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Can e-government solutions enhance the work in municipalities? Empirical evidence from case Lupapiste

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ABSTRACT

Digitalization and increasing demand of e-government services are not changing only the way the citizens can use public services, but also the nature of work of many municipality employees. At best this kind of digitalization can offer added value in the form of enhancing the work of the municipality personnel. In this paper, we study the effects of adopting an e-government service on work in municipalities. Based on an empirical investigation of five municipalities we propose flow efficiency as a key metric to grasp the added value of digitalization of a public service, as it reveals the most valuable activities as well as the potential bottlenecks. Flow efficiency measurement gives therefore a better indicator to be used in e-government process development than e.g. simple throughput time especially when evaluating the effects of digitalization on knowledge work productivity.

CCS Concepts

• **Information systems~Data mining** • **Applied computing~E-government** • **Software and its engineering~Open source model** • *Human-centered computing~Empirical studies in visualization*

Keywords

E-government; work enhancement; flow efficiency; municipality; case study.

1. INTRODUCTION

According to Irani et al. [12] electronic government (e-government) encompasses a wide range of activities in public sector, such as dissemination of information, cooperation with the private sector, services to individual citizens and organizations, and participatory democracy. Due to this kind of wide nature of e-government, it is not a surprise that e-government services have been studied from a variety of perspectives, like e.g. information systems (IS) procurement in the public sector [17, 18, 16], hindrances and/or success factors in e-government [4, 1, 3], benefits management and realization perspectives [20, 25, 6], and value assessment [10, 8, 26].

Generally in IS literature several approaches have been proposed for value assessment, such as financial [21, 27, 9], economic [13, 9] and strategic approaches [13, 27, 9]. From value assessment point of view improving lead time (throughput time) from application to decision has been recognized as one central indicator of added value [25] enabled by e-government services. For developing government processes also other efficiency indicators are needed. Lean philosophy emphasizes value efficiency as an important metric in developing more value for customers [15] that has been investigated in the context of knowledge work [14], but only scarcely in the context of e-government. The perspective of the government employees as the users of the IS (see e.g.[5]) and the enhancement of work have been studied even more little when it comes to the added value of e-government services.

In this paper we explore the e-government metrics perceived important by the municipality personnel and present a proof-of-concept of measuring lead time and value efficiency of the studied e-government service. The aim is to study the enhancement of knowledge work and added value of adopting an e-government service in a municipality context through flow efficiency metrics. Thus, this research seeks answers to the following research question:

- In what ways adoption of an e-government solution influence on the knowledge work productivity of the municipality employees?

This study is empirically driven. For this reason the theoretical bases of the research are in next shortly presented as presenting knowledge work productivity viewpoints and as building the concept of *flow efficiency* – that is then empirically tested and evaluated in a case study of an e-government service called Lupapiste. Contributions of this empirical investigation both on e-

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government [26] and knowledge work productivity [e.g. , 19] research streams are presented in the end of the paper.

2. THEORETICAL BASES

Over a few years, e-government services access time has been reduced dramatically, lead time for decisions has been shortened and the number of staff reduced, meaning that both effectiveness and efficiency has been improved [25]. However, municipalities are facing increasingly complex situations with diverse goals, in which case the problems of both deciding on and measuring evaluation criteria will prove challenging [25].

Flow efficiency has been defined as the sum of value-adding activities in relation to the throughput time [15]. Although throughput time is itself often used as an indicator of value, where the quicker it goes the better is the result, this is not always the case in services, as humans have also indirect needs. In measuring flow efficiency, the needs dictate what the value-adding activities are and therefore what flow efficiency is. Flow efficiency concerns the share of value-adding activities in relation to the throughput time. [15]

For instance, while quickly rejecting applications municipalities can maintain low average throughput times. While returning an application for citizen to be corrected increases throughput time, it can actually increase value adding time, which is captured in flow efficiency measurement. Also municipalities might be tempted not to accept incomplete or erroneous electronic applications, and thus maintaining low throughput times, however, masking real flow efficiency. Flow efficiency measurement gives therefore a better indicator to be used in e-government process development if municipalities are willing to make use of the data.

In situations, where value-adding activities are required from multiple parties, flow efficiency measurement could be used to highlight the time each party has spent on value-adding activities and also who are responsible for most delays in the process. In this way flow efficiency can provide a realistic view both on the municipality's citizen's added value and the municipality's personnel's work productivity increase caused by the use of the digitalized service. In this paper we focus on the latter one, aiming at study the enhancement of work in a municipality context through flow efficiency metrics.

Based on the knowledge work literature, several different aspects that enhance knowledge work can be identified, for example organizational culture [28], physical work environment [11], and motivation [24]. They can enhance different knowledge work actions, such as acquiring, analyzing and generating information, leading to increased knowledge work productivity. Franssila et al. [7] also draws attention to information ergonomics as a vehicle to enhance knowledge work productivity e.g. in the form of more efficient and meaningful use of information technology.

3. RESEARCH PROCESS

3.1 Lupapiste service as the case

Lupapiste is a web-based open source service that enables digital application of construction permits and other permits related to infrastructure. Lupapiste is compatible with software that municipalities use in managing and archiving documents related to construction activities. Pricing of the service is divided into two parts: monthly payment, which depends on the size of the municipality and payments per transactions, which is dependent upon the total number of applications in the service (i.e. more applications nationwide, lower the price per application). In addition, Solita offers complementary services, like electronic archiving, training and consultancy services.

Lupapiste service was developed as a part of Action Programme on eServices and eDemocracy (SADe programme) set by the Ministry of Finance in Finland [22]. The programme aimed at providing interoperable, high-quality public sector services via digital channels in order to improve cost-efficiency, create savings, and generate benefits to citizens, businesses, organisations and local and government authorities. Special attention was paid to the achievement of cost benefits to municipalities. Lupapiste was one of the sub-projects in the programme coordinated by Ministry of Environment. In addition to Lupapiste, Ministry of Environment coordinated six other projects, and total budget for those projects was 11,5 M€. After a competitive bidding, Solita was chosen as a service provider for Lupapiste. Lupapiste service was developed in co-operation with municipalities that worked as pilots in the project.

3.2 Research methods

The empirical data is consisted of qualitative interview data and data extracted from the Lupapiste service. The qualitative interviews were mostly conducted by one researcher, whereas researcher triangulation was used in the analysis of interview results. Three of the researchers participated in the data collection and data analysis of the Lupapiste data.

3.2.1 Interviews

For the qualitative data we carried out 10 semi-structured interviews [23] in 5 municipalities ranging from small to large (inhabitants varying from 19 000 to 210 000). All participating municipalities were pilots in the development project SADe.

Before interviews researchers familiarized with the topic by having a workshop at Solita, including staff from sales, product development and service support. After the workshop, an expert interview with a leading building inspector who had been active in Lupapiste development and implementation was carried out. Themes of the interview and structure of the interview was decided after the workshop and expert interview. Themes of the interviews included: motivation for the introduction of Lupapiste, benefits and challenges related to the introduction and use of Lupapiste, the functionality of the system and feedback to the service provider. In addition, respondents were asked to describe what data and what indicators related to construction permit applications were utilized in decision making related to construction permit application process, and what type of data needs have they identified (if any) related to application process.

In each municipality, building inspector or leading building inspector and person from customer service (usually office secretary or customer service secretary) was interviewed. The conducted interviews are presented in Table 1.

Table 1. Interviews conducted.

Muni-cipality	Roles of interviewees	Number of interviews
Hyvinkää	Building inspector Secretary, customer service	1 1
Kuopio	Engineer, construction permit Secretary, supervision of building	1 1
Vantaa	Director, supervision of building Secretary, supervision of building	1 1
Sipoo	Manager, supervision of building Secretary, supervision of building	1 1
Mikkeli	Leading building inspector Office secretary	1 1

3.2.2 Lupapiste data analysis

Lupapiste service creates data from user's actions that are stored in server log and also of each completed step and document, which are stored in operative database. Both of these data sources were used in computing the lead time and flow efficiency metrics.

The dataflow necessary to implement the data analysis includes the following six sequences illustrated in Figure 1. In the first sequence, the user performs an action in the user interface (1) of the SaaS (Service as a Platform). Second, the data of the usage event is saved to the server log (2). Third, the application stores the data to the operative database (3). Fourth, the usage data converter reads the server log an extracts a CSV file (4). Fifth, the operative data converter extracts the data from the operative database (5). Finally, the data analysator combines the two data sources and produces a CSV file (6).

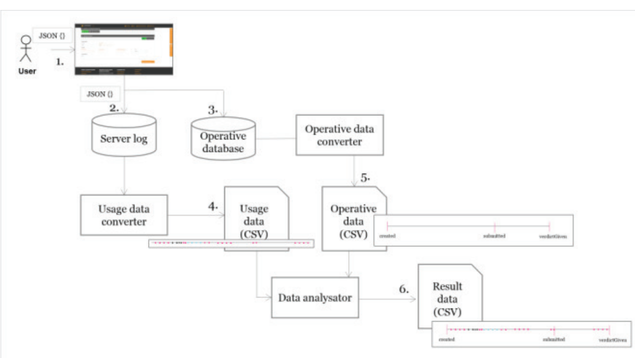

Figure 1. Dataflow from Lupapiste service.

During the data analysis project, the usage data converter was published as open source and is available from GitHub: https://github.com/timole/sopernovus. Also the operative data converter was published: https://github.com/timole/sopernovsa. The data analysator under development was programmed in R.

In next the findings from the empirical study based on both the interviews and the Lupapiste system produced data are presented.

4. EMPIRICAL FINDINGS

4.1 Insights from the interviews

In the interviews, many types of work enhancers were identified. Ability to process applications 24/7 wherever internet connection is available increased flexibility of work by enabling flexible working hours and remote work. Because of declined amount of customer visits, work in customer service was perceived more flexible; now personnel can reply to questions online, and the pressure created by customers standing in line is eased. In addition, time savings related to printing activities were considerable for municipal employees, since printing large plans that was required before digital service, is time consuming and also costly. Even though these kinds of printing and scanning activities were usually done by assistants, it still was considered as one of the key factors increasing work productivity in overall in interviewed municipalities.

Productivity improvements related to increased ability to utilize resources was also brought up by the interviewees; especially building inspectors had more time to focus on their core tasks instead of searching for paper files and documents, which for example ended up productivity improvements of 65% in application handling (with the same amount of personnel) in one of the studied municipalities. Lupapiste also reduces information asymmetries by adding transparency between authorities and customers. Transparency was in fact considered as one of the major benefits related to Lupapiste by the interviewees. This also has an effect e.g. on the information ergonomics [7] that further influences on the work productivity. Due to Lupapiste features, all parties involved in the application process have access to the latest information regarding the process, which enables faster and more informed decision-making. Transparency also declines the amount of customer visits and phone calls and thus improves overall productivity.

According to interviews, current software provide rather general indicators related to construction permits, like total amount of permits per year, amount of square meters built within a year, and average lead times of construction permits. In practice, average lead times were the only indicators related to application process. According to respondents in managerial position lead times were insufficient indicators to measure performance of municipal authorities in processing applications, since applicants' actions affect to the lead time, e.g. if applicant delays with the supplementary documents required, lead time will increase. In addition, municipalities measured lead times differently; some included weekends to the count, some did not etc.

From data analysis point of view, the focal question was to find out what type of data managers in municipalities are missing for process management, and if there are data needs that could be fulfilled by Lupapiste data, i.e. how Lupapiste data could facilitate process management in municipalities.

Respondents were not aware what data Lupapiste could provide in general. After seeing visualizations of user data, e.g. adaptation diagram, and discussions with researchers, respondents got the view about the possibilities that Lupapiste data could provide. The most cited need regarding the data related to more precise lead time. Municipalities were lagging information about the efficiency of the application process, i.e. what is the efficient work time municipal authority spends per application. Thus, municipalities needed information about the *flow efficiency*.

4.2 Data-driven evidence

Two sets of measurements were computed from the Lupapiste service. First set, presenting the lead time measurements of applications is illustrated in Table 2 and the second set of flow efficiency metrics of applications is illustrated in Table 3. The first set was gathered only from three municipalities, each representing a different adoption phases of the Lupapiste and thus, also varying amounts of processed applications through Lupapiste.

Table 2. Measured lead times in municipalities.

Municipality	Approved applications	Distinct operations	Average lead times	Median lead times
Municipality A	730	41	77	57
Municipality B	55	17	57	46
Municipality C	1600	39	69	56

The current adoption status of the Lupapiste service in the studied municipalities is clearly visible from Table 2. **Municipality B** has so far only 55 approved applications, from 17 distinct operations, whereas Lupapiste has been already used more widely in **Municipality A** and **Municipality C**.

In calculating the flow efficiency metrics, the two operations that had the most approved applications in the studied municipalities were chosen. Median flow efficiencies were calculated if a minimum of 10 applications were approved during the year in the different operation categories. The resulting flow efficiency calculations are presented in Table 3.

Table 3. Measured median flow efficiencies in municipalities.

Municipality and operation	2014	2015	2016
Municipality A ground source heat	N/A	38	32
Municipality B ground source heat	N/A	N/A	N/A
Municipality C ground source heat	45	54	57
Municipality A small houses	N/A	43	45
Municipality B small houses	N/A	N/A	40
Municipality C small houses	N/A	44	44

From Table 3 it can be observed that flow efficiencies have improved in **Municipality C** in ground source heat applications from the year 2014 to the year 2016. The flow efficiencies remained the same for small houses during the years 2015 and 2016 (2014 n=0, 2015 n=156, and 2016 n=160) in **Municipality C**. For **Municipality B** there was sufficient data to calculate flow efficiency only for small houses in the year 2016. In **Municipality A** flow efficiency increased on small houses from the year 2015 to 2016, but decreased on ground source heat applications. It must be noted that the situation may still change, as data was collected only until September 2016.

In order to more deeply understand the time spent on value adding activities, we calculated median application processing time in minutes for the same operation categories. The results from the calculations are presented in Table 4.

Table 4. Median time in minutes used to process the applications.

Municipality and operation	2014	2015	2016
Municipality A ground source heat	N/A	114	94
Municipality B ground source heat	N/A	N/A	N/A
Municipality C ground source heat	91	86	73
Municipality A small houses	N/A	552	603
Municipality B small houses	N/A	N/A	326
Municipality C small houses	N/A	634	730

In **Municipality C** there was statistically significant difference in the application processing times of ground source heat applications, decreasing each year from 2014 to 2016. For instance, Mann-Whitney U test on the ground source heat application processing times of 2015 and 2016 years revealed a statistical significant difference, with a P value of 0.03. While flow efficiency remained the same for small houses in **Municipality C**, the overall time used to process the application increased from the year 2015 to 2016.

For **Municipality A** and **B** there less available data to perform the calculations. In **Municipality A** median times used to process the applications followed the trend of measured flow efficiencies. For **Municipality B** we had sufficient data to calculate the value only for small houses in the year 2016.

5. DISCUSSION AND CONCLUSIONS

This research has searched answers to the question "In what ways adoption of an e-government solution influence on the knowledge work productivity of the municipality employees?" Based on the interview data, adoption of e-government solution (Lupapiste), has enhanced the work of municipality personnel in many ways, leading also in remarkable increase in knowledge work productivity. The main factors increasing the knowledge work productivity were increased flexibility of the work, possibility to concentrate on the core work, information transparency and time savings due to digitalization of the application process. These empirical findings are in line with previous literature concerning digitalization of knowledge work and knowledge work productivity [2, 7, 19].

The new insights and contribution of the present study to the knowledge work productivity research stream lays on the development of data-driven metric of flow efficiency to evaluate the effect of digitalization to knowledge work. Flow efficiency calculations together with the median times used to process the applications provide new indicators for evaluating the efficiency improvement from digitalization. The most significant improvements in efficiency were achieved in **Municipality C**, which were the most active used of Lupapiste e-government solution. In **Municipality C** statistically significant improvements were achieved in application processing in ground source heat operation category. This may indicate that benefits from digitalization are more easy to achieve from applications that are not very complex and time consuming handle. In more complex applications, such as, small houses, the delays in the application processing may be due several reasons. This could be an interesting topic for future research.

Further empirical research is needed to validate the results, as the present study has also several limitations regarding the data. The interviews included only personnel from the municipalities, thus lacking the perspective of citizens or professional users of Lupapiste service. As the adoption of Lupapiste service is still ongoing in municipalities, e.g. new application categories being adopted each year, there is yet no stable longitudinal data available for analysis. Furthermore, the municipalities only started adopting the Lupapiste service in 2014 and the data from the year 2016 is only partial, until September 2016. Technically it is also possible that an employee from one municipality processes an application from another municipality, providing even more influence on the knowledge work productivity among a network of municipalities. However, this detailed level of analysis was not included in the present study due to limited depth of the currently available Lupapiste data.

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