

Adopting open source software in public administration: The importance of boundary spanners and political commitment

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Abstract

Open source software (OSS) adoption in public administrations around the world has been uneven. Despite the substantive economic and efficiency-related implications of OSS adoption, there is surprisingly little research into the determinants of the diffusion of OSS across public sector jurisdictions. In this article we explore the variation in OSS adoption among Dutch local administrations. The Dutch central government adopted a policy to stimulate the use of OSS in the public sector, but the non-mandatory character of the policy resulted in great differences in the degree of adoption of OSS at the local level. Using data from a new survey of municipalities in the Netherlands and proportional odds statistical models to analyze the data, we show that the degree of OSS adoption crucially depends on the presence of boundary spanners and political commitment within the local government. On the other hand, oft-suspected factors like financial stress and jurisdiction size have no discernible effects. Our findings have implications for understanding the spread of OSS in the public sector and for public policies designed to encourage OSS diffusion.

What are the factors that determine the spread of institutional and technological innovations in the public sector? How can we explain why certain public organizations are more likely to be at the forefront of innovation while others lag behind? These questions have a central place in the study of public administration, but we still have only imperfect understanding of how individual-, organization-, and system-level variables interact to produce the patterns of diffusion we observe in the world. In this article we analyze the diffusion of open-source software (OSS) in Dutch municipalities: a process that can shed new light on the diffusion of innovations in the public sector since there was a great degree of variation in the extent to which these organizations progressed towards OSS adoption. The variety of outcomes in a set of similar organizations provides us with a window of opportunity to isolate potential causal factors that can account for the differences: an opportunity that we pursue in this study.

OSS provides many potential benefits for public and private organizations. For example, it is often available for no license costs, it is not the exclusive property of a single software vendor, and users have the freedom to study, change and redistribute OSS. Not surprisingly, OSS is making gains in market share rapidly. A study from 2009 estimated that worldwide revenue from OSS would grow at an annual rate of 22,4% to reach US \$8,1 billion by 2013. The economic crisis is an extra stimulus for that growth (International Data Group, 2009).

The advantages of using OSS have not gone unnoticed in the public sector. Perhaps one of the most well-known users of OSS in the public sector is the municipality of Munich. It started a plan to migrate to OSS in 2003 with the aim to finish the migration of all of its 12.000 workstations by the end of 2012. The municipality calculated that

the current cost of its migration project is € 11,7 million, while an upgrade to a comparable environment based on Microsoft Windows and Office would have required € 15,52 million, excluding costs of € 2,8 million for license fees for upgrades recurring every 3 to 4 years for a Microsoft infrastructure (von Eitzen, 2012).

Even larger migrations have been undertaken elsewhere in Europe. The Spanish autonomous region of Extremadura decided in 2002 to migrate to Linux as well. With 40.000 workstations (Hillenius, 2012c) it expected to save € 30 million annually (Hillenius, 2012b). The French national police force decided to migrate to OSS in 2004. This enabled the organization, which had 90.000 workstations in 2004, to save over € 50 million on software licenses, hardware and maintenance since the migration was started (Hillenius, 2009).

Globally, there have been 354 initiatives for OSS policies from 2000 to 2009, of which 245 have been approved. 235 of those are national policies but only 54 are mandatory. 163 of these initiatives originate from Europe, with the Netherlands having implemented a preferential OSS policy in 2002 (Lewis, 2010). In that year the Dutch House of Representatives accepted a motion which requested the government to ensure that all software used in the public sector would work with open standards by the year 2006 and to stimulate the use of OSS in the public sector. The arguments given for the motion were the lack of competition in the software market and the high switching costs for choosing a different software vendor (Dutch House of Representatives, 2002).

This resulted in several policy programs started by the national government since then. The last program 'The Netherlands in Open Connection' (*Nederland Open in Verbinding*, abbreviated as NOiV) was launched in 2007.

For open standards it enacted a ‘comply-or-explain and commit’ regime. The regime requires that public sector organizations use select open standards for IT projects and demanded an explanation and plan for future implementation if that requirement was not met. It explicitly required that governmental organizations would support the Open Document Format, an open standard for documents. Compared to the open standards policy, the OSS policy was less demanding. It asked public organizations to formulate an implementation strategy for OSS. The government announced research on the release of its own software as OSS and on the economic benefits of OSS. The program bureau would provide support and advice to further the adoption of open standards and OSS and measure progress with a ranking and periodic reports (Ministry of Economic Affairs, 2007).

Especially the OSS policy was a stimulus policy which lacked instruments for enforcing adherence. As such, adherence to the policy was highly dependent on the discretion of the governmental organizations. When the NOiV program was ended in December 2011 the program’s final progress report judged the policy to have been effective (NOiV, 2011a). Yet, the program’s benchmarks revealed that there still existed large variation in the adoption of OSS (NOiV, 2011b).

In this article we explore the variation in adoption of the NOiV program to reveal the factors that explain the differential success in the diffusion of OSS. We employ data from a new survey of the Dutch municipalities to test the possible impact of a number of variables related to the organizational, political and economic contexts. Using proportional odds statistical models to analyze the data, we show that the degree of OSS adoption crucially depends on the presence of boundary spanners and political commitment within the local government. On the other hand, oft-suspected factors like financial stress and jurisdiction size have no discernible effects. Our findings have implications for understanding the spread of OSS in the public sector and for public policies designed to encourage OSS diffusion.

The remainder of the article proceeds as follows. The next section presents an overview of the existing literature on OSS diffusion from which we derive our theory and the hypotheses we test. Next, we outline our research design, and the operationalization and measurement of our variables. Next, we present the results from the empirical statistical analyses. Finally, the concluding section summarizes our inferences and draws their implications.

Towards an explanation of the diffusion of open source software in public administrations

The literature on organizational learning and the diffusion of policy, institutional and technological innovations is immense and spans public administration, organization studies, sociology and other related disciplines. In this review we will focus only on the most-directly relevant part of this scholarship that deals with the spread of innovations related to e-government in the public sector. Since OSS is part of the information technologies (IT) infrastructure of organizations, it is natural to expect that the findings from

studying the diffusion of e-government in general would suggest potential explanations for the adoption of OSS as well. Few studies deal with the adoption of OSS in the public sector in specific and the theoretical insights they offer while valuable remain limited. For example, Cassell (2008) performed an exploratory qualitative study of the motivations of four German municipalities to adopt OSS. Ven and Verelst (2008b) have been the only ones so far to execute a quantitative study. They investigated factors in the adoption decisions of OSS on a sample of both public and private Belgian organizations.

The study of e-government has identified the novel use of IT in government as an important element for increasing public trust in government (Welch, Hinnant, & Moon, 2005), curbing corruption (Shim & Eom, 2009), enhancing political control of the bureaucracy (Ahn, 2011), and reducing red tape (Welch, 2007). Although the enthusiasm for the transformative potential of e-government has been somewhat cooled lately (Baldwin, Gauld, & Goldfinch, 2012; Norris & Reddick, 2013), the e-government agenda remains one of the most important innovation drives facing the public administrations of the XXI century. Since the progress towards the adoption of e-government practices has been highly uneven both between and within countries, much academic attention has been focused on the topic.

The resulting literature has identified a plethora of possible explanatory factors that operate at three distinct levels: systemic, organizational, and individual. Important factors in the organizational adoption of innovations can be categorized as the characteristics of the innovation itself, the characteristics of the adopting organization and environmental influences (Frambach & Schillewaert, 2002). The interactions between individual organizations and their environment (e.g. fiscal or political pressures), the institutional characteristics of organizations (e.g. bureaucratic structures or form of government) and personal cognitive biases and predisposition have all been implicated in explaining the patterns of innovation diffusion.

In a big cross-national study of e-government adoption, Lee and Chang (2011) find evidence for the impact of policy learning, political norms, competition, and citizen pressure. Analyzing digital innovativeness of the American states over time, Tolbert and Mossberger (2011) conclude that institutional capacity, and the modernization of state institutions, are important for continued innovation. Ganapati (2011) also emphasizes institutional barriers for the utilization of new technologies in the public sector. In a study of the diffusion of six e-government practices among American municipalities, Ahn (2011) finds that the interaction of the preferences of the elected mayors and the perceptions of nonelected officials shape the chances of an innovation being adopted. More generally, the political environment and the bureaucratic structure seem to matter (see also Ahn (2011)). Focusing on one particular institutional characteristic, Nelson and Svara (2012) argue that the form of municipal government (council-manager or not) has the greatest leverage for explaining the adoption of e-government innovative practices in the US. In a study of e-government in Italy conducted at the municipal level, Nasi, Frosini, and Cristofoli (2011) find that organiza-

tional factors are more important than the environmental ones in explaining the pattern of adoptions. In sum, there is a broad consensus that institutional characteristics matter, although different authors have quite different understanding of which the relevant institutions are. But there is more to explaining diffusion than institutions.

Jun and Weare (2011) emphasize the search for efficiency and the need for legitimacy in the eyes of the peer organizations. In a longitudinal study of the Italian e-government policy, Mele (2008) argues that a 'substantial osmosis between the policy and the political community' was needed to put the policy in place and to sustain the e-government program in the country. Studying the spread of geo-information technologies, Vonk, Geertman, and Schot (2007) conclude that individuals knowledgeable of the technology, like geo-information specialists and planners, should participate in the design of organizational diffusion policies and formal strategies to enhance the process. Bhatti, Olsen, and Pedersen (2011) single out the presence of administrative professionals acting as drivers of innovation in their analysis of the spread of integrated citizen service centers among Dutch municipalities. Looking more into the individual-level decision making process of the people responsible for authorizing technological innovations (e-voting machines in particular), Moynihan and Lavertu (2012) find the effect of cognitive biases and predispositions, like general trust in technologies. So it appears that the presence of individuals with the right set of knowledge and preferences can have a big impact on the chance of successful adoption of innovations. We focus on this insight and incorporate it the design of our empirical study. In addition, we attempt to address factors operating at the environmental level (fiscal pressures), the interface between the organization and its political context (the presence of activist politicians), and institutions (and the hierarchical fragmentation of IT departments in particular). Below we expand on each of these concepts and outline their expected effects.

Boundary spanners

In their exploratory, qualitative field study of OSS adoption by several companies Morgan and Finnegan (2007) define boundary spanners as 'individuals who connect their organization with external knowledge and can bring the organization in contact with new innovations'. They write that adoption of OSS is mostly a bottom-up initiative instead of top-down and mention that in most of the companies they studied, there are some employees who are knowledgeable on OSS and can support its introduction. These individuals are influenced by the technical and business benefits of OSS to become advocates of OSS. In other research the concept of 'OSS champions' is used, but they find this concept hard to distinguish from the boundary spanner.

Ven and Verelst (2008b) investigated which factors influence the adoption of open source server software in 332 private and public Belgian organizations. They reference Morgan and Finnegan (2007) as a source for existing research on boundary spanners and found some evidence in favor of the hypothesis in their own qualitative research (Ven & Verelst, 2006). Because evidence for the hypothe-

sis based on large-N quantitative studies was missing they tested it in their own research project, expecting the presence of boundary spanners to be positively related to the adoption of open source server software. The results of their research show that the presence of boundary spanners is the most influential independent variable on adoption. In one of their other qualitative studies Ven and Verelst (2008a) found that boundary spanners can sometimes be driven by ideology in their choice for OSS. As such their beliefs can influence adoption decisions in smaller organizations, but the majority of organizations are pragmatic in their decision making.

The authors cited above do not specifically exclude the managerial level, but they do focus on the bottom-up aspect of innovation. According to Damanpour and Schneider (2009) managers with a positive attitude towards innovation will make the adoption of innovation more likely as well.

Hypothesis 1: The presence of boundary spanners in the organization is positively related to the probability of adopting OSS.

Activist politicians

In municipalities and other public organizations politicians such as city councilors can also be responsible for a top-down process of innovation, aside from the managers mentioned earlier. In two of the four municipalities studied by Cassell (2008) the adoption of OSS was initiated by councilors and in Amsterdam councilors also took the initiative (de Winter, 2011). In Dutch municipalities the College of Mayor and Alderman is the executive board of a municipality, which is also occupied by politicians.

Determined politicians could thus play the role of the top-down boundary spanner, but their influence is different. The council might be able to force its will on the public servants with a majority, but public servants can resist. In the case of Amsterdam top public servants deemed the plans to migrate to OSS to be impossible because of the existing problems with its IT facilities, which angered local politicians (de Winter, 2011).

Hypothesis 2: The presence of active political support in the organization is positively related to the probability of adopting OSS.

Fiscal stress

As noted in the introduction, financial motives are an important reason to adopt OSS. Cassell (2008) confirms that municipalities are no exception to this. He mentions that a drop in tax revenues triggered two of the smaller German municipalities he investigated, Schwäbisch Hall and Treuchtlingen, to migrate to OSS. Likewise, Dutch municipalities have also been confronted with decreasing budgets. According to a report by the Centre for Research on Local Government Economics municipalities expected to cut their spending up to 7% in 2010 as a consequence of the 2008–2012 global recession, increasing to 12% in 2012. They plan to include their own organization in the auster-

ity measures (M. A. Allers & Hoeben, 2010). This raises the question how the austerity measures will affect the desire and ability to adopt OSS.

The literature on organizational decline is divided over the question if fiscal stress leads to more or less innovation. Mone, McKinley, and Barker (1998) studied the effect of organizational decline on the innovation of private organizations. According to their findings, decline can stimulate or inhibit innovation depending on the conditions. Highly institutionalized missions, widely diffused power structures, high levels of resource commitment and the attribution of decline to temporary or uncontrollable causes have a negative effect on innovation. Conversely, less institutionalized missions, more concentration of power, high levels of uncommitted (slack) resources and the attribution of decline to permanent or controllable causes positively affect innovation. They add that many public sector organizations are affected by the former negative factors. As a consequence they consider the private sector to have better credentials for innovation. In his study of local public health organizations Mohr (1969) likewise identified the availability of slack resources as a stimulus for innovation. Because larger organizations possessed more slack resources, they had more potential to innovate.

Wolman (1986) on the other hand considers the characteristics of the innovation itself. He argues that local governments under fiscal stress are more likely to pursue innovations if they increase efficiency and less likely to pursue those that involve risk and resource commitment. It is difficult to determine in which category OSS fits best. It could be argued that OSS falls in both categories depending on the scale of migration projects, which vary. While Schwäbisch Hall and Treuchtlingen had migrated to OSS relatively easily, this was not the case for Munich, where the migration did involve a lot of risks and significant commitment of resources (Cassell, 2008). For Munich an adequate budget for the migration was an important requirement for its success (Editors of Binnenlands Bestuur, 2010). In the Netherlands most municipalities take a more evolutionary step-by-step approach, none so far have migrated to OSS (almost) completely like the German municipalities in the study of Cassell (2008). So it is to be expected that their style of innovation is more compatible with the kind of innovation induced by fiscal austerity. Even though previous research suggests a negative relationship between fiscal pressure and adoption of innovation in general, the evidence of OSS adoption in practice suggests a positive relationship with fiscal pressure.

Hypothesis 3: Higher fiscal stress on the municipality's IT budget is positively related to the probability of adopting OSS.

Fragmentalization of the IT hierarchy

Finally, the organization of the IT services of the municipality is likely to have an important impact on the adoption. The municipality of Munich underestimated the difficulties of migrating to open source software and open standards. Because the municipality had twenty-one indepen-

dent IT departments which did not share standardized software the migration took longer than expected (von Eitzen, 2010). The municipality of Zaragoza also experienced difficulties with its migration due to a fragmented organization (NOiV, 2010). The research of Cassell (2008) confirms this; it mentions that organization structure was the most important factor affecting the implementation of the migrations.

Amsterdam faced similar problems. It had a huge amount of applications in use, with estimates ranging from ten to fifteen thousand. The municipality used at least fifty different software packages for e-mail servers and for some other applications the municipality had at least five different versions in use. The total costs for IT in the municipality, € 128 million, were at least twice as high as in other municipalities. Amsterdam ultimately abandoned its plan for a migration because it wanted to standardize on proprietary software first (de Winter, 2011; Visser, 2011).

The highly independent departments with their own IT management in Munich, Zaragoza and Amsterdam can be described as silos or stovepipes. In an analysis of the national Irish public sector Bannister (2001) explains how IT silos came to evolve in the public sector and why the public sector is more vulnerable to silo development than the private sector. Some of the reasons for this are internal politics in which control of information systems is a key form of power and influence within departments, the relatively uninfluential positions of IT managers in some departments, the absence of central authority and the level of independence of departments. These characteristics run counter to some success factors of information system implementation given by Nah, Lau, and Kuang (2001), which include having a project leader placed in charge with high-level backing and the collaboration of the departments. As mentioned previously, Mone et al. (1998) also identified diffusion of power in the organization structure as an inhibitor of innovation. It is to be expected then that fragmentation negatively influences adoption.

The three municipalities mentioned as examples are all very large municipalities. Zaragoza had 701.090 inhabitants as of 1 January 2010 and Munich had 1.353.186 inhabitants as of 31 December 2010. The size of municipalities in the Netherlands varies widely. As of 2012 the Netherlands has 415 municipalities (Statistics Netherlands, 2012). Amsterdam is the largest with 790.110 inhabitants and Schiermonnikoog is the smallest with 932 inhabitants. Many small municipalities have just one IT department. Cassell (2008) describes how the two smaller municipalities of Schwäbisch Hall (37.137 inhabitants as of 31 December 2010) and Treuchtlingen (12.778 inhabitants as of 31 December 2010) migrated to OSS relatively easily. Their IT departments are very small and they did not have many workplaces to migrate. While there is contradictory evidence which states that centralization has a well-tested negative relationship to innovation adoption in general (Li & Feeney, 2014), OSS is expected to be an exception based on the evidence from practice.

Hypothesis 4: A fragmented IT hierarchy is negatively related to the probability of adopting OSS.

In summary, based on theoretical insights from the general literature on the diffusion of innovations and findings from the empirical literature on the spread of OSS, we identified a number of hypotheses that related to the organizational, political and economic environment of the public organizations we study. Taken together, the hypotheses address different possible avenues for influence on the probability of OSS adoption in a single jurisdiction. In the remainder of this article we present the design of an empirical study testing the hypotheses and the results of the analysis of the data.

Research design

In order to test the hypotheses about the determinants of OSS diffusion we rely on new data collected using a web-based survey. As explained in the introduction, we focus on the municipal level in the Netherlands which is an appropriate empirical setting for our research goals given that municipalities are encouraged but not required to adopt OSS, and that a considerable variation in the degree of adoption of OSS exists.

Our sampling strategy was as follows. First, from all 415 municipalities in the Netherlands we selected all 50 municipalities with more than 70.000 inhabitants (because almost half of the total population of the Netherlands lives in these municipalities) and we took a random sample of 130 from the remaining 365 municipalities. We contacted the selected organizations with the request to fill in the online survey initially in June 2012, and followed up with two waves of phone call and e-mail reminders in July and August 2012. We were not able to exercise control over who exactly answered the survey: in order to increase response rates this was left at the discretion of the municipality itself. Eventually, out of the 180 organizations which were contacted, 65 responded which resulted in a response rate of 36.1%.

Importantly, the final sample of responses does not differ significantly from the population of Dutch municipalities in terms of size (taking into account the deliberate over-representation of large municipalities) and financial capabilities. One municipality has less than 10.000 inhabitants; 31 have between 10.000 and 50.000; 13 have between 50.000 and 100.000; 15 have between 100.000 and 200.000 and five municipalities number between 200.000 and 800.000 inhabitants. Furthermore, the sample matches rather closely the distribution of OSS adoption as measured by the NOiV Monitor ranking (NOiV, 2011b) in 2010. In the NOiV ranking municipalities were asked in how many fields of application they used OSS: infrastructure, system administration, Internet and end users. The data compiled from the ranking is shown in the table in figure 1.

Thus, our results should not be subject to a selection bias from conditioning the responses on overall administrative and technological capacity (a potential factor influencing both the likelihood of OSS adoption and responding to the survey). In other words, in our final sample laggards

in the adoption of OSS are represented along with municipalities with a moderate and high degree of adoption, and in a roughly proportional way to our best estimates of the distribution of OSS adoption in the population of local governments.

Having described our sampling strategy, now we turn towards the operationalization of our concepts by the survey items and the construction of the variables used in the analysis. A full list of the survey questions and how they could be answered is provided in the appendix. To measure the central outcome – OSS adoption – we reused the distinction between four fields of applications for OSS from the NOiV rankings: infrastructure, system administration, Internet and end users. We used a five point Likert scale to measure each of these four items more accurately.¹

We aggregate the items in two different ways to arrive at our dependent variable. First, we sum the scores on the four questions, z-transform (center and divide by the standard deviation) the result and treat it as a continuous measure (which enables us to use linear regression for data analysis). Second, we construct an ordered categorical variable with three levels from the raw item scores. The categories range from 'low adoption' (average score less than two), to 'medium adoption' (average score between 2 and 4) and 'high adoption' (average score above 4). The number of categories and the cut-off points were selected after examining the distribution of the data.

The advantage of the first approach is that it provides for more, and finer, variation, but the disadvantage is that we have to assume that differences along the entire length of the scale have the same significance. On the other hand, the categorical variable is coarser but possibly better in capturing true differences between the municipalities rather than minor fluctuations in the scores resulting from measurement error and statistical noise.²

The questions for the dependent variable inquired about the state of OSS adoption at the moment the survey was taken, but for the independent variables the respondents were requested to consider a longer period of time for their answers, approximately a year. This way issues such as personnel turnover in the case of boundary spanners could be taken into account.

Based on the literature on boundary spanners five questions were devised to capture this concept. We first ask if there are employees who promote using OSS, which is likely the lowest common denominator which characterizes boundary spanners in the context of OSS adoption. We continue with questions increasingly asking for more explicit evidence of boundary spanning: trying to convince the management to adopt OSS and having the knowledge to support a migration towards OSS. Because managerial acceptance and influence are important factors the last two questions ask if the management values the ideas of the boundary spanners and if there are boundary spanners which are part of the management.

With regard to the presence of active political support, talks with public servants suggested that at the very least,

¹Because many smartphones and tablets ship exclusively with Google's open source Android operating system and do not offer a choice for proprietary operating systems the respondents were requested to exclude these devices.

²We also tried a five-level categorical variable which allows for more variation but the results from the analysis remained essentially the same.

	Number of fields				
	0	1	2	3	4
Adoption of OSS in %	17	12	31	27	13
N = 183					

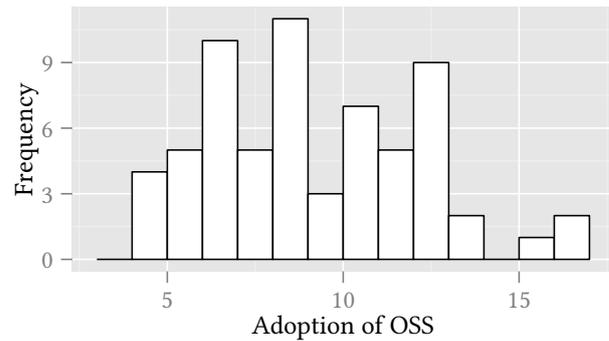


Figure 1: Left: relative frequency table of OSS use by municipality as measured by the NOiV rankings (2011). Right: histogram of OSS adoption in municipalities (2012), cumulative score based on four 5-point Likert-scale items.

city councilors have a limited interest in OSS adoption and ask questions about it to the College of Mayor and Aldermen. The survey asks if this occurred in the first question. Stronger determinants of political activism would be submitting proposals to adopt OSS to a vote in the council and this proposal actually being supported by other councilors. This is asked in the second and third questions.

Fiscal pressure is a difficult concept to investigate. Using the budget documents to determine a municipality's total spending and IT-spending in specific over several years is very time-consuming and possibly misleading as well. For example, in the budgeting system used by Dutch municipalities expenditures can also include writedowns of assets. As such we opted to investigate the concept with survey questions instead.

To determine fiscal pressure, the first question asked if the municipality had to implement austerity measures. This was expected to be the case for the vast majority of municipalities. The following questions were only asked if the answer to the first was positive. Austerity in the municipality as a whole does not necessarily translate to austerity measures in the IT-budget in specific. To determine if the IT-budget is affected, the survey asks for this in the second question. Because the absence of license fees is seen as an important benefit for OSS, the third question asks if the austerity led to budget reductions for license fees of proprietary software. The fourth question asks if the austerity measures led the municipality to investigate the use of more OSS. The fifth question asks if this leads to the actual adoption of more OSS.

Fragmentation of the IT hierarchy is measured by asking for two factors which are characteristic for this according to the anecdotal evidence and literature: different departments all running their own IT-facilities and power over IT being highly distributed over multiple decision makers. The third question is more generic, asking if IT decision making is difficult and time-consuming, which is likely to be the case if the other two factors apply.

Two control variables were used in the research design. Using municipality size as a control variable was necessary because larger municipalities have greater budgets per inhabitant than the smaller ones in the Netherlands (M. Allers, 2011). As such the municipality size is likely to

have an effect on the fiscal pressure. Organizational fragmentation is likely to be influenced as well because larger municipalities probably have more complex organizational structures. Possibly there is a relationship with the presence of boundary spanners or activist politicians too. If a municipality simply has more public servants and politicians, the chance that they may be present could be higher.

The debt quote is the best measurement of the financial position of a municipality (van der Lei, 2011b). It is the net debt as a share of the total income of the municipality. This control variable is especially useful for the third hypothesis on fiscal pressure. In itself, a high debt quote does not say much about fiscal pressure because policies are different in every municipality and this leads to different solutions for austerity. Asking respondents about fiscal pressure is therefore more relevant, but the debt quote is an objective measurement.

The most recent data (van der Lei, 2011a) was compiled for 31 December 2009, newer data is not yet available. According to van der Lei (2011c) high debt quotes are not a problem if the municipality has a large stock of plots and loans to third parties. Future revenue from the sale of plots and interest on loans to third parties can offset the cost for financing those plots and loans. In theory it costs the municipality nothing to finance them, but in reality there is a risk that a plot might sell for less than its original purchase price or that third parties default on loans.

Results from the empirical analysis

Table 1 presents the descriptive statistics of the variables used in the analysis. Note that for first five variables, the reported numbers are based on the average score of the units on the number of questions related to each variable (for example, four in the case of OSS adoption).

Before we present the multivariate analyses, we first focus on the distribution of OSS adoption. The histogram in figure 1 shows the distribution of frequencies for the summed scores of all four questions regarding the dependent variable OSS adoption. The theoretical maximum score for the individual questions on OSS adoption is five, in which case the organization would use OSS exclusively. The mean score is 2.18 which implies that the average

Variable	Minimum	Mean	Median	Maximum	SD
OSS adoption	1.00	2.19	2.00	4.00	0.75
Boundary spanners	1.00	2.83	3.00	4.80	1.10
Activist politicians	0.00	0.42	0.33	1.00	0.39
Fiscal stress	0.00	0.45	0.40	1.00	0.25
IT fragmentation	1.00	2.34	2.33	5.00	1.01
Inhabitants	8,954.00	95,600.00	54,551.00	790,110.00	122,857.00
Debt quote	-62.00	77.07	74.00	237.00	50.60

Table 1: Descriptive statistics

Dutch municipality has some experience with OSS and has incorporated it in at least some part of its organization and management activities. The standard deviation is 0.75 and the overall distribution is not too far off the normal curve.

The maximum value for the total score of all questions is sixteen and was observed only twice. Four respondents score the theoretical lowest value of four and do not use any OSS at all. The vast majority of the respondents do not use more OSS than proprietary software if the score of twelve is used as a guideline.^{3 4}

Having discussed the distribution of OSS adoption, we turn towards the multivariate statistical models which try to capture the factors behind the differential adoption.⁵ As explained above, we run two models: the dependent variable is operationalized as a continuous measure in the first one, and as a categorical variable in the second one. The methods of analysis are linear regression for Model 1 and proportional odds logistic regression for Model 2. Proportional odds analysis is a appropriate method for modeling ordered categorical variables, as the one we are dealing with here (see Long (1997) for details).

Table 2 summarizes the results from the two models. Both models lead to very similar inferences with the direction and significance of all variables being consistent across the models. There are positive and significant effects for the two variables that test the hypotheses that the presence of respectively boundary spanners and active political support increase the likelihood of OSS adoption. On the basis of the linear model (Model 1) we can calculate that a point increase in the boundary spanners score leads to a 0.27 increase in the OSS adoption score which is relatively small compared to the existing estimates from the literature (Ven & Verelst, 2008b); the effect of political activists is almost twice as big, but is estimated with less certainty. Interestingly, the effect of fiscal stress on the IT budget on OSS adoption is in the expected positive direction but is not statistically significant. Similarly, the effect of a fragmented IT hierarchy is negative as expected but is not significant in the reported models (it reaches marginal statistical significance if the control variables are excluded). The model has an adjusted R-square of 0.34 which indicates relatively low fit.

While the proportional odds model supports the above conclusions about the direction and significance of the effects, the effect sizes of the coefficients are more difficult to illustrate since the model is non-linear. Figure 2 shows the predicted probability of a municipality being in a specific category (low, average, high) of OSS adoption for different values of boundary spanners and political activists according to the estimates of the model, and holding the other variables at their means. For example, if a municipality has a score of 2 for the presence of boundary spanners it has almost 50 percent chance of being in the 'Low' category and less than 10 percent change of being in the 'High' category of OSS adopters. But with a score of 4 on the boundary spanners variables the chance of being a 'High' adopter has increased to 25 percent and the change of being a laggard to less than 10 percent. We can interpret the lower panel of Figure 2 in a similar way but with regard to the effect of political activism.

Conclusions

In this article we explored the determinants of variation in the adoption of OSS in public organizations. Our findings partly support existing research but also contradict some received wisdom in the field. First, our analyses confirm the influence of boundary spanners (Ven & Verelst, 2008a) and political activism (Cassell, 2008). Having people within the organization who promote, inform about, and politically support the adoption of OSS appears almost indispensable for OSS adoption. On the other hand, the influence of economic factors, like the financial stress of the municipality appears to have no real influence according to our analyses. The effect of organizational (IT) fragmentation remains uncertain but is likely negative. Altogether, it seems that the adoption of OSS depends less on the broader economic and social context but more on the particular confluence of personal and political support for OSS within the organization.

A confirmation of the boundary spanner hypothesis is not surprising given the existing evidence, but the very small effect size was not expected. The presence of activist politicians is potentially much more influential but

³It is notable that the scores of six, eight, ten and twelve occur quite frequently compared to their neighboring scores. This could be caused by the relatively small sample size. It could also be attributed to central tendency bias and proximity bias, well-known problems of measurement with Likert scales. Respondents can be reluctant to give extreme scores and might give similar answers for similar items (Albaum, 1997).

⁴We conducted a principle components analysis of the items comprising the OSS adoption scale but found that essentially all questions load on the same dimension, so we decided to use the average of all questions for the construction of the final variable rather than construct two or more factors based on the individual items.

⁵The cross-correlations between the variables can be found in the Appendix.

Variable	Model 1		Model 2	
	Linear regression Coef.	SE	Proportional odds Coef.	SE
Intercept	1.26***	(0.32)		
Intercept (Low-Avg.)			2.25*	(1.23)
Intercept (Avg.-High)			5.33***	(1.45)
Boundary spanners	0.27**	(0.09)	0.88**	(0.34)
Activist politicians	0.62*	(0.23)	2.18**	(0.86)
Fiscal stress	0.36	(0.35)	1.74	(1.23)
IT fragmentation	-0.11	(0.09)	-0.43	(0.34)
Inhabitants	-0.04	(0.09)	0.03	(0.30)
Debt quote	0.04	(0.08)	-0.10	(0.31)
Adjusted R-squared	0.33			

Significance levels: * 0.05; ** 0.01; *** 0.001. Unstandardized coefficients.
Dependent variable: adoption of open source software. N=51.

Table 2: Factors influencing OSS adoption

this finding might be related to the specific empirical setting of our study.

According to this study fiscal pressure on municipal IT departments does not lead to more adoption of OSS, which is difficult to explain considering the evidence of financial benefits of OSS. It could be that Dutch municipalities make a different appraisal of cost benefits than the municipalities investigated in the study of Cassell (2008) and use other measures to implement austerity. If we assume that the cost benefits of OSS are real, it is unfortunate that so many municipalities fail to capitalize on this advantage of OSS. In that case the current policy of stimulus is obviously insufficient as it allows for these vast differences in OSS adoption to exist. As this study has shown that top-down decisions by politicians in the municipality are the most important factor in terms of effect size on adoption of OSS, a new national policy in the Netherlands allowing for less discretion might be a good idea.

Another option might be that a policy on OSS simply needs more effort, in which case lessons might be drawn from Iceland's migration to OSS. The motivation for Ice-

land's policy is similar to those of other municipalities and public institutions which have been mentioned previously: gaining independence from vendors and cost savings (Clark, 2012). In early 2012 the government started a migration project to OSS for all its public institutions, after many of them had already been migrating to OSS over the last four years at a slower pace (before the country was affected by the financial crisis). These include all of its ten ministries, the city of Reykjavik, the National Hospital and schools. The project also entailed setting up a common infrastructure for the migrations and a group of specialists to monitor the project. In the next phase the project aims to work on a call for tender to purchase services based on OSS (Hillenius, 2012a). The Dutch policy on OSS never involved a similar level of effort.

Our general contribution to the study of the diffusion of innovations in public organizations is to identify the political and/or expert support for innovations as factors that can override external pressures from the environment. Organizations are not passively reacting to stimuli for change but have the potential to actively steer reform, provided

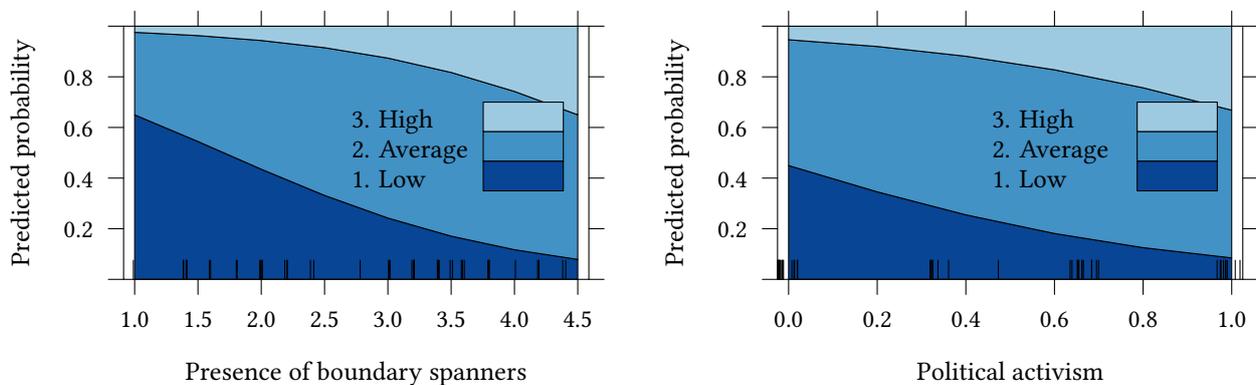


Figure 2: The effects of boundary spanners and political activism on the probability of being in each category of OSS adopters, based on the estimates from Model 2 (the remaining variables are held at their means).

that support exists within the organization. In this respect it is interesting to speculate whether either political or internal expert support is sufficient to guarantee reform and the adoption of new technology. For now we are not able to isolate the impact of activist politicians from the impact of boundary spanners and this remains as an area for future research.

How likely it is that our results generalize beyond the case of the Netherlands? The Dutch policy context of OSS adoption is to some extent characteristic of other governments' efforts as well since OSS adoption is encouraged but is not demanded through binding regulations and little support is available for the actual migration to OSS. In such circumstances it seems that the presence of boundary spanners and political support within the organization could be found important in more public organizations than the Dutch municipalities we survey. Public organizations are less subject to direct economic pressures than the private ones which might explain why the internal environment has a bigger influence on the chance of adoption than the external environment. In any case, more research needs to be done to probe the generalizability of our results and to examine how endogenous the presence of boundary spanners is to the political commitment of the organizational leadership to the adoption of open source software.

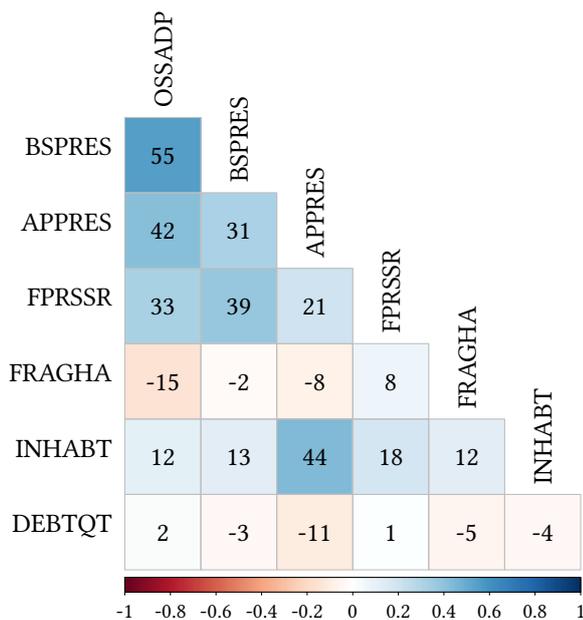


Figure 3: Correlation matrix of all variables. *ADOP* is the total score for OSS adoption, all independent variables appear in the same order as in table 1.

Appendix

Use of OSS

Could you give an estimate of the share of OSS used in the following fields?

1. To which degree is OSS used for infrastructure?
2. To which degree is OSS used for system administration?

3. To which degree is OSS used by end users?
4. To which degree is OSS used for communication over the Internet?

Presence of boundary spanners

1. There are one or more employees in the municipality who promote the usage of OSS.
2. There are one or more employees in the municipality who make an effort to convince management to adopt (more) OSS.
3. There are one or more employees in the municipality who possess adequate knowledge to support a migration towards OSS.
4. The decision makers value the opinions of those employees who press for the use of OSS and take their opinions into account.
5. One or more of the employees in the municipality who promote the usage of OSS are part of the management.

Presence of activist politicians

1. Members of the municipal council or the College of Mayor and Aldermen have asked questions about the use of OSS.
2. Members of the municipal council or the College of Mayor and Aldermen have been vocal in their support for OSS and have pushed the municipality to adopt OSS, but failed to get the support of a majority.
3. The municipal council or the College of Mayor and Aldermen have accepted motions or made decisions to make the municipality use more OSS.

Fiscal pressure on the IT department

1. Our municipality had to implement austerity measures.
2. As a consequence of the austerity measures the IT budget was reduced.
3. As a consequence of the austerity measures we spent less budget on license fees (for the right to use the software) for proprietary software during this period.
4. As a consequence of the austerity measures increasing the use of OSS was investigated.
5. As a consequence of the austerity measures we increased our use of OSS.

The second to the fifth questions were conditional, they were only asked in case the answer to first question was positive.

Fragmentation of the IT hierarchy

1. Authority over IT matters is divided over different departments. There is no central IT department.
2. There is no single person who has the final say in decisions related to IT affairs.
3. It is very difficult and time-consuming to make decisions on IT affairs.

References

- Ahn, M. J. (2011). Adoption of e-communication applications in U.S. municipalities: The role of political environment, bureaucratic structure, and the nature of applications. *The American Review of Public Administration*, 41(4), 428–452. doi:10.1177/0275074010377654
- Albaum, G. (1997). The Likert scale revisited: An alternate version. *Journal of the Market Research Society*, 39(2), 331–348.
- Allers, M. A. & Hoeben, C. (2010). Bezuinigingen en crisisbeheersing: Financiële plannen van gemeenten, 2010-2012. Retrieved from <http://www.coelo.nl/rapporten/enquetebezuinigingen.pdf>
- Allers, M. (2011, November 23). Prof. Maarten Allers: 'local government funding unnecessarily complex and inefficient'. Retrieved from http://www.rug.nl/kennisdebat/Debat/opinie/2011/opinie49_2011
- Baldwin, J. N., Gauld, R., & Goldfinch, S. (2012). What public servants really think of e-government. *Public Management Review*, 14(1), 105–127. doi:10.1080/14719037.2011.589616
- Bannister, F. (2001). Dismantling the silos: Extracting new value from IT investments in public administration. *Info Systems Journal*, 11(1), 65–84. doi:10.1046/j.1365-2575.2001.00094.x
- Bhatti, Y., Olsen, A. L., & Pedersen, L. H. (2011). Administrative professionals and the diffusion of innovations: The case of citizen service centres. *Public Administration*, 89(2), 577–594. doi:10.1111/j.1467-9299.2010.01882.x
- Cassell, M. (2008). Why governments innovate: Adoption and implementation of open source software by four European cities. *International Public Management Journal*, 11(2), 193–213. doi:10.1080/10967490802095680
- Clark, J. (2012, March 22). Iceland swaps Windows for Linux in open-source push. Retrieved from <http://www.zdnet.com/iceland-swaps-windows-for-linux-in-open-source-push-3040154870/>
- Damanpour, F. & Schneider, M. (2009). Characteristics of innovation and innovation adoption in public organizations: Assessing the role of managers. *Journal of Public Administration Research and Theory*, 19(3), 495–522. doi:10.1093/jopart/mun021
- de Winter, B. (2011, September 1). ICT-chaos in Amsterdam nekt open source. Retrieved from <http://webwereld.nl/nieuws/67011/ict-chaos-in-amsterdam-nekt-open-source.html>
- Dutch House of Representatives. (2002, November 20). File number 28 600 xiii, sub number 30. Retrieved from <https://zoek.officielebekendmakingen.nl/kst-28600-XIII-30.html>
- Editors of Binnenlands Bestuur. (2010, April 8). München tart Microsoft-wereld. Retrieved from <http://www.binnenlandsbestuur.nl/digitaal-besturen/nieuws/nieuws/munchen-tart-microsoft-wereld.155300.lynkx>
- Frambach, R. T. & Schillewaert, N. (2002). Organizational innovation adoption: A multi-level framework of determinants and opportunities for future research. *Journal of Business Research*, 55(2), 163–176. doi:10.1016/S0148-2963(00)00152-1
- Ganapati, S. (2011). Uses of public participation geographic information systems applications in e-government. *Public Administration Review*, 71(3), 425–434. doi:10.1111/j.1540-6210.2011.02226.x
- Hillenius, G. (2009, March 6). FR: Gendarmerie saves millions with open desktop and web applications. Retrieved from <https://joinup.ec.europa.eu/news/fr-gendarmerie-saves-millions-open-desktop-and-web-applications>
- Hillenius, G. (2012a, March 21). All of Iceland's public administrations moving towards open source. Retrieved from <https://joinup.ec.europa.eu/news/all-icelands-public-administrations-moving-towards-open-source>
- Hillenius, G. (2012b, March 31). Extremadura overhauls IT to save millions and to increase open source. Retrieved from <https://joinup.ec.europa.eu/news/extremadura-overhauls-it-save-millions-and-increase-open-source>
- Hillenius, G. (2012c, January 23). Extremadura to move all of its 40,000 desktops to open source. Retrieved from <https://joinup.ec.europa.eu/news/extremadura-move-all-its-40000-desktops-open-source>
- International Data Group. (2009, July 29). Open source software market accelerated by economy and increased acceptance from enterprise buyers, IDC finds. Retrieved from <http://www.idg.com/www/pr.nsf/ByID/IDGC-8MBQJM>
- Jun, K.-N. & Weare, C. (2011). Institutional motivations in the adoption of innovations: The case of e-government. *Journal of Public Administration Research and Theory*, 21(3), 495–519. doi:10.1093/jopart/muq020
- Lee, C.-p. & Chang, K. (2011). Testing the development and diffusion of e-government and e-democracy: A global perspective. *Public Administration Review*, 71(3), 444–454. doi:10.1111/j.1540-6210.2011.02228.x
- Lewis, J. A. (2010, April 16). Government open source policies. Retrieved from <http://csis.org/publication/government-open-source-policies>
- Li, M.-H. & Feeney, M. K. (2014). Adoption of electronic technologies in local u.s. governments: distinguishing between e-services and communication technologies. *The American Review of Public Administration*, 44, 75–91. doi:10.1177/0275074012460910
- Long, J. S. (1997). *Regression models for categorical and limited dependent variables*. Thousand Oaks, California: SAGE Publications.
- Mele, V. (2008). Explaining programmes for change: Electronic government policy in Italy (1993 – 2003). *Public Management Review*, 10(1), 21–49. doi:10.1080/14719030701763179
- Ministry of Economic Affairs. (2007). Nederland Open in Verbinding: Een actieplan voor het gebruik van Open Standaarden en Open Source Software bij de (semi-)publieke sector. Retrieved from <https://www.ictu.nl/archief/noiv.nl/files/2009/12/Actieplan-Nederland-Open-in-Verbinding.pdf>

- Mohr, L. B. (1969). Determinants of innovation in organizations. *American Political Science Review*, 63(1), 111–126.
- Mone, M. A., McKinley, W., & Barker, V. L. (1998). Organizational decline and innovation: A contingency framework. *Academy of Management Review*, 23(1), 115–132.
- Morgan, L. & Finnegan, P. (2007). How perceptions of open source software influence adoption: An exploratory study. In H. Österle, J. Schelp, & R. Winter (Eds.), *Proceedings of the 15th European Conference on Information Systems (ECIS 2007)* (pp. 973–984). St. Gallen, Switzerland: University of St. Gallen. Retrieved from <http://aisel.aisnet.org/ecis2007/118>
- Moynihan, D. P. & Lavertu, S. (2012). Cognitive biases in governing: Technology preferences in election administration. *Public Administration Review*, 72(1), 68–77. doi:10.1111/j.1540-6210.2011.02478.x
- Nah, F. F.-H., Lau, J. L.-S., & Kuang, J. (2001). Critical factors for successful implementation of enterprise systems. *Business Process Management Journal*, 7(3), 285–296.
- Nasi, G., Frosini, F., & Cristofoli, D. (2011). Online service provision: are municipalities really innovative? The case of larger municipalities in Italy. *Public Administration*, 89(3), 812–839. doi:10.1111/j.1467-9299.2010.01865.x
- Nelson, K. L. & Svava, J. H. (2012). Form of government still matters: Fostering innovation in U.S. municipal governments. *The American Review of Public Administration*, 42(3), 257–281. doi:10.1177/0275074011399898
- NOiV. (2010, September 6). 'Politieke steun noodzaak voor open source-desktop bij gemeenten'. Retrieved from <https://www.ictu.nl/archief/noiv.nl/voorbeeldprojecten/politieke-steun-noodzaak-voor-open-source-desktop-bij-gemeenten/index.html>
- NOiV. (2011a, December 13). De derde voortgangsrapportage Nederland Open in Verbinding. Retrieved from <http://www.rijksoverheid.nl/ministeries/eleni/documenten-en-publicaties/rapporten/2011/12/13/de-derde-voortgangsrapportage-nederland-open-in-verbinding.html>
- NOiV. (2011b, June 7). Ranking 2010. Retrieved from https://www.ictu.nl/archief/noiv.nl/resultaten/ranking_2010/gefilterd-op-gemeenten/
- Norris, D. F. & Reddick, C. G. (2013). Local e-government in the United States: Transformation or incremental change? *Public Administration Review*, 73(1), 165–175. doi:10.1111/j.1540-6210.2012.02647.x
- Shim, D. C. & Eom, T. H. (2009). Linking citizen satisfaction with e-government and trust in government. *International Review Of Administrative Sciences*, 75(1), 99–116. doi:10.1177/0020852308099508
- Statistics Netherlands. (2012, January 3). 415 Dutch municipalities in 2012. Retrieved from <http://www.cbs.nl/en-GB/menu/themas/overheid-politiek/publicaties/artikelen/archief/2012/2012-3529-wm.htm>
- Tolbert, C. J. & Mossberger, K. (2011). Institutions, policy innovation, and e-government in the American states. *Public Administration Review*, 68(3), 549–563. doi:10.1111/j.1540-6210.2008.00890.x
- van der Lei, J. (2011a, June 28). Schuldpositie van gemeenten op 31 december 2009 op basis van kengetallen. Retrieved from http://www.vng.nl/Documenten/actueel/beleidsvelden/gemeentefinancien/2011/20110628_Lijst_schuldpositie_gemeenten_op_31_december_2009.pdf
- van der Lei, J. (2011b, September 15). 'Wordt de gemeenteschuld een last?' Retrieved from <http://www.vng.nl/eCache/DEF/1/10/479.html>
- van der Lei, J. (2011c, September 12). Wordt de gemeenteschuld een last? *B&G Magazine*, 38, 21–25. Retrieved from http://www.bng.nl/bng/pdf/2011septokt_Lei_21-25.pdf
- Ven, K. & Verelst, J. (2006). The organizational adoption of open source server software by Belgian organizations. In E. Damiani, B. Fitzgerald, W. Scacchi, M. Scotto, & G. Succi (Eds.), *Open source systems* (Vol. 203, pp. 111–122). IFIP International Federation for Information Processing. doi:10.1007/0-387-34226-5_11
- Ven, K. & Verelst, J. (2008a). The impact of ideology on the organizational adoption of open source software. *Journal of Database Management*, 19(2), 58–72.
- Ven, K. & Verelst, J. (2008b). The organizational adoption of open source server software: A quantitative study. In W. Golden, T. Acton, K. Conboy, H. van der Heijden, & V. K. Tuunainen (Eds.), *Proceedings of the 16th European Conference on Information Systems (ECIS 2008)* (pp. 1430–1441). Galway, Ireland: National University of Ireland. Retrieved from <http://is2.lse.ac.uk/asp/aspecis/20080121.pdf>
- Visser, J. (2011, April 15). Amsterdamse onmacht. Retrieved from <http://www.binnenlandsbestuur.nl/digitaal-besturen/achtergrond/achtergrond/amsterdamse-onmacht.1051907.lynkx>
- von Eitzen, C. (2010, March 19). LiMux project management, "We were naïve". Retrieved from <http://www.h-online.com/open/news/item/LiMux-project-management-We-were-naive-958824.html>
- von Eitzen, C. (2012, March 29). LiMux: cheaper and more robust than Windows. Retrieved from <http://www.h-online.com/open/news/item/LiMux-Cheaper-and-more-robust-than-Windows-1485895.html>
- Vonk, G., Geertman, S., & Schot, P. (2007). New technologies stuck in old hierarchies: The diffusion of geo-information technologies in Dutch public organizations. *Public Administration Review*, 67(4), 745–756. doi:10.1111/j.1540-6210.2007.00757.x
- Welch, E. W. (2007). E-government and bureaucracy: Toward a better understanding of intranet implementation and its effect on red tape. *Journal of Public Administration Research and Theory*, 17(3), 379–404. doi:10.1093/jopart/mul013
- Welch, E. W., Hinnant, C. C., & Moon, M. J. (2005). Linking citizen satisfaction with e-government and trust in government. *Journal of Public Administration Research and Theory*, 15(3), 371–391. doi:10.1093/jopart/mui021
- Wolman, H. (1986). Innovation in local government and fiscal austerity. *Journal of Public Policy*, 6(2), 159–180. doi:10.1017/S0143814X00006474