Differences in Information Systems Development and Evolution Practice between the Local and Governmental Public Sector

John Krogstie, Amund Fredrik Strømsnes
IDI, NTNU, Trondheim, Norway
krogstie@idi.ntnu.no

Abstract: We have in earlier work reported differences between how public and private Norwegian organizations are able to use time on value adding activities in their work on IT. Using responses to the 'IT i Praksis' – surveys done by Rambøll in 2021, we in this paper look upon differences between local (municipalities) and governmental agencies. 'IT i praksis' is distributed to Norwegian public organizations, and the overall response rate is around 45-50%, although not all respondents answer all questions. The data presented in this paper is based on responses from 255 public organizations, with 176 municipalities, and 79 public organizations on national or regional level that have responded. Overall, the investigation confirms the results from earlier investigations when it comes to maturity of practice in public sector and how this might influence their ability to have time available for value added IT-activities. In this investigation we also find differences within public sector, with municipalities scoring worse on several parameters for successful management and evolution of IT.

1 Introduction

Many authors have over the years claimed that there are more problems with effective and efficient digitalization in the public than in the private sector. In Moløkken-Østvold [27] it is reported that "Public projects had an average effort overrun of 67%, as opposed to the 21% average in private projects. This observed difference appears to be caused by systematic differences between private and public organizations found at 1) the political level, 2) the organizational level, and 3) and the individual level". A number of reports indicate that this has been an international issue [7] in OECD countries, USA and in the UK [29].

A reason these failures get so well-known though might be because they are in the public sector, thus information about success and failure is also public information. As reported in [2] failure is happening both in public and private sector, and usually,

the failures are only partial; most systems eventually get delivered and are used at least partly. In Jørgensen [14], it was not reported any significant differences between project success in public and private organizations as for delivered benefit, cost overrun and adherence to schedule.

On the other hand, the work in this area is in our view too narrowly focused on development projects. Although it has long been known that only a small fraction (15-20% on average) of the effort used on IT in organizations is done on making new systems [11], research in information systems and software engineering is excessively interested in this part of the system lifecycle. It is also important that it is possible to evolve system through the life-cycle, also being able to add new functionality to systems in production. Application systems are valuable when they provide information in a manner that enables people to meet their objectives more effectively and efficiently [1]. An application system is part of a larger organizational information system, which in turn is part of a broader environment that is under constant change. This environment of change raises constantly new requirements and possibilities that an organization must address which implies that the supporting information systems also must be easily adaptable.

The goal of both development 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 usually labelled 'maintenance', are in this light value-adding activates, enabling the users of the systems to do new task. On the other hand, a large proportion of the 'new' systems being developed are so-called replacement systems, mostly replacing the existing systems without adding much to what end-users can do with the overall application systems portfolio of the organization [10]. Based on this argumentation we have earlier developed the concept functional maintenance[1] as a high-level measure to evaluate important aspects of to what extent an organization is able to evolve their application system portfolio efficiently. In [6], it was shown how public and private organization differed on such measures. How application portfolio upkeep is different from maintenance is described further below.

Norway has a large number of organization which are defined as private, but yet having substantial public ownership, the state being a major shareholder. Also, a lot of previous public organizations have been transformed to private companies or state owned limited companies or other kinds of organizations with varying degrees of freedom being run more according to private business principles than what was usual earlier. On the other hand, we find certain important traits among public organizations e.g. that they all have to abide to the same (arguably non-optimal) rule of procurement found in the EU legal framework for public procurement and development of IT-solutions. For instance, when external companies are involved in developing the requirements to a system, they are not allowed to be involved in the implementation of the system [8]. A stricter year to year budgeting regime can also be witnessed in public sector than private sector. Public sector organizations also have a different safety net. E.g. a municipality will not cease to exist due to bankruptcy (although it can be

[1] Also called 'application portfolio upkeep' in some papers

put under administration). Public organizations often have political constraints that can change frequently and in an unpredictable manner. This might lead to an unstable long-time environment of a different sort than the economic environment found in the private sector. There is often little competition on the services they are delivering, and this means that they do not need to fight for the customers like private organizations do. Regarding goals, a public organization have stricter goals on equality and accountability. The primary goal of a private organization is to make profits. All this makes the dichotomy between private and public organization meaningful as was investigated in [6]. On the other hand, there are quite some differences between the municipal and governmental level, which is what we will investigate here based on a survey-investigation performed in Norwegian public organizations in this area in 2021. It can be argued that there are also differences between municipalities such as size, but they all has to deliver the same set of services to the citizens. Our core research question is:

1. Is information systems development support conducted differently in the municipalities, compared to how it is done in other parts of the public sector in Norway?

We will first give definitions of some of the main terms used within information systems evolution. We describe the research method, including more detailed hypotheses spawned from the field detailing the above research question, before the main results from our investigation are presented. Then a closer investigation on the differences between municipalities and other public sector respondents are presented. The last section summarizes our results and presents ideas for further work.

2 Definition of core concepts

Effort related to development and maintenance can be split into various types of activities. In this paper, we distinguish between the activity types shown in Fig. 1. The activity types are well established in literature; they were initially defined by Swanson [36] and have been gradually refined [10,18]. Maintenance activities is work on software in operation as follows (Fig. 1): corrective maintenance (1a) is performed to identify and correct processing, performance, and implementation failures; adaptive maintenance (1b) is performed to adapt the software to a changing technical environment; non-functional perfective maintenance (1c), which includes preventive maintenance [12], is performed to improve the quality of the IT system and features that are important to the evolution of the system, such as modifiability; finally enhancive maintenance (1d) is performed to change or add new functionality [3]. Software development activities are divided into the development of replacement systems (2a) and the development of new systems with new functionality (2b).

To better distinguish between activities that have a potential direct impact on value for the end-users, we further distinguish between functional maintenance and functional development as initially introduced by Krogstie & Sølvberg [22].

- Functional maintenance is the effort needed to keep the existing application portfolio afloat by maintaining the existing functionality (1a, 1b, 1c and 2a). The term "total application portfolio upkeep" is used when also taking user support (3) and IT operations (4) into account.
- Functional development consists of activities that help advance the IT portfolio by adding or enhancing functionality that is potentially valuable to the end-users (1d and 2b).

An important reason to look at activities across the traditional border between development and maintenance is that these activities have become increasingly blurred in modern system development and maintenance. For example, enhancive maintenance consists of value-adding activities enabling the users of the systems to perform new tasks. The development of this additional functionality on systems in operation is also often being organized as projects in the same way as how new systems are developed. However, a large proportion of the systems being developed are replacement systems, for the most part replacing existing systems in the organization without adding much to what end-users can do with the overall application systems portfolio of the organization, at least not in the first version. The need for closer interaction between systems being developed and work done on systems in operation (maintenance) is witnessed by the increased focus on DevOps by integrating the work done by developers and system operations people [5]. We refer to [19] pp. 132-134) for further description of the activity types.

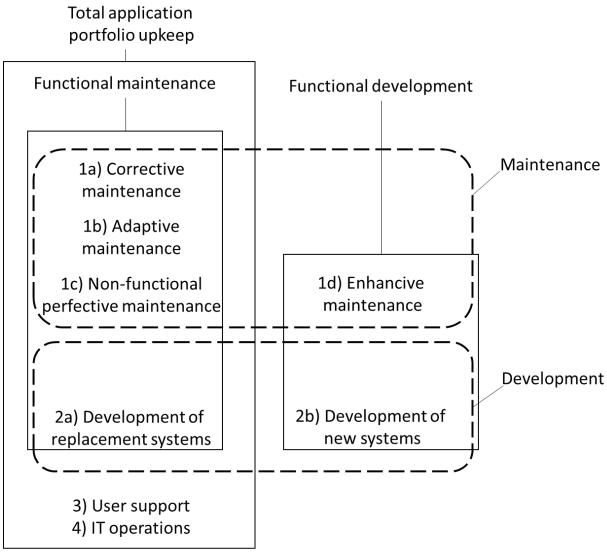

Fig. 1. Types of development and maintenance activities

We will compare some of the results of this study with the result reported in [6]. To illustrate the stability of numbers in this area, we also present data from investigations of this sort back to 1993, taken from [11]. These studies focused mainly on assessing the work distribution and compared it with previous studies to uncover changing patterns in how IT-related activities are distributed across the various work categories. They have also looked at other characteristics of the system portfolio. To a limited extent, they have sought an explanation of the various work distributions by, for example, trying to relate the work distribution to other characteristics of the organization. We have included the string of numbers here, illustrating that numbers for e.g. functional maintenance is stable also in the last investigation, thus supporting the probability of these data giving an accurate picture.

In 'IT i Praksis', one has also investigated the level of the organizations on to what extend one have achieved the goals of the national digitalization strategy, and indicators for the effort being made for achieving these goals.

The goal indicators are:

- Openness and inclusion
- Solve task digitally
- All communication digital
- Collaborate to make explicit the potential of data
- Services part of common ecosystem
- Value realization

The effort indicators are

- Continous services with the user at the center
- Increased reuse of data
- Common ecosystem as a basis for service development
- Laws and regulation that are easy to automate
- Governance towards a connected public sector
- Increase collaboration with private sector
- Digital security
- Digital competence

3 Research Method

In connection to this work, we have used data from the yearly 'IT i Praksis' survey arranged by Rambøll in 2021 [34]. We have earlier used data from 'IT i Praksis' from 2014, 2015 and 2016 [6, 31, 32, 33]. In these surveys we have included the questions on work distribution from our own studies, to compare this with e.g. the perceived result of IT and the IT management process maturity.

The 'IT i Praksis' investigation is sent out to around 500 organizations each year. In the last years, all respondents have been in public sector. In 2021 out of 500 distributed survey forms in 'IT i Praksis', 255 responses (i.e. 51%) where returned. This is a quite high response rate for such surveys, but still there are limitations with survey

methods, which we will discuss in some more detail in the discussion and conclusion section. Unfortunately, it is not room in the paper to include the full survey form. See [34] for more detail on how the investigations are carried out and a report from the full survey.

3.1. Previous Investigations

We have earlier compared results with the results of similar investigations. This included:

1. The investigation carried out by Davidsen and Krogstie in 2008 reported in [4].
2. The investigation carried out by Jahr, Krogstie, and Sjøberg in 2003 [21].
3. The investigation carried out by Holgeid, Krogstie and Sjøberg in 1998 [10].
4. The investigation carried out by Krogstie in 1993 [22].
5. The Lientz and Swanson investigation (LS) [25]: That investigation was carried out in 1977, with responses from 487 American organizations on 487 application systems.
6. The Nosek and Palvia investigation (NP) [28]: 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.

We have later also performed an investigation in 2018 [11]. Several other investigations on the distributions of work have been done, but they typically focus on the distribution of maintenance tasks only [9, 24, 35], many only looking on the situation in one organization. As mentioned above [14] only look at development.

3.2. Hypothesis

In [6] differences were found between private and public organizations. Since 'IT i Praksis' only had public sector respondents in 2021, we could not investigate data from this investigation for such differences. On the other hand, we find small differences in the investigation from 2018 (with respondents from both public and private sector) from earlier investigations as illustrated in table 1 and 2 [11], thus comparing 'IT i Praksis' 2021 with numbers of key variables from [6] will give indication that it still is a difference or not between public and private sector. More importantly in this paper is the difference between municipalities and other public organizations.

Since we are looking for differences, we have formulated the hypothesis as the two groups are equal (to potentially refute this).

- H1: There is no difference between the percentage of time used for development in public sector organization in 2021 and what was reported in [6]. Rationale: When comparing the percentage of time used for development activities in organizations earlier, we have found this to be decreasing slowly, but not so much between the four last investigations. It is interesting to see if public sector on average follows the same trend.
- H2: There is no difference between the distribution of work among maintenance and development in public sector organization in 2021 and what was reported in

[6]. 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 15-20 years ago, we found it beneficial also in the surveys in 1993, 1998, 2003, 2008, 2013, 2018 to look at the proportion between development and maintenance time only, a figure that has been quite stable over the last decade. We would like to see if this is also stable among public organization

- H3: There is no difference between the distribution of functional maintenance in public sector organization in 2021 and what was reported in [6]. Rationale: These numbers were on the same level in 2018, 2013, 2008 and 2003 as in 1998, and it interesting to see if it would be similar also within public sector. A high percentage functional maintenance would in particular signal poor IT support practice cf. the discussion in the introduction.
- H4: There is no difference between distribution of work between municipalities and other public organizations. We will here investigate for all the recorded constructs. Most important is the amount of effort used for functional maintenance.
- H5: There is no difference between the maturity of IT management practice as measured in the goal and effort indicators from 'IT i Praksis' between municipalities and other public organizations.

4 Descriptive results

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, 2003, 2008, 2013 and 2018 in own studies, and also from 2015 in the yearly 'IT i Praksis' investigation

The below tables are taken from [11], showing previous results from own surveys. Table 1 and Table 2 summarize the descriptive results on the distribution of work in the categories in our investigations. Forty percent of the total work among the responding organizations in 2018 is maintenance activities, 17% is

Table 1 IT work distribution (percentage of work)

Category	**1993**	**1998**	**2003**	**2008**	**2013**	**2018**	**Mean**
Corrective	10	13	9	8	10	11	10
Adaptive	4	8	7	6	10	9	7
Enhancive	20	15	13	11	13	12	14
Perfective	5	5	8	9	8	8	7
Total maintenance	**40**	**42**	**37**	**35**	**41**	**40**	**39**
Replacement	11	8	10	10	8	9	9
New dev.	18	10	12	11	8	8	11
Total development	**30**	**17**	**21**	**21**	**17**	**17**	**21**
IT operations	NA	23	24	24	23	22	23
User support	NA	19	17	20	19	21	19
Other	**30**	**42**	**41**	**44**	**43**	**43**	**41**

Table 2 IT work distribution: disregarding other work, and func.effort (percantage of work)

Category	1993	1998	2003	2008	2013	2018	Mean
Disregarding other work							
Development	41	27	34	34	27	30	32
Maintenance	59	73	66	66	73	70	68
Functional effort							
Functional development	56	38	39	36	35	35	40
Total application portfolio upkeep	61	75	75	77	79	80	74

development activities. Table 2 shows that the work distribution from the 2018 study is in line with ours on all variables. However, if we "zoom out" and look across all studies, we observe a downward-sloping tendency of functional development between 2003 and 2013. Our 2018 study found the same low level of functional development as the 2013 study.

Table 3 list time usage on different categories from 'IT i Praksis' 2022, differentiating between respondents from municipalities and other part of public sector organizations. We will investigate the differences between different categories further in the next section.

Table 3 IT work distribution – difference between Municipalities and Governmental level

Report

	Stat eller kommune									
	Kommune					Stat				
	N	Minimum	Maximum	Mean	Std. Deviation	N	Minimum	Maximum	Mean	Std. Deviation
Corrective	176	,000	51,020	11,745	8,189	79	,000	20,000	7,434	5,312
Adaptive	176	,000	30,000	8,598	6,215	79	,000	21,505	8,608	5,601
Enhancive	176	,000	20,000	5,734	5,377	79	,000	50,000	13,167	9,183
perfective	176	,000	22,222	7,966	5,343	79	,000	21,053	7,649	4,696
Replace	176	,000	35,000	5,497	6,567	79	,000	50,000	10,614	10,316
New	176	,000	94,118	5,576	8,938	79	,000	40,000	9,547	7,800
Drift	176	,000	80,000	25,404	14,510	79	,000	44,444	19,343	10,824
Support	176	,000	70,000	25,009	13,059	79	,000	66,667	16,549	13,931
Regler	176	,000	11,765	4,471	3,998	79	,000	33,333	7,089	6,613
Non-func-perf	176	,000	30,000	12,437	7,355	79	,000	35,000	14,738	7,676
Maint	176	,000	75,510	38,513	15,720	79	10,000	68,421	43,947	12,895
Dev	176	,000	94,118	11,074	12,906	79	,000	55,556	20,161	14,196
Maintonly	176	,000	100,000	79,551	21,419	79	30,000	100,000	71,416	17,525
Devonly	176	,000	100,000	20,449	21,419	79	,000	70,000	28,584	17,525
Funcdev	176	,000	100,000	20,932	16,298	79	,000	100,000	34,441	17,987
Funcmaint	176	,000	100,000	79,068	16,298	79	,000	100,000	65,559	17,987
Totevo	176	,000	94,118	11,310	10,988	79	,000	72,222	22,714	13,108
Totupkeep	176	5,882	100,000	88,690	10,988	79	27,778	100,000	77,286	13,108

5. Hypothesis testing

Table 4 includes data on the amount of time used for development, maintenance and functional maintenance in the public sector organizations in 2014, 2015, 2016 and 2021. Since the amount of work reported on these variables in our own investigations reported above in table 1 and 2 were almost equal over the last decade, we would expect a similar pattern when it comes to the public sector organizations. For development and maintenance, we see also for the public sector organizations a stable amount of time usage, thus not rejecting H1 and H2. For functional maintenance we see a slight increase from investigation to investigation, partly rejecting H3 as formulated, but not rejecting that public sector overall appears to score worse on this measure than private sector organizations.

Table 4: Work distribution among public sector organizations

Measure		N	Mean	SD
Development, percentage of all work	2014	167	14.2	12.8
	2015	140	14.3	13,2
	2016	137	14.2	13,9
	2021	255	13,9	13,9
Maintenance, disregarding other work	2014	164	75.7	19.0
	2015	137	75.7	19.6
	2016	137	76.9	18.7
	2021	255	77,0	20,6
Functional maintenance	2014	164	68.2	16.7
	2015	137	70,0	19,5
	2016	137	73,1	18,1
	2021	255	74,9	17,9

To find out if the distribution for the value in the indicators looks the same whether one is a state organization or municipality, an Independent-Samples Mann-Whitney U Test was performed for each time category. Several of these categories are interdependent, but that should not affect this test. The null hypothesis is that there is no difference in distribution between state and municipality. In table 3 we spot several differences, and we have here investigated to what extent the differences are significant. The results are listed in table 5 below.

Table 5: Time distribution – significant differences between municipalities and other public organization (see table 3 for actuals)

Time category	Equal amount of time use in municipalities and other public organizations
Corrective	Rejected, p = .000
Adaptive	Not rejected, p = .877
Enhancive	Rejected, p = .000
Perfective	Not rejected, p = .059
Replacement	Rejected, p = .000
New systems	Rejected, p = .000
IT operations	Rejected, p = .002
Support	Rejected, p = .000
Maintenance	Rejected, p = .009
Develoment	Rejected, p = .000
Maintenance only	Rejected, p = .000
Development only	Rejected, p = .000
Functional development	Rejected, p = .000
Functional maintenance	Rejected, p = .000
Total application portfolio evolution	Rejected, p = .000

From table 3 and 5, we see municipalities scores poorer on most indicator, in particular on important aggregate variables such as amount of development, and functional development, thus H4 is rejected.

As an initial investigation of H5, we have looked at differences between municipalities and other public organizations on the score of the indicators also using Independent-Samples Mann-Whitney U Test. Where there is a difference, the score for municipalities is lower, except E: Increased reuse of data. As we see in table 6 this is a bit different for different goal and factors, thus we can only partly reject H5.

Table 6 Goal and effort indicators – significant differences between municipalities and other public organization

Indicator	No difference municipality and other public organizations	Municipalities	Governmental
G:Openness and inclusion	Rejected, p = .043	3.13	3.38
G:Solve task digitally	Rejected, p = .000	2.69	3.18
G:All communication digital	Rejected, p = .000	3.82	4.21
G:Explit the potential of data	Rejected, p = .000	2.45	2.98
G:Common ecosystem	Not rejected, p = .939	3.10	3.08
G:Value realization	Not rejected, p = .586	3.36	3.45
E:The user at the center	Rejected, p = .000	3.09	3.51
E: Increased reuse of data	Rejected, p = .015	3.35	3.09
E: Common ecosystem	Not rejected, p = .222	3.48	3.39
E: Regulation easy to automate	Not rejected, p = .447	3.08	3.15
E: Governance	Not rejected, p = .299	2.95	2.98
E: Collaboration with private sector	Not rejected, p = .431	3.28	3.37
E: Digital security	Rejected, p = .002	3.43	3.76
E: Digital competence	Rejected, p = .043	3.39	3.57

6 Conclusions and Further Work

A survey investigation of this form has known limitations [13, 17]. In our case we had a larger number of responses than in earlier surveys, and a response rate of around 51% with responses from around 255 organizations gives us increased confidence in the results. Most of the persons who responded were IT managers in the organization. They may have different views of the reality than developers and maintainers. For example, Jørgensen [13] found that managers estimate the proportion of corrective maintenance to be too high when based on best guesses instead of good data, see also [35] which report a similar effect. All our investigations have data from IT managers though, thus it is reasonable to compare these investigations when looking for trends.

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 [13] 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. A pilot study in several companies to detect unclear questions is done each year in 'IT i Praksis' to address among other thing terminological issues. A challenge for us is that apart from our own questions, we have not been able to control the other questions asked.

Another issue is that all the investigations have been done in Norway. When we did the first investigations [22], these were compared with the main international investigations at that time, finding similar patterns as what had been reported in other countries. 'IT i Praksis' has been run in Denmark for more than 20 years, and it would be interesting to compare the results from the Norwegian studies with similar studies done in Denmark.

To try to look in more detail on what is behind the difference between municipal and governmental public sector we have also looked upon the different sectors using selected indicators. We also here find a significant difference between the sectors. We will in further work investigate how these variables co-variate with e.g. the distribution of work figures.

Several of our results have spurred new areas that could be interesting to follow up on in further investigations. First we will also to more detailed analysis on the data from the 2022 'IT i Praksis' investigation, which has just been made available.

On the short-term, we plan to collaborate with Rambøll on 'IT i Praksis' also in 2023 to get additional data points being able to confirm or refute the pattern found in this investigation. We also hope to be able to include some questions on relevant dimensions on dynamic organizational capabilities and newer technologies [26]. A long-term plan is to do a similar investigation as done in 1993, 1998, 2003, 2008, 2013 and 2018 in 2023 in parallel to following the 'IT i Praksis' investigation, also following up the 5 year cycle of the original investigations.

ACKNOWLEDGEMENT

We would like to thank all the participants of the survey-investigation for their effort in filling in the forms. We would also thank the people behind the 'IT i Praksis' investigation for letting us include central questions in their investigation and have access to the full dataset.

REFERENCES

1. Boehm, B. and Sullivan, K. (1999) Software economics: status and prospect. *Information and Software Technology* **41**(14) 937-946.
2. Budzier, A.,Flyvbjerg, B. (2011) Double Whammy – How ICT projects are Fooled by Randomness and Screwed by Political Intent. Said Business School Working paper available at http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2238057

3. Chapin, N. (2000) Software Maintenance Types – A Fresh View. *In proceedings of the International Conference on Software Maintenance (ICSM'2000)* pp 247-252.
4. Davidsen, M. K. and Krogstie, J. (2010) "A longitudinal study of development and maintenance" *Inf. Softw. Technol*., **52**(7):707–719
5. Ebert, C., Gallardo, G., Hernantes, J., Serrano, N. Devops. IEEE Software, 2016, 33(3), pp. 94–100.
6. Engelstad, H.T and Krogstie, J.(2016): Differences between the public and the private sector I information systems development and evolution practice and result. Paper presented at NOKOBIT 2016, Bergen, 28-30 Nov. *NOKOBIT*, vol. 24, no. 1, Bibsys Open Journal Systems, ISSN 1894-7719
7. Flak, L.S., Dertz, W., Jansen, A., Krogstie, J., Ølnes, S., Spjelkavik, I. (2009) "What is the Value of eGovernment - and How can we actually realize it". *Transforming Government: People, Process and Policy* 3 (3):220-226
8. Følstad, A., Jørgensen, H., Krogstie, J. (2004) User Involvement in e-Government Development Projects. *Paper presented at NordiChi'2004* Tampere, Finland
9. Gupta, A., Slyngstad, O. P., Conradi, R., Mohagheghi, P., Rønneberg, H., Landre, E. (2006) An Empirical Study of Software Changes in Statoil ASA - Origin, Priority Level and Relation to Component Size. *In Proceedings of ICSEA* (October 29 - November 03). IEEE Computer Society, Washington, DC, 12
10. Holgeid, K.K., Krogstie, J. and Sjøberg, D. I. K. (2000) "A study of development and maintenance in Norway: Assessing the efficiency of information systems support using functional maintenance" *Information and Software Technology*. **42**: p. 687-700.
11. Holgeid, KK, J Krogstie, P Mikalef, EE Saur, D IK Sjøberg (2022) Benefits management and Information Technology work distribution IET Software, 16 (4) 438-454
12. IEEE Standard Glossary of Software Engineering Terminology (1991)
13. Jørgensen, M. (1994) *Empirical Studies of Software Maintenance*, PhD Thesis University of Oslo Research Report 188, ISBN 82-7368-098-3.
14. Jørgensen, M. (2015 a) Suksess og Fiasko i offentlige IKT-prosjekter: En oppsummering av forskningsbasert kunnskap og evidensbaserte tiltak (In Norwegian) https://www.regjeringen.no/contentassets/9018344feae44c1f9a2a114e768ebd1b/suksess_fiasko_offentlige_ikt-prosjekter.pdf Last accessed July 1 2015
15. Jørgensen, M. (2015b). "Better Selection of Software Providers Through Trialsourcing." IEEE Software January
16. Holgeid, K.K., Krogstie, J. and Sjøberg, D. I. K. (2000) "A study of development and maintenance in Norway: Assessing the efficiency of information systems support using functional maintenance" *Information and Software Technology*. **42**: p. 687-700.
17. Kitchenham, B. A., Pfleeger, S.L., Pickard, L.M., Jones, P.W., Hoaglin, D.C. and Rosenberg, J. (2002) "Preliminary guidelines for empirical research in software engineering", *IEEE Transactions on Software Engineering*, **28** (8) pp. 721-734 August.
18. Krogstie, J. (1995) "On the distinction between functional development and functional maintenance", *Journal of Software Maintenance*, **7** pp. 383-403.
19. Krogstie, J. (2006) Work Distribution, Methodology and Technology for ISD and Maintenance Trends over the last 30 Years.In IFIP International Federation for Information Processing, Volume 214, The Past and Future of Information Systems: 1976–2006 and Beyond, eds. D. Avison, S. Elliot, J. Krogstie, J. Pries-Heje, (Boston: Springer), pp. 131–142
20. Krogstie, J. (2012) Comparing Private and Public Sector on Information Systems Development and Maintenance Efficiency. In *proceeding of eGov 2012* Lecture Notes in Computer Science, 7443, pp. 222-233

21. Krogstie, J., Jahr, A. and Sjøberg, D. I. K. (2006). "A Longitudinal Study of Development and Maintenance in Norway: Report from the 2003 Investigation". *Information and Software Technology* **48** (pp. 993-1005).
22. Krogstie, J. and Sølvberg, A. (1994) Software maintenance in Norway: A survey investigation, *in: H. Muller and M. Georges (Eds.) Proceedings of the International Conference on Software Maintenance (ICSM'94)*, IEEE Computer Society Press, Victoria, Canada, pp. 304-313.
23. Krogstie, J. and Veld, T. K. (2015) Information Systems Evolution Efficiency – Differences between the Public and the Private sector *Proceeding eGov*
24. Lee, M.-G., and Jefferson, T.L. (2005) An Empirical Study of Software Maintenance of a Web-Based Java Application, *Proceedings ICSM'05*
25. Lientz, B.P. and Swanson, E.B. (1980) *Software Maintenance Management*, Addison Wesley.
26. Mikalef, P., Pappas, I.O., Giannakos, M.N. , Krhstie, J., and Lekakos, G. (2016) Big Data and Straetgy: A research framework. *Proceedings MCIS 2016*, Paphos, Cyprus.
27. Moløkken-Østvold, K. (2004) Effort and schedule estimation of software development projects. , PhD thesis, University of Oslo, Norway
28. Nosek, J. T. and Palvia, P. (1990) "Software maintenance management: Changes in the last decade". *Journal of Software Maintenance*, **2** pp. 157-174.
29. PASC (2011) Government and IT – "a recipe for rip-offs": time for a new approach", Volume I, 28 July http://www.publications.parliament.uk/pa/cm201012/cmselect/cmpubadm/715/71502.htm (Accessed August 25, 2016)
30. Paulk, M. C., Weber, C. V., Curtis, B., Chrissis, M. B. (1993) Capability Maturity Model for Software (Version 1.1). Technical Report (Pittsburgh, PA: Software Engineering Institute, Carnegie Mellon University). CMU/SEI-93-TR-024 ESC-TR-93-177.
31. Rambøll (2014) IT i praksis 2014 Rambøll Management Consulting.
32. Rambøll (2015) IT i praksis 2015 Rambøll Management Consulting
33. Rambøll (2016) IT i praksis 2016 Rambøll Management Consulting
34. Rambøll (2021) IT i praksis 2021 Rambøll Management Consulting
35. Schach, S. R., Jin, B., Yu, L., Heller, G. Z. and Offutt, J. (2003) "Determining the Distribution of Maintenance Categories: Survey versus Measurement". *Empirical Softw. Engg*. **8**, 4 (Dec. 2003), pp. 351-365.
36. Swanson, E.B. (1976) The dimensions of maintenance. *In proceedings of the Second International Conference on Software Engineering,* San Francisco, USA, August pp. 492-497.
37. Teece, D. J. (2007). "Explicating dynamic capabilities: the nature and microfoundations of (sustainable) enterprise performance". *Strategic management journal*, 28 (**13**), 1319-1350
38. Tichy, L. and T. Bascom (2008). "The business end of IT project failure." Mortage Banking 68(628): 28
39. Veld, T.K, Krogstie, J. (2014) Work Distribution in Information Systems Development, Maintenance and Evolution: A Replication Study Proceedings NOKOBIT