon the complete portfolio of the responding organizations. Most interesting for comparison with other surveys is looking at corrective, adaptive, and perfective maintenance, which appears to be much more stable than the numbers reported from others. We do note though that the enhancive maintenance part of perfective maintenance appears to have stabilized on a lower level than we found 20 years ago.

Table 3 Distribution of maintenance activities

Category	2013	2008	2003	1998	1993	LS
	Mean	Mean	Mean	Mean	Mean	Mean
1 Corrective maintenance	25	24	24	31	26	17
2 Adaptive maintenance	24	19	20	20	10	18
3 Enhancive maintenance	32	30	35	37	51	
4 Non-functional perfective maintenance	19	27	21	13	13	
Perfective maintenance (3+4)	51	57	56	50	64	60

Further comparisons of descriptive results between different studies are presented in Table 4. The first column lists the category, whereas the other columns list the numbers from our investigation, the one in 2003, the one in 1998, the one in 1993, the Nosek/Palvia (NP) investigation and the Lientz/Swanson (LS) investigation. The first set of number compare the numbers for development, maintenance and other work. The amount of *other work* reported in our investigations is much larger than in the American investigations. Therefore, in the second set of figures, we compare the data without considering other work. For the categories application portfolio evolution and application portfolio upkeep, we only have numbers from our own investigations.

Table 4: Comparisons of maintenance figures with previous investigations

Category	2013	2008	2003	1998	1993	NP	LS
Development	17	21	21	17	30	35	43
Maintenance	41	35	35	41	40	58	49
Other work	43	44	44	42	30	7	8
<b><i>Disregarding other work</i></b>							
Development	27	34	34	27	41	38	47
Maintenance	73	66	66	73	59	62	53
<b><i>Functional effort</i></b>							
Application portfolio evolution	35	36	39	38	56	NA	NA
Application portfolio upkeep	65	64	61	62	44	NA	NA

Test of significance of differences of results between earlier investigations have been presented in (Davidsen & Krogstie 2010a, Holgeid et al 2000, Krogstie et al 2006). Similar tests in the 2008 investigations showed that there was no significant development in these numbers. Although also in this round the differences on many variables are relatively small, the large number of responses makes it more possible to find if the differences actually are significant. Before looking for significant relationships to follow up the stated hypothesis related to trends, the variables used in the comparisons were tested for normality as illustrated in Table 5. We provide here data to test the distribution of the relevant variables from the 2013 and 2008 investigation. As indicated by the significant numbers (in boldface), data for a number of variables cannot be investigated as if they were normally distributed, since we in these cases must reject the null-hypothesis that the numbers are normally distributed, since either the Shapiro-Wilks (S-W Sign) and/or the Kolmogorov-Smirnov (Lilliefors-Sign) significance levels are less than 0.05. On some variables (application portfolio upkeep) we could use the assumption of normal distribution in the tests below, using t-tests, whereas for the others we use a non-parametric test (Mann-Whitney).

Table 5: Test for normality of variables

Figure	Kolmogorov-Smirnov	Sign (p)	Shapiro-Wilks	S-W Sign (p)
Corrective maintenance 2013	.238	<b>.000</b>	.770	<b>.000</b>
Corrective maintenance 2008	.208	<b>.000</b>	.752	<b>.000</b>
Adaptive maintenance 2013	.124	<b>.000</b>	.922	<b>.000</b>
Adaptive maintenance 2008	.231	<b>.000</b>	.881	<b>.000</b>
Perfective maintenance 2013	.121	<b>.000</b>	.901	<b>.000</b>
Perfective maintenance 2008	.080	.200	.973	.204

Maintenance 2013	.086	<b>.000</b>	.979	<b>.001</b>
Maintenance 2008	.073	.200	.986	.705
Development 2013	.117	<b>.000</b>	.271	<b>.000</b>
Development 2008	.106	.086	.946	<b>.009</b>
Maintenance relative to development 2013	.097	<b>.000</b>	.948	<b>.000</b>
Maintenance relative to development 2008	.117	<b>.038</b>	.941	<b>.006</b>
Application portfolio upkeep 2013	.051	.089	.990	.060
Application portfolio upkeep 2008	.096	.200	.961	.051

We tested H1-H5 by comparing with our previous survey as summarised in Table 6.

*Table 6: Test of hypothesis*

	<b>Year</b>	<b>N</b>	<b>Mean</b>	<b>SD</b>	<b>Δ</b>	<b>P</b>
Maintenance, percentage of all work (vs. H1)	2008	63	34.9	17.6	6.9	.053
	2013	271	40.8	16.4		
Development, percentage of all work (vs. H2)	2008	63	21.1	16.4	4.5	<b>.035</b>
	2013	271	16.6	14.2		
Corrective maintenance, percentage of all work (vs. H3a)	2008	63	8.2	8.0	2	.175
	2013	275	10.2	8.0		
Adaptive maintenance, percentage of all work (vs. H3b)	2008	63	6.3	5.5	3.4	<b>.000</b>
	2013	275	9.7	6.4		
Perfective maintenance, percentage of all work (vs. H3c)	2008	63	20.1	13.7	0.8	.884
	2013	275	20.9	12.7		
Maintenance, disregarding other work (vs. H4)	2008	61	65.7	21.5	7.5	<b>.013</b>
	2013	271	73.2	19.1		
Application portfolio upkeep (vs. H5)	2008	61	63.9	18,6	1.3	.613
	2013	271	65.2	16.4		

We list the number of cases, the mean and the standard deviation for all relevant figures to test the seven hypotheses (for H3, there are three test, for the difference in corrective, adaptive, and perfective maintenance respectively), having the numbers from 2008 on the top and those from 2013 on the bottom.  $\Delta$  is the absolute difference in the mean from the 2008 and the 2013 study, and  $p$  is the probability for erroneously rejecting the equality of means. We briefly summarise the results in the start of the conclusion after discussion threat to validity.

## **5 THREATS TO VALIDITY**

The results of our study should be interpreted cautiously as there are several potential threats to its validity. The discussion below is based on recommendations given in (Jørgensen 1994, Kitchenham et al 2002).

### **5.1. Population**

The sample of our study was initially intended to represent the population of Norwegian companies or organizations with own development and maintenance work. Since a substantial number of the major Norwegian IT companies are members of The Norwegian Computer Society (NCS) we pragmatically chose the around 1000 member companies of NCS as our population for companies in the private sector. To have respondents also from the public sector, we chose the member organizations of OSDF - the public sector IT-forum. We distributed our survey forms to a random selection of 388 of those companies. *IT i praksis* is also sent to private and public sector organizations that perform at least part of the IT-activities internally. There is currently more than 800 organizations in public sector, only some of which are members of OSDF. Some of the large public sector organizations are also members of NCS, thus the total population is roughly close to 2000 organizations. Other studies also use member lists as a source of subjects, e.g. (Lientz & Swanson 1980). In particular, NCS-members were also used in the studies in 2008, 2003, 1998 and 1993. As noted in section 3, the actual responding organizations have changed a lot between the different studies which is inevitable in such studies, thus rather than presenting a truly longitudinal study, what we are able to do is to present a replication study.

### **5.2. Response rate**

According to (Saunders, Lewis & Thornhill 2009), it is common for Internet and e-mail surveys with a response rate of 11 % or lower. The response rate on the main replication survey of 22% can still be argued to be rather low. We experienced the same kind of problem of getting a high response rate in 2008, 2003, 1998 and 1993. The '*IT i praksis*'-investigation though had a response rate of 51%, and as reported around 39% responded in total. These close to 300 organizations are around 15% of the total population though. A problem with a low response rate is that the respondents may not be representative of the population, that is, the companies may be particularly mature, have less pressure (they have time to answer survey forms), etc. However, the same selection mechanism was used in the 2013, 2008, 2003, 1998 and 1993 studies, so a comparison between those five studies should be reasonable.

### **5.3. Respondents**

Most of the persons who responded were IT managers in the company. They may have different views of the reality than developers and maintainers. For example, Jørgensen (1994) found that manager estimates of the proportion of effort spent on corrective maintenance were biased towards too high values when based on best guesses instead of good data, see also (Schach et al 2003) which report a similar effect. There might be biases in our study of this kind, but they may not affect the comparison with the 2008,

2003, 1998 and 1993 studies as the survey forms of these studies were also filled in by IT managers. Also in the previous American studies, IT managers have responded to the surveys.

#### **5.4. Understanding of concepts**

Achieving consistent answers requires that the respondents have a common understanding of the basic concepts of the survey form. This may be difficult to ensure in practice. For example, Jørgensen (1994) found that the respondents used their own definition of, for example, “software maintenance” even though the term was defined at the beginning of the questionnaire. We conducted a pilot study in a few companies to detect unclear questions and whether the time for filling-in the forms was reasonable. On earlier versions of the form we also got comments from several colleagues including experts in cognitive psychology which were highly familiar with the use of survey techniques and ensuring clarity of the formulation of questions. The forms were then refined. For many questions, there was space available to issue comments. This possibility together with the possibility to crosscheck numbers between different questions was the main mechanisms used to identify possible misunderstanding among the respondents, which could be followed up afterwards.

#### **5.5. Biased questions**

Among the risks when designing survey forms are leading or sensitive questions, resulting in biased or dishonest answers. We believe that we have mostly avoided this problem. We promised and effectuated full confidentiality to the respondents.

#### **5.6. Quality of data**

On some of the questions, we were interested in the quality of the answers, recognizing that some of the information called for might not be easily obtainable. Answers of some of the quantitative questions were checked against each other for control. The remarks made on the questions gave more insight into the answers. We qualified for instance all data regarding distribution of work both in our study and the studies in 1993, 1998, 2003 and 2008 without finding significant differences on the variables we have used in the hypothesis testing between those reporting having good data and those coming with qualified guesses.

## **6 CONCLUSION AND FURTHER WORK**

Revisiting our hypotheses, we conclude the following:

- H1: There is no difference between the percentage of time used for maintenance reported in our survey and what are reported in previous surveys: Not rejected. From table 6, we observe a large increase in this number (from 34.9 to 41.3 percent), but this is not significant. We note from table 2 that we seem to have returned to the level reported in the nineties on this figure.
- H2: There is no difference between the percentage of time used on development reported in our survey and what are reported in previous surveys: Rejected. The amount of development work has gone down significantly (on the 0.05 - level) between 2008 and 2013, from 21.1 to 16.8% of the total time. The level of development in 2013 is as low as it was in 1998, which was largely influenced by the Y2K-preparations. It is in particular the time for development of new systems that is lower. This can be related to that more of the development work is being outsourced to external organizations, a hypothesis we will investigate in further work.

- H3: There is no difference between the breakdown of maintenance work (in corrective, adaptive, and perfective maintenance) in our survey and what are reported in previous surveys. Not rejected for corrected and perfective maintenance, but rejected for adaptive maintenance. A large number of changes in the underlying IT-development infrastructure such as the introduction of cloud computing and increasing popularity of mobile applications might be behind this development.
- H4: There is no difference between the distribution of work among maintenance and development in our survey and what is reported in previous surveys when disregarding other work than development and maintenance. Rejected. The percentage of development vs. maintenance is back at the level reported before Y2K (1998), having a significant increase in the amount of work done for maintenance.
- H5: There is no difference between the distribution of application portfolio upkeep and application portfolio evolution in our survey and what are reported in previous surveys. Not rejected. Even if more work is done on maintenance, more of this work is done on enhanceive maintenance, offloading the decrease in the amount of work spent on developing new systems. Thus even if the report on maintenance figures only could be a source of alarm, the functional maintenance measure which we have argued gives a better indication on to what extent resources are used well in an organization, is kept at a stable, albeit arguably high level.

To explain differences better, we will look on other aspects from the replication study. There are for instance a number of differences in the underlying technology, which is as expected. This is very clearly witnessed in the distribution of programming languages used, where procedurally languages like COBOL have to a large extent been suppressed by object-oriented languages like Java, C++ and C# and by scripting languages. Note still that this has happened later than one might would have originally expected, applications exist for a number of years in organizations before they are being replaced. New architectural trends such as SOA and cloud computing are starting to make some impact on the use of resources, although less than expected given that it is more than ten years ago that web services and SOA was heralded as the way to develop systems for the future. Another marked trend is that less and less of IT is done internally in organizations (this applies to development, maintenance, operations and use). On the other hand, even if most organizations outsource part of the IT-activities, most still do the majority of the activities in-house. Overall percentage of time used for application portfolio evolution is remarkably stable. The same can be said about the rate of replacement, although slightly increasing, more than 60% of 'new' systems to be developed are actually replacement systems, constituting around 13% of the current application portfolio. Since more complex infrastructures are supporting the information systems, and they have increasing number of users, more of the resources are used for other tasks than development and maintenance than when we started these investigations, but also this seems to have stabilized.

As we in the current investigation have data from many more organizations than in the previous studies, it will hopefully be easier to find significant results relative to what characterizes organizations with good practice, having a high degree of application portfolio evolution. Among other things we investigate the differences between private and public sector organization. This follows up the previous exploratory investigation on this difference (Krogstie 2012). Here, small, but not statistically significant differences were found. Another area is to investigate to what extent the integration of IT and business strategy influences the ability to prioritize resources to developing new functionality either as new systems or as enhanceive maintenance.

A survey investigation of this form has known limitations as discussed in the previous section. To come up with more concrete empirical data on to what extent the application systems support in an organization is efficient, demands another type of investigation, surveying the whole portfolio of the individual organization, and getting more detailed data on the amount of the work that is looked upon as giving the end-user improved support, and how efficient this improved support was provided. This should include the views of the users of the application systems portfolio in addition to those of the IS-managers and developers. Results from such detailed case studies on the other hand are hard to generalize.

We have just started on the analysis of the data, and we are currently performing more detailed statistical analysis. Contrary to our main study, 'IT i praksis' is run yearly, and getting high level work distribution data regularly is interesting for further investigations. A long-term plan is to do a similar replication investigation in 2018, following up our five-year cycle, but before that have done some additional case studies to more precisely pinpoint relevant issues including methodological, managerial and technological trends to investigate.

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