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Complete Research

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Abstract

The value of e-government, services to citizens by public institutions through the internet, is dependent on the mutual adoption of e-government by both the public institution and the citizens. This paper describes a longitudinal study of e-government adoption by municipalities and citizens in Denmark. We studied the e-government initiative Digital Post – encrypted digital communication between municipalities and citizens. Over the three-year adoption period, we found four adoption patterns among municipalities, characterized by a slow, late, gradual or early increase in the use of Digital Post. The adoption patterns among citizens were less distinct. We calculated the realized savings to only 20% of the anticipated savings, leading to a deficit of nearly €5 million in 2013. Municipal funding was reduced according to the anticipated savings. In addition, the variation in adoption by municipal staff explained much more of the variation in the deficit than the variation in adoption by citizens did. We wish to draw attention to the overly optimistic expectations of savings from e-government and to a need for further research into the governmental processes of e-government.

Keywords: adoption patterns, diffusion, e-government, longitudinal study, local government, municipality, benefits.

1 Introduction

Government institutions at central and municipal levels have long been introducing information systems to become more efficient and provide better service to citizens. Previously, such systems focused mainly on supporting processes internal to the government institutions and included systems for document management (Hertzum, 1995), geographical information (Frøkjær & Korsbæk, 1997), and collaboration support (Pipek & Wulf, 1999). However, with the widespread diffusion of the Internet, part of the focus has shifted to e-government, which is understood as public digital services for citizens through the internet. The realization of benefits from e-government depends on the adoption within government institutions as well as by citizens. This dual dependence has proved a challenge for at least two reasons. First, benefits from internal governmental systems have in many cases failed to materialize or they have been much smaller than expected (Goldfinch, 2007; Northrop, Kraemer, Dunkle, & King, 1990), even though these systems are introduced within an organizational structure with the possibility of mandating their use. Second, citizens adopt, or hesitate to adopt, e-government systems for reasons that may differ from those of government and the means for mandating citizen usage of the systems are weak, politically charged, or both.

In this study we investigate the adoption of the e-government system Digital Post by municipal staff and citizens in Denmark. Digital Post is a system for encrypting and sending digital letters between municipalities and citizens without the need for email addresses (which may change over time). The major incentive for municipalities to adopt Digital Post is the ensuing reduction in postal costs when digital letters replace physical letters. This incentive is being enforced by a cut in municipal budgets corresponding to the estimated savings. The major incentive for citizens to adopt Digital Post is easier management of their correspondence with their municipality and other public institutions because all

the correspondence is in one place and remains accessible across changes in citizens' address, email provider, and so forth.

The aim of this paper is to analyze how the adoption of Digital Post has evolved from when it was launched in June 2010 until September 2013 in relation to the anticipated adoption and effects. Specifically, we will analyze the degree and pattern of adoption by the municipal staff and the citizens in Denmark's 98 municipalities. We will also relate the adoption pattern of municipal staff to that of citizens to better understand this critical element in the success of e-government. Our analyses are based on monthly usage data for Digital Post, monthly data about the percentage of citizens registered to receive communication from their municipality in digital form, and the agreement between the national government and the municipalities detailing the business case for Digital Post. We contextualize the degree of Digital Post use by comparing the number of mails sent through Digital Post to the total number of digital and physical letters sent from municipalities to citizens. This supplementary analysis involves four municipalities.

2 Related Work

Rogers (2003, p. 21) defines adoption as the "decision to make full use of an innovation as the best course of action available". The emphasis on full use has been contested by others, who argue for including partial adoption as an important and frequent type of adoption (e.g., Jasperson, Carter, & Zmud, 2005; Jeyaraj & Sabherwal, 2008). In the following section, adoption includes both full and partial adoption.

2.1 Individual adoption

An individual's decision about whether to adopt an innovation depends on a range of factors. It has been studied from many perspectives, including reasoned action (Fishbein & Ajzen, 1975), task-technology fit (Goodhue & Thompson, 1995), technology acceptance (Davis, 1989), and the diffusion of innovations (Rogers, 2003). The factors studied differ across the perspectives but are mainly among those available to the adopter prior to becoming a (regular) user of the innovation. A unified view of much of the previous work has been presented by Venkatesh, Morris, Davis, and Davis (2003) who provide evidence for the influence of four factors on the adoption decision:

Performance expectancy is 'the degree to which an individual believes that using the system will help him or her attain gains in job performance' (Venkatesh et al., 2003, p. 447). This includes, among others, perceived usefulness (from Davis, 1989) and relative advantage (from Rogers, 2003), which have been the strongest predictors of adoption in previous studies. In the unified model, performance expectancy has, likewise, been found to influence adoption.

Effort expectancy is 'the degree of ease associated with the use of the system' (Venkatesh et al., 2003, p. 450). This includes, among others, perceived ease of use (from Davis, 1989), which has been found to influence adoption directly as well as indirectly. The indirect influence is mediated by perceived usefulness, indicating that an easier-to-use system is perceived as more useful. In the unified model, effort expectancy has, likewise, been found to influence adoption.

Social influence is 'the degree to which an individual perceives that important others believe he or she should use the new system' (Venkatesh et al., 2003, p. 451). This includes, among others, subjective norm (from Fishbein & Ajzen, 1975). In the unified model social influence has been found to affect adoption when use is mandated. The effect of mandated use is noteworthy in relation to e-government because adoption is often mandatory for governmental staff but rarely for the citizens.

Facilitating conditions is 'the degree to which an individual believes that an organizational or technical infrastructure exists to support the use of the system' (Venkatesh et al., 2003, p. 453). This includes, among others, compatibility (from Goodhue & Thompson, 1995; Rogers, 2003). In the

unified model, facilitating conditions have only been found to influence adoption for older people who are experienced in the use of a system.

While the four factors may collectively explain as much as 70% of the variation in individuals' intention to adopt systems (Venkatesh et al., 2003), they reveal little about how much *time* individuals need to gain knowledge about a system and form an attitude toward it before they make the adoption decision. This temporal aspect of adoption depends to a considerable extent on characteristics of the adopter and has led to the grouping of people into adopter categories such as innovators, early adopters, early majority, late majority, and laggards (Rogers, 2003). These categories have been found to depend on people's age, education, gender, income, self-efficacy, and other demographic and psychological variables (e.g., Lin, 1998; Martinez, Polo, & Flavián, 1998; Zayim, Yildirim, & Saka, 2006).

The temporal aspect of adoption also depends on the concept of critical mass, which is particularly important to the adoption of systems aimed at supporting communication and coordination (Markus, 1987). For such technologies, of which Digital Post is an example, there is little incentive to be among the first to adopt because the benefits of adoption are dependent on many others also adopting. Rather, there is an incentive to delay adoption until a sufficient number of others have already adopted. The critical mass is the tipping point between these two mechanisms. Before critical mass is achieved, adoption is at risk of never taking off; after critical mass has been achieved, adoption becomes self-sustaining and accelerates. Markus (1987) argues that for communication and coordination technologies there are only two stable states of adoption: all or nothing. Any intermediate state is unstable because the need to communicate and coordinate by other means entails maintaining the functionality necessary for these alternative means to function and possibly take off.

2.2 Organizational adoption

Governmental staff's adoption of e-government systems occurs, contrary to that of citizens, in an organizational context. The defining characteristic of organizational adoption is that it involves multiple adoption decisions. Gallivan (2001) distinguishes between a primary adoption decision by management and secondary adoption by the individual employees. This distinction emphasizes, as earlier pointed out by Tornatzky and Klein (1982), that primary, organization-level adoption may be governed by factors different from those that govern secondary, individual-level adoption. Therefore, it cannot be assumed that secondary adoption will follow smoothly from a primary adoption decision. For example, Jeyaraj and Sabherwal (2008) find that a primary adoption decision mandating the use of a technology tends to lead to partial rather than full adoption at the secondary level.

Fichman and Kemerer (1999, p. 256) introduce the notion of assimilation gap to conceptualize the insight that "widespread acquisition of an innovation need not be followed by widespread deployment and use by acquiring organizations". That is, secondary adoption may remain partial or temporally lag behind primary adoption. Fichman and Kemerer (1999) propose two primary reasons for assimilation gaps. First (mirroring Markus, 1987), for many technologies there is little incentive to be among the first to adopt because the full potential of the technology cannot be reaped until many have adopted it. Second, the knowledge and skills required to exploit the potential of a technology may not initially be present among the employees, thereby creating knowledge barriers that can only gradually be overcome through organizational learning. A third reason is proposed by Mark and Poltrock (2004), who argue that adoption is driven by communication, which is more frequent within a social world (such as an organizational site) than across social worlds. Consistent with this argument, their empirical data show that the different sites in a distributed organization adopted a system to different extents, and that employees who were part of multiple social worlds within the organization (due to membership in distributed teams) experienced tension regarding whether to adopt the system. In addition, Tyre and Orlikowski (1994) show that the period during which employees experiment with a new system is brief and that after this period their use of the system congeals. Subsequent changes in use practices require some triggering event. This suggests a fourth reason for assimilation gaps, namely that an initial partial adoption quickly becomes the way a system is routinely used.

Primary adoption becomes more likely with increasing specialization, professionalism, functional differentiation, vertical differentiation, managerial attitude toward change, managerial tenure, external communication, internal communication, technical knowledge resources, administrative intensity, and slack resources. It becomes less likely with increasing formalization and centralization (Damanpour, 1991). The difference between these thirteen factors and the four factors influencing individual adoption (Section 2.1) is apparent. Damanpour (1991) further finds that the type of organization is a stronger moderator of the influence of the thirteen primary-adoption factors than the type of innovation considered for adoption. This suggests caution in transferring findings about adoption in industry to an e-government setting.

2.3   Adoption of e-government

E-government has been suggested by many researchers to evolve through stages. The e-government maturity model by Layne and Lee (2001) contains four stages: (1) catalogue, where governments solely display information to citizens, (2) transaction, where citizens and governments perform mutual transactions, (3) vertical integration within domains, where back-office systems are integrated with e-services for citizens, and (4) horizontal integration, where systems from all domains are integrated drawing on the same metadata. These models have been criticized for being over-optimistic, building on weak if any empirical ground and highly normative (Coursey & Norris, 2008), for neglecting the citizen' ownership perspective (Andersen & Henriksen, 2006), and for not being deep and broad enough to understand the relation between technology, organization, and government values (Grönlund, 2010). E-government researchers contend that e-government evolves slowly and incrementally (e.g. Norris & Moon, 2005; West, 2004); only some governments are in the transactional stage and none beyond. To explain this, Bannister and Connolly (2012) argue that everything involved in e-government – except technology – changes slowly (law, culture, administration, organization, government structures, and human behavior). In the beginning of the e-government era, many researchers, private consultants, and politicians believed that 'build it and they [citizens] will come' (Coursey & Norris, 2008). However, there is empirical evidence that citizens' adoption of e-government is slow, especially regarding e-government transactions (Gauld, Goldfinch, & Horsburgh, 2010). Access to computers, availability of the internet, and lack of information and technology skills are among the reported barriers to citizens' e-government adoption (West, 2004).

Goldfinch (2007) notes that even though an IS system performs as intended, it may not be used as intended or may not be used at all. Productivity may even decrease due to the problem of agency. Agency refers to the relationship between a principal (manager) who has delegated decisions to an agent (staff) in a situation with different interests and information asymmetry (the agent having more information than the principal). Goldfinch (2007) refers to management not knowing what is going on, staff hesitating to deliver 'bad news' about IS challenges, and public organizations not holding people accountable for IS failures. Irani, Elliman, and Jackson (2007) elicited practitioners' perception of challenges in e-government from workshops and claim that IS 'tended to surface quite often as the creator of problems rather than a solution' (p. 330). Irani et al. (2007) state that coordination and integration of public institutions at all levels is key and that their roles, processes, and policies reflected in systems 'are all fundamental to e-government success' (p. 332). Local government faces a multitude of back-office systems, most of them being off-the-shelf systems with a high need for configuration (Rose, Persson, Kræmmergaard, & Nielsen, 2012). Failure to address interoperability is also recognized as a key barrier to e-government (Bannister & Connolly, 2012).

Yildiz (2007) recommends evaluating not only the output of e-government but also 'the processes that shape the management of e-government' (p. 658) and the question of how national e-government affects local e-government. This is in line with an extensive literature review (Andersen & Henriksen, 2007) finding that IS research dominates e-government research and recommending less 'e' and more 'government' in future research. From 15 empirical cases, Chircu and Lee (2005, p. 619) find that civil servants identify with their institutional tasks to a high degree and that doing things digitally is not key to a nurse or a teacher. Moreover, they find that mandated use 'is one of the best things one can do to

increase the likelihood of the [e-government] initiative's success'. Several scholars argue that New Public Management (NPM) values dominate e-government strategies, considering e-government 'as a linear process of change which leads to more efficient and less costly organization management' (Cordella & Bonina, 2012, p. 512) and that 'these changes have political and administrative consequences that should not be overlooked' (Cordella & Bonina, 2012, p. 515).

3   The Digital Post system

Digital Post was designed, developed, and implemented by the Danish Ministry of Finance to make communication between the public sector and its affiliates more efficient; it constitutes a major cornerstone in the current 2011-2015 e-government strategy. 'By 2015, we expect to be able to send 80% of all correspondence to citizens in digital form. […] This will save billions of kroner on administration throughout the public sector' (The Danish Government, Danish Regions, & Local Government Denmark, 2011). It is basically an email system in which identified actors can communicate in an encrypted environment. Municipal staff sends mail to Digital Post through an output manager. If the citizen has adopted Digital Post, the output manager sends a digital letter; otherwise, the output manager sends a physical letter. The municipality saves around € 0.8 per digital letter sent from Digital Post. Citizens access Digital Post through the Danish national public portal borger.dk using the national eID solution with their social security number. Digital Post is free of charge for citizens. The Ministry of Finance issued a national business case that posited that 'The costs of continuing to send letters in paper form is considerable, equivalent to between DKK 1.8 and 2.5 billion' (€ 240 and € 330 million) (Rambøll, 2010). Municipal services are partly state funded and to some degree subject to negotiation between the Local Government Denmark (LGDK) and the Ministry of Finance (FM). LGDK and FM agreed that state funding would be reduced by € 6 million in 2013 due to estimated postal cost savings, by € 7.5 million in 2014, and by € 14 million in 2015 (The Danish Government and LGDK, 2012).

4   Method

We used transaction data from the two major output managers on the market during the three-year period (doc2mail from KMD from 98 municipalities and OM from Itella/KMD from 6 municipalities). These data were provided by KMD and gave the number of transactions per month per municipality from inauguration of Digital Post and onward. To convert the data to monthly transactions per 1000 citizens in each municipality, we retrieved the population distribution by municipality for January each year from the Ministry of Economic Affairs and the Interior. During the period, the population rose by 0.5% a year and we introduced a minor discontinuity from one year to the next. In late 2011, the Danish government centralized welfare payments; hence, administrative workload was reduced in the municipalities. This caused a 20% decrease of municipal communication (September 2013). Utilizing the citizen identification in each transaction from the new institution, we had Statistics Denmark generate transaction sum data per municipality to correct for the drop in communication.

The citizen adoption data came from two sources. The total number of Danish citizens who had adopted Digital Post from 2010 until November 2011 was provided by the vendor of Digital Post and converted to a percentage of the population using population data from the Ministry of Economic Affairs and the Interior. Since December 2011, Statistics Denmark published statistics about the percentage of citizens registered in Digital Post, based on transaction data from e-Boks (the vendor of Digital Post) and population data. The statistics gave the proportion of Danish citizens, registered in Digital Post per municipality on a weekly basis. We used the proportion from the week that included the last day in the month as the monthly value.

Estimated unit costs and amounts from business cases (Local Government Denmark, 2012; Rambøll, 2010) were used to compare the realized municipal savings with estimated savings. We used mail analyses provided by four municipalities to determine the adoption potential. The realized adoption

was calculated using Digital Post output data. Monthly sum data of output from Digital Post, distributed on public institutions, in the period from July 2010 was provided by the Danish Digitization Agency according to an agreement between the Agency and the authors.

5   Results

The overall adoption of Digital Post by municipal staff and citizens is depicted in Figure 1 for the period July 2010 to September 2013. Data about the citizens' adoption until November 2011 (the dotted line in Figure 1, right) were only available as a national percentage and will not be analyzed further.
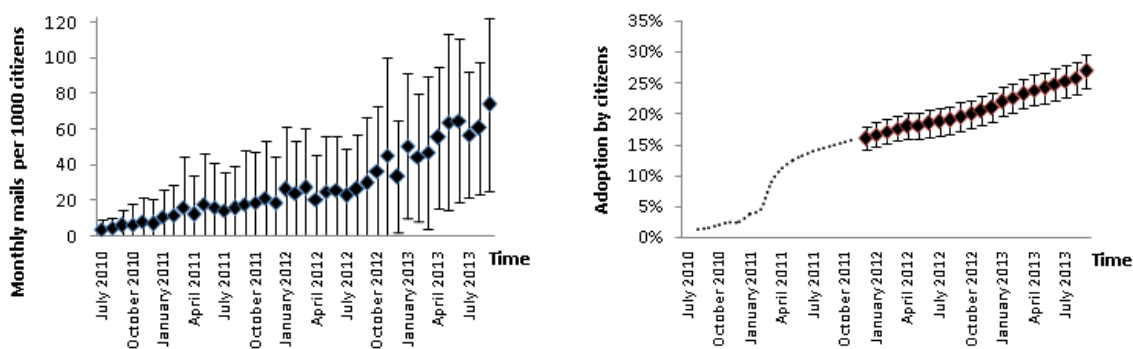

Figure 1.   *Adoption of Digital Post by municipal staff (left) and citizens (right). Error bars show the standard deviation.*

The number of mails sent to citizens by municipal staff is subject to seasonal variation. For example, Danish municipalities send correspondence about property tax in January or February. To circumvent seasonal variation, we analyzed the trend in the data by comparing the average number of monthly mails per 1000 citizens sent by municipal staff during the third quarter (July-September) of each year. The annual increase was significant from 2010 to 2011, $F(1, 97) = 23.96$, $p < 0.001$, from 2011 to 2012, $F(1, 97) = 24.92$, $p < 0.001$, and from 2012 to 2013, $F(1, 97) = 137.18$, $p < 0.001$. However, the standard deviations were large for all years except 2010, indicating that adoption evolved differently in different municipalities. We analyze the different adoption patterns among the municipal staff in the next section.

To assess whether adoption by citizens was increasing during the period, we calculated the adoption rate for each quarter. All six comparisons of one quarter to the next were significant, $Fs(1, 97) > 472$ (all $ps < 0.001$), indicating that adoption increased throughout the period. In addition, the standard deviations were modest, thereby leaving less room for different adoption patterns among the citizens in different municipalities compared with the municipal staff.

5.1   Adoption patterns by municipal staff

To analyze the adoption patterns among the municipal staff in more detail, we made a cluster analysis. For this analysis, each municipality was described by the number of monthly mails per 1000 citizens in the third quarter of 2010, 2011, 2012, and 2013. We then used K-means clustering to classify the municipalities into clusters with a similar adoption pattern. K-means clustering requires pre-selection of the number of clusters. We made classifications with three to six clusters and inspected the results. On the basis of these inspections we chose a classification into four clusters because it yielded clusters with distinctly different profiles, because these profiles translated into clear adoption patterns, and because the municipalities were reasonably spread across the clusters. Figure 2 shows the four

clusters. For each cluster the figure shows the evolution in the average number of monthly mails sent per 1000 citizens in the third quarter of the years 2010 to 2013.

The first cluster (Figure 2, top left) represented slow adoption of Digital Post by municipal staff throughout the period. This adoption pattern was the most frequent in that the cluster contained 51 of the 98 municipalities. In the third quarter of 2013, adoption had reached a modest average of 33.5 (*SD* = 15.7) monthly mails per 1000 citizens. The increased growth rate from 2012 to 2013 compared to the previous years might, however, point toward accelerated adoption in the coming years.

The second cluster (Figure 2, top right) represented limited adoption during the period 2010-2012 followed by a substantial increase in 2013. Until 2012 this cluster resembled the first cluster, but from 2012 to 2013 the use of Digital Post increased by a factor of 6.9, reaching an average of 100.5 (*SD* = 24.0) monthly mails per 1000 citizens in the third quarter of 2013. The municipal staff in 21 municipalities followed this adoption pattern.

The third cluster (Figure 2, bottom left) represented gradual adoption at a fairly even annual rate, reaching an average of 91.1 (*SD* = 25.0) monthly mails per 1000 citizens in the third quarter of 2013. This adoption pattern, followed by 21 municipalities, differed from the two previous adoption patterns by an earlier increase in adoption to a level beyond marginal.

The fourth cluster (Figure 2, bottom right) represented substantial adoption already in 2011 and no further adoption increase in the remainder of the period. Contrary to the three other adoption patterns, this pattern suggests that adoption has reached a plateau and might remain at this level in future years. An average of 104.0 (*SD* = 4.2) monthly mails were sent per 1000 citizens in the third quarter of 2013. This adoption pattern was followed by five municipalities and was, thereby, the least frequent.
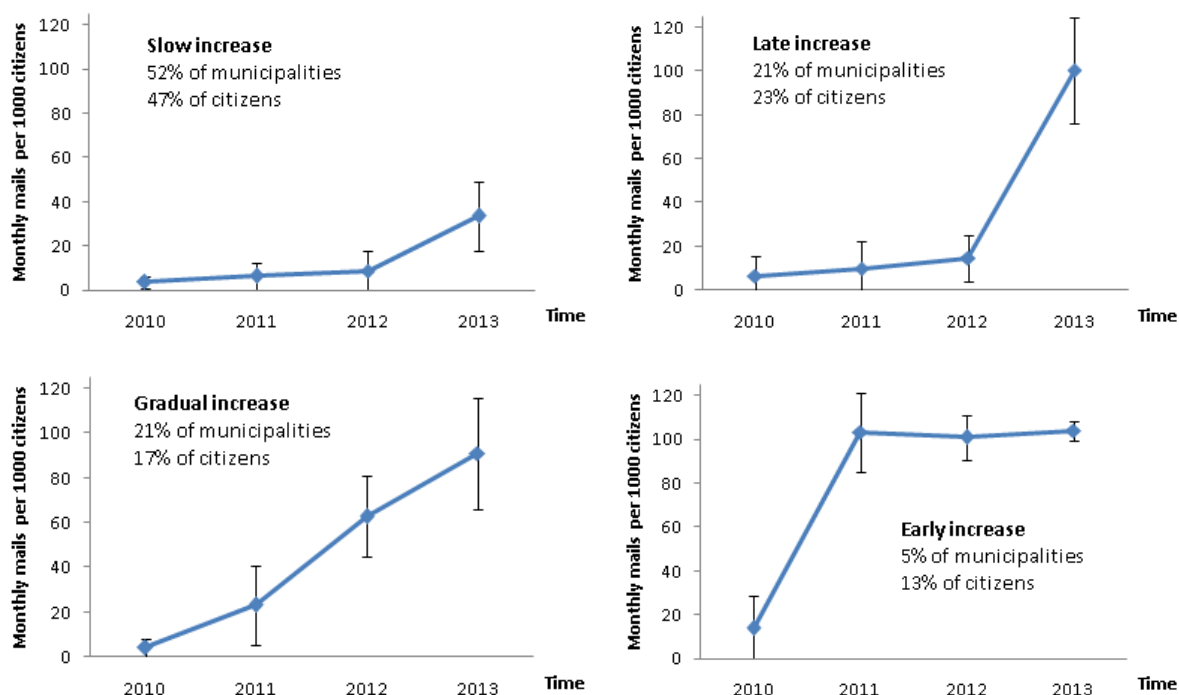

Figure 2.   *The average number of monthly mails per 1000 citizens sent by municipal staff in the third quarter of the years 2010 to 2013. Each graph shows one cluster of municipalities. The clusters contain 51 (top left), 21 (top right), 21 (bottom left), and 5 (bottom right) municipalities. Errors bars show the standard deviation.*

5.2   Adoption patterns by citizens

To analyze the adoption patterns among the citizens, we again applied K-means clustering. For this analysis, the citizens in each municipality were described by their rate of adoption of Digital Post in seven quarters (from the first quarter of 2012 to the third quarter of 2013). We made classifications with two to six clusters and inspected the results. On the basis of the inspections, we chose a classification into two clusters because it divided the municipalities into what could readily be interpreted as a lower and a higher rate of adoption, with a fairly even spread of the municipalities between the two clusters. We decided against higher numbers of clusters because all clusters evolved in a similar, roughly linear, manner and only differed in the rate of adoption. Figure 3 shows the two clusters.

The first cluster (Figure 3, left) represented a gradual adoption increase from 17.9% to 27.5% over the seven quarters. In our two-cluster classification, the 39 municipalities with this adoption pattern were those with a high level of adoption among the citizens. The annual increase in adoption was 5.4 percentage points.

The second cluster (Figure 3, right) contained the municipalities with a lower level of adoption among the citizens. In these 59 municipalities, the citizens' adoption of Digital Post increased from 15.0% to 23.4% over the seven quarters, corresponding to an annual increase of 5.1 percentage points. Thus, the annual increase resembled that for the first cluster.
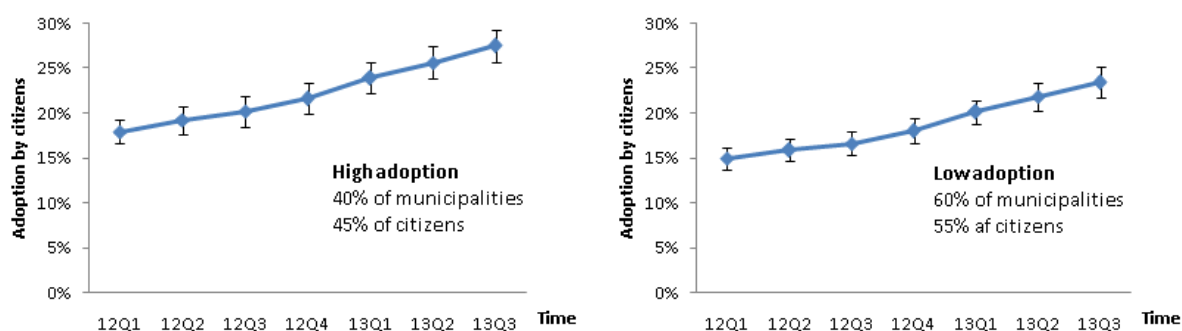

Figure 3.   *The percentage of citizens in a municipality who have adopted Digital Post in the period from the first quarter of 2012 to the third quarter of 2013. Each graph shows one cluster of municipalities. The clusters contain 39 (left) and 59 (right) municipalities. Errors bars show the standard deviation.*

5.3   Relation between the adoption patterns of municipal staff and citizens

Table 1 shows a contingency tabulation of the adoption patterns of municipal staff and citizens. For the municipalities with a slow, late, and gradual increase in the use of Digital Post by municipal staff, the citizens' adoption of Digital Post was low more often than high. For the municipalities with an early increase in the use of Digital Post among the municipal staff, the citizens' adoption was always high. This difference between the municipalities with an early increase in the use of Digital Post and those with a slow, late, and gradual increase was significant, $\chi^2(3, N = 98) = 8.44$, $p < 0.05$.

With respect to the level of adoption reached by the third quarter of 2013, the Pearson correlation between the municipal staff's adoption (measured by the number of monthly mails sent per 1000 citizens) and citizens' adoption was 0.324. Thus, the variation in the municipal staff's adoption explained a modest 10.5% of the variation in the citizens' adoption, and vice versa.

Municipal staff Citizens	Slow increase	Late increase	Gradual increase	Early increase	Total
High adoption	18	7	9	5	39
Low adoption	33	14	12	0	59
Total	51	21	21	5	98

Table 1   Relationship among the adoption patterns of municipal staff and citizens.

5.4   Realized, estimated and potential savings from Digital Post

The net savings for sending mail through Digital Post is estimated at DKK 6.2 per mail (€ 0.8) (Rambøll, 2010). The dual adoption by municipalities and citizens resulted in 1.3 million digital letters in 2013, a saving of € 1.4 million. The correlation between the savings distributed on municipalities was calculated against municipal adoption and citizen adoption. The variation in citizen adoption explained only 3% of the variation in savings ($p = 0.07$). The variation in municipal adoption explained 60% of the variation in savings ($p < 0.005$).

Four municipalities, one from each cluster, had data about Digital Post potential (see Table 2). Potential was found by calculating (from postal costs) the number of physical letters sent from all units in a municipality. The slow-increase municipality only reached 3% of its potential in 2013, whereas the late-increase municipality reached 6% and the gradual- and early-increase municipalities reached 18%.

Municipality		A	B	C	D
Municipal adoption cluster		Slow	Late	Gradual	Early
Annual physical letters per 1000 citizens		2618	3418	1795	2127
2012	Realized	31	45	121	274
	Percentage realized (corrected)	1%	2%	8%	15%
2013	Realized	50	149	217	254
	Percentage realized (corrected)	3%	6%	18%	18%

Table 2.   Potential (physical letters per 1000 citizens) and percentage realized of the potential for a single municipality in each municipal adoption cluster. Annual physical letters for A and D are from 2010; data for B and C are from 2012. The percentage realized has been corrected for a decrease in workload caused by centralization.

6   Discussion

We find that substantially more of the variation in the obtained savings is explained by the variation in adoption by municipal staff than by the variation in adoption by citizens. This finding appears at odds with the dominant focus on citizen adoption in most e-government adoption research. In the discussion, we will address the findings from the viewpoint of the municipal adoption.

6.1   Significant deficit due to slipped effects from Digital Post

When we compare the whole municipal sector with the business case, the difference between anticipated and realized savings is large. According to our estimate, the municipal sector reduced postal costs by € 1.2 million in 2013 while the state funding was cut by € 6.0 million due to estimated savings; this is a deficit of € 4.8 million. In an average municipality of 40000 citizens, this corresponds to one headcount (using the headcount unit cost from the national business case). Danish municipalities need to cut staff, lower the service toward citizens or draw on their savings to recoup the deficit from the Digital Post initiative. The consequences will be most severe in the 51 municipalities in the slow-increase cluster.

The estimated total potential from the business case is 27 million mails in 2013, equivalent to 5000 letters per 1000 citizens. If we compare this number with the number of physical letters for the four municipalities in Table 2, the four municipalities' own estimate of the potential is 37% to 71% of the business case potential (mean: 51%). This finding is consistent with earlier reports of overly optimistic expectations toward e-government among researchers (Coursey & Norris, 2008) and politicians (Goldfinch, 2007). This study also supports the claim by Cordella and Bonina (2012) that the NPM values embedded in e-government initiatives may have political and administrative consequences.

6.2 The adoption process

A barrier to quick adoption is that Digital Post was designed without a functionality for municipal staff to try it out. The lack of opportunity to experiment with new innovations has been found to slow down adoption (Rogers, 2003). To try Digital Post, employees had to use themselves as 'test citizens', but to do that, they needed to register as users of Digital Post and use their personal social security number. One municipality ordered its staff to do so but this was later deemed illegal by the Danish Data Protection Agency. When municipalities started to adopt Digital Post by the end of 2010, only 2% of citizens had adopted Digital Post. If the adoption by municipal employees is equally low, only a minority of employees can use themselves as 'test citizens'.

Another reason for hesitation in the adoption of Digital Post is that some legal issues remained unresolved. One such issue is that mail from a Danish public institution must be signed by the employee who has handled the case. To satisfy this requirement, municipalities have resorted to workarounds (e.g., scanned signatures, a practice later deemed illegal). The law that makes it legal to communicate electronically without a written signature was passed at the end of 2013, more than 3 years after inauguration of Digital Post. A second legal issue is that municipal staff needs a citizen's social security number to communicate digitally with him or her via Digital Post. Due to the possibilities for misusing access to social security numbers, the system in which municipal staff can look up social security numbers contains a prominent message emphasizing that it is illegal to retrieve social security numbers unless they are necessary to the handling of a case. It was only in February 2014 officially declared that communicating digitally with a citizen, rather than by physical letter, is a lawful reason for retrieving a social security number. This shows how individual-level adoption by municipal staff was entangled in legal issues that were left unresolved when the organization-level decision to adopt was made. As a consequence, the municipal staff has been in an uncomfortable situation. Staff has been lacking the authority to solve the problem 'exported' to them and was, at the same time, expected to derive benefit from Digital Post. Municipal management has been in a similar situation because they, too, have lacked the authority to solve the problem. Thereby, the legal issues illustrate that organization-level adoption is a possibly yearlong process; it is not merely a decision to adopt, as implied by Gallivan (2001).

The vast majority of mails from municipalities to citizens are cover letters with attachments. The dominant work situation is that municipal staff generate documentation from one of a variety of systems and attach this documentation to a cover letter from the word processor. However, it was only in August 2012 that the vendor of the output manager that sends mail to Digital Post released a version that could handle attachments easily. The interoperability challenge is emphasized as vital by practitioners (Irani et al., 2007) and recognized as a major barrier to e-government by Bannister and Connolly (2012). They argue that governments need to stop chasing new ideas and instead focus on old challenges that remain unsolved and thereby hamper adoption of further e-government.

6.3 Differences across municipalities

We found differences amongst municipalities in current adoption level and in adoption process. The municipal tasks are the same, Digital Post is the same, and the surrounding systems are similar. When looking at bigger municipalities with populations of more than 100000 citizens, we find that these municipalities appear in all four clusters.

At least 72 of the 98 municipalities (slow and late increase) have suffered from the type of assimilation gaps, where acquisition does not necessarily lead to deployment (Fichman & Kemerer, 1999); they hardly used Digital Post during the two years after its technical implementation. Only 16% of citizens had adopted Digital Post after the first two years, thus there was little citizen pressure on municipalities to adopt Digital Post. Tyre and Orlikowski (1994) found that after a brief window of opportunity, only interventions like external events could reopen the window. In summer 2012, two things happened that may have reopened the window. The Danish parliament passed the Digital Post law that makes it mandatory for businesses and citizens to receive digital letters from the public sector in 2013/2014. At the same time, the Ministry of Finance and LGDK made the agreement to cut state funding for local governments in 2013 due to anticipated savings from Digital Post. These two events may have stimulated municipal adoption.

The early-increase municipalities seem to hit a ceiling at about 100 monthly mails per 1000 citizens. The majority of municipal case handling is supported by legacy systems. In most cases these systems are designed to only print physical letters. As long as these systems cannot produce mails to integrate with Digital Post, physical letters are being sent. The primary vendor of the legacy systems, KMD, has promised integration to Digital Post and the ceiling will move upward as this happens.

We speculate that the gradual and early increase municipalities have a more centralistic culture with a higher degree of mandated use. Gallivan (2001) found that a 'strong top-down, bureaucratic organizational culture may facilitate early stages of innovation assimilation'. A strategy for e-government initiatives is important to guide the change process. The early increase municipalities may have specified the anticipated effects from the Digital Post, made these effects measurable, and set up targets, along with allocating the necessary project management skills and resources (Ndou, 2004).

6.4   Relation between adoption by municipal staff and citizens

We find a merely modest relationship between the adoption by municipal staff and citizens. This finding suggests that the adoption of Digital Post is subject to factors that moderate the critical-mass effects expected for communication and coordination systems (Markus, 1987). One moderating factor explicitly built into the output manager is that the system checks whether the citizen (to whom a mail is sent) has adopted Digital Post; it sends the mail as a physical letter if the citizen has not adopted Digital Post. Thus, municipal staff can send mail to citizens using Digital Post, irrespective of whether the citizens have adopted Digital Post. From the point of view of the municipal staff, this functionality simulates full adoption among citizens. Another moderating factor is that since November 2010 municipalities have been required to accept incoming mail from citizens in Digital Post. Thus, citizens can, in principle, send mail to their municipality through Digital Post even if the mail they receive from their municipality is a physical letter. While municipalities have not fully lived up to this requirement, it has contributed to reducing the effects of critical mass on the adoption of Digital Post.

In spite of these moderating factors, the municipal staff's adoption is likely affected by their perception of how citizens feel about communicating digitally with the municipality. This perception is further affected by their personal feeling, as citizens, about using digital communication for such purposes. Thus, their perception of how citizens feel about Digital Post is affected by their concomitant membership of one social world (Mark & Poltrock, 2004) as municipal staff and another as citizens. Conversely, citizens' adoption is likely to be somewhat affected by their perception of whether their municipality prefers digital communication through Digital Post. These perceptions may help explain why the adoption pattern characterized by an early increase in the use of Digital Post by municipal staff always co-occurs with the pattern of high adoption among citizens. However, this co-occurrence involves only 5 of the 98 municipalities. For the remaining 93 municipalities, it appears as though municipal staff and citizens have adopted or not adopted Digital Post on the basis of factors related to their own use of the system, such as whether they have the required knowledge and skills (Fichman & Kemerer, 1999) and whether adoption is compatible with their other tasks, technologies, and values (Goodhue & Thompson, 1995).

6.5   Limitations

Three limitations must be remembered in interpreting the results of this study. First, the total number of mails sent from municipalities to citizens (the potential) is only known for a small subset of the municipalities. Therefore, adoption by municipal staff cannot be analyzed as the percentage of mails sent through Digital Post. This makes it difficult to assess how far the municipal staff has progressed toward full adoption. Second, the need for communication between municipalities and citizens may not be evenly distributed among municipalities. Big municipalities may have an overrepresentation of citizens who are in considerable contact with the welfare system, and, hence generate relatively more mails. Third, the study does not contain empirical data about why municipal staff and citizens adopt or refrain from adopting Digital Post.

7   Conclusion

More than three years after Digital Post was launched, municipal staff use it for sending an average of 74 monthly mails per 1000 citizens (less than one per year per citizen), and 27% of Danish citizens have adopted it. However, these national averages contain considerable variation from one municipality to another. We have identified four adoption patterns among the municipal staff and two among citizens. Our extrapolation of the use of Digital Post to full adoption among municipal staff and citizens indicates that only about 50% of the cost saving estimated in the business case can be realized. Though the extrapolation is based on data from only 4 of the 98 municipalities, it suggests that the business case exaggerates the possible saving from adopting Digital Post. This illustrates the uncertain and political environment of which e-government initiatives such as Digital Post are part.

We see three research implications of our study. First, organization-level and individual-level adoption in the municipalities are entangled. For example, interoperability problems and legal issues speak against the notion of an organizational decision to adopt followed by secondary adoption by individual staff. Rather, organization-level adoption appears to be a continuing process that runs in parallel with individual-level adoption. Second, adoption by municipal staff and adoption by citizens have been decoupled to an extent that has moderated the critical-mass effects otherwise seen for communication and coordination systems. This decoupling eases adoption during early stages but also entails that adoption will be less self-sustaining after critical mass has been achieved. Third, case studies are needed to investigate how municipal staff and citizens experience the incentives and disincentives for adopting Digital Post. The adoption patterns identified in this study provide a starting point for selecting case-study municipalities and a context for interpreting case-study results.

In terms of implications for practice, two issues appear particularly noteworthy. First, the four different adoption patterns among the municipal staff imply that the municipalities are at different stages of e-government readiness and, therefore, need different types of initiatives (at different times) to increase their use of Digital Post. The differences in adoption patterns and readiness also suggest a potential for exchanging lessons learned among the municipalities. Second, as long as municipal budgets are cut by an amount derived from the business case for Digital Post it appears that municipalities will have to cut expenses in other areas to meet the cut in their budgets motivated by the introduction of Digital Post.

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