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LIBERALISED PUBLIC PROCUREMENT OF ICT SERVICES FOR SCHOOLS: AN EMPIRICAL CASE FROM FINLAND

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ABSTRACT. The aim of this research was to evaluate the new procurement practices of information and communication technology (ICT) services in Finnish-speaking schools in the City of Kauniainen. In the new model, schools define their needs and school administration mandates the procurement through tendering. The research included a review of the problems associated with procurement practices and the assessment of the procurement model. The results show that service levels have been improved and unit costs as well as the environmental load have been reduced. The new model requires the schools to have the skills and expertise to define their needs and the competencies to prepare and execute the procurement process. The case analysis of the Finnish "Dream School" in Kauniainen shows that administrative and governance aspects are equally important in successful deployment of technology.

INTRODUCTION

Schools are taking big steps towards adopting ICT in learning, teaching and various education processes. ICT is part of everyday life

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for today's young pupils, and teachers face a challenge introducing new technology both in the classroom and as educational tools. Nations are taking measures to integrate ICT in educational processes not only at higher levels but also in basic (primary and secondary) education. Examples of determined strategies can be found e.g. in Singapore (see e.g. Ministry of Education Singapore, 2008; Ng, 2008) and Finland (see e.g. National Board of Education, 2010; Kankaanranta, 2007). Not surprising, the education systems of these countries have attained excellent results when compared with other systems worldwide (McKinsey, 2007), although the governance structures of education and societal models are very different (Leviäkangas et al., 2010). The strengths of Finlands' education system are also examined by Hargreaves and Fink (2008). Marquet (2011) found that applying ICT in education carries a more generic challengewhere technological systems are isolated from their practical contexts – a problem encountered not only in the educational sector.

In Finland, municipalities and cities govern the schools as well as the procurement processes of ICT, which are then implemented in schools. The recent Finnish national plan for ICT in education (National Board of Education et al., 2010) defines the strategies, policies and proposed measures for the educational use of ICT. There is still much room for improvement in the deployment and use of ICT (Britschgi et al., 2011; Hautala et al., 2011a; 2011b).

According to the Finnish national plan, ICT procurement should be carried out as a comprehensive process involving both users and service providers. The ultimate goal is a systemic change resulting in a brand new way of procuring and utilising ICT. An example of such a new, non-mainstream approach comes from the City of Kauniainen, a bi-lingual municipality in Finland (Swedish and Finnish are the official languages) where service procurement in Finnish-speaking basic education has been decentralised and cooperative partners now work more closely with the school as providers of various services through competitive tender processes. In fact, it was the model of Kauniainen and its proven results, reported by Hautala et al. (2011a), that boosted a quick drafting of the national plan.

The national plan further sets priority targets for the use of ICT in schools. The recommendation of the National Board of Education

from 2005 sets the target of workstation density to be at 4-5 students per workstation. Today, the national average in basic (primary and secondary levels) is about 5.5 students per workstation and the variation between regions, municipalities, cities and schools is quite substantial. However, the targets are mainly either very descriptive and qualitative or utmost quantitative. For service levels there are few if any targets. It has been recognised (also in this study) that the targets tell only indirectly about the efficiency, service level and utilisation rate of ICT in schools

This paper tells the story of Kasavuori and Mäntyvuori Schools in Kauniainen, Finland, and shows the impacts of the decentralised and user-needs oriented approach, in which the school defines the ICT services and their quality level independently. This approach differs radically from the previous centralised system applied throughout the cities and municipalities in Finland. Also it should be noted that the small service companies were able to deliver the quality and service level required by the users. Different aspects of the impacts on working time efficiency, level of service of ICT, economy and user satisfaction are analysed with different methods and then summarised. The paper is based on a VTT research report published in Finnish only (Hautala et al., 2011a). It was written in connection with a national project on ICT utilization in schools (OPTEK), which was carried out in 2009-2011. This multidisciplinary cooperation project involved 13 research units and was carried out in close collaboration with 28 companies and schools from 12 municipalities. OPTEK belonged to governmental Ubiquitous Information Society Advisory Board's development programme (http://www.arjentietoyhteiskunta.fi/inenglish) which attempts to boost information society in a number of sectors, one being education. This programme was initiated and chaired originally by Prime Minister Vanhanen himself in 2007 and it stood very high on the Finnish government's agenda until the resignation of the Prime Minister.

The OPTEK project results included models and solutions for innovative application of ICT in Finnish schools. This paper presents one of the main results of the project.

The school concept developed for Kauniainen has been nick-named "Dream School" because the idea is to build a solid ground for the good life. The concept emphasises sustainable social and global values, and puts very little weight on educational technologies as

such (http://kasavuori.fi/images/stories/dream_school.pdf). However, as we will show, \technology plays its part not as the leading character but rather as the assisting crew member, and the support processes that enable "good life build-up" are techno-economical, like organisational (planning, procurement, interfacing with service providers), technological (ICT) and administrative (decision making, mandate division).

The Kauniainen case was evaluated with EVASERVE (www.evaserve.fi), a service evaluation tool. EVASERVE was developed to evaluate either ex post witnessed or ex ante expected impacts of information intensive services. It had been previously applied in evaluaton of transport-related and meteorological information services. Examples of the latter-mentioned can be found in Leviäkangas (2009) and Leviäkangas and Hautala (2009).

We will show bydetailed case analysis how changing the structure of value chain and especially the mandates of value chain actors in municipal procurement has resulted in better service and positive impacts, both internal and external, which are both quantified in value. We also show that these positive results are due to both structural changes in value chain and new, server-oriented ICT architecture. Our research is strictly empirical, although obviously based on a single case study. Furthermore, our research does not rely on methodological finesses but is of normative approach and is aimed to provide intruments for the policy makers who deal with educational ICT and its procurement. The profound starting point is the consideration of ICT not as a technological system but as a service system. This fact should be reflected to the procurement process too. The service-focused approach has been successful in overcoming the typically encountered problems of utilising ICT in primary education in Kauniainen. The results have been utilised in the national strategies for educational ICT (National Board of Education et al., 2010).

Furthermore, the Finnish innovation policies and strategies are recognizing public procurement as one of the means to enhance the policies and strategies and to boost innovations (The Ministry of Development and Economy, 2012)."Demand driven innovation" aims at developing public procurement practices facilitate new innovations. The ICT services procurement deployed in Kauniainen can be regarded as a process innovation – in plain words, a new way

of doing public procurement, re-shaping the Finnish state-of-the-art practices. Especially, public procurement of ICT systems and services concerning health care and social sector ICT procurement has been criticized in Finland, most recently by the National Audit Office On municipal ICT projects/procurement the same type of analysis has not been carried out.

OBJECTIVE AND CARRY-OUT OF THE STUDY

The first goal was to provide an overall description of the current state and development needs of ICT in primary education, using Kauniainen as a case example. The second objective was to assess the impacts and generalizability of the new procurement and deployment model that Finnish-speaking schools in Kauniainen have used for their ICT services since autumn of 2007. Two schools comprise the Finnish-speaking education in Kauniainen, the Kasavuori School (lower comprehensive school) and Mäntyvuori School (upper comprehensive). Both schools are physically attached and use the same infrastructure. The main focus was on the analysis of the impacts of the ICT service procurement and deployment model. The assessment emphasises the quality and cost-effectiveness of workstation services used in primary education, as well as the impacts on the life cycle of ICT equipment. Pedagogical impacts were not included in the scope of this study.

Research methods differed depending on the research stage. The first stage, a survey of identified problems and challenges, was carried out through non-strcutred interviews and discussions with 27 experts and decisionmakers (including staff from the municipal education sector, national educational administration authorities and business representatives active in educational sector) (see Appendix A). The wide spectrum of those interviewed was selected because a holistic view of the problems and challenges was pursued. The researchers wanted to be sure that the analysis they were about to carry out within one single city had a wider interest and national scope. Material collected through thematic interviews was used to create a picture of the general current state of using ICT in schools and the problems and challenges related to it. This was used as a starting point for the study, as it was checked whether the same more general problems were also present in Kauniainen. For this check the researchers met for discussion with several teachers from the

Kauniainen Finnish-speaking educational system. This way, one could verify whether the problems identified at higher levels of administration were truly witnessed at operational level.

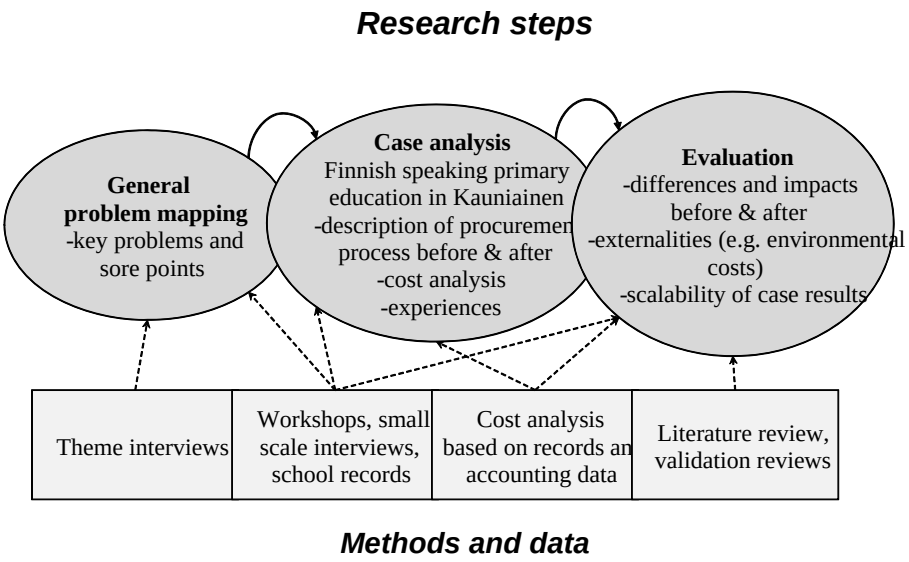
In the second stage, the new procurement model (giving schools greater autonomy in ICT purchases) and the deployment approach that were adopted in the Finnish-speaking schools in Kauniainen in autumn 2007 were compared with the previous traditional approach, in which the implementation of basic ICT services was handled and provided by a municipal ICT unit. The procurement models were compared both in terms of the service level achieved and the operating costs incurred. The cost analysis was based on accounting records of Kauniainen's educational administration and ICT unit. In addition, savings in external costs achieved using the Kauniainen procurement model were evaluated using references from literature. These externalities were mainly considered to comprise environmental expenses.

The teachers, rector, and director of School Administration of Kauniainen were interviewed and participated in discussions several times in addition to being subjected to thematic interviews. These were free-format, non-structured discussions and the researchers made their own notes based on their perception on the experiences and insights of the discussants. Discussions were also conducted with service providers (Opinsys Ltd., IBM) as well as with representatives from the Kauniainen ICT unit. Two external experts working in the field of educations, and with recognized experience nationwide, finally made a review of the research report and provided their comments.

The impact on the ICT services was evaluated indirectly by measuring the service level achieved in procurement models, as well as by applying a preliminary assessment system for educational ICT services. This system, interactively produced in the OPTEK project (Hautala et al., 2011b), includes both qualitative and quantitative criteria, indicators, key figures and methods supporting service assessment. In the case of Kauniainen, the assessment of user experiences was based on the discussions mentioned above and financial and economic impacts were based on solid accounting and cost record data.

The cost data covers years 2007-2009, but the analysis is based on nominal values only. There are several reasons for this. First, the ICT technologies prices change rapidly for some items and more slowly for others. As the analysis contained several cost items (work stations, data communications, servers, human resources, licences, and software), the inflation and price adjustments for each item would have been too complicated. Secondly, the GDP in Finland did not change practically at all when compared to 2007 and 2009 data, so the overall economy indicated very little growth, if at all. This was reflected also to inflation in general. Thirdly, the discovered facts were evidence that minor inflation or price level adjustments would have had insignificant effect on findings. Figure 1 illustrates the research process.

FIGURE 1
Research Process, Methods and Data



DESCRIPTION OF PROCUREMENT MODELS

Traditional Procurement Model

The public procurement processes are extremely well defined in Finland, both at state and municipal level. The Ministry of Finance

has assumed responsibility on many municipality level affairs in an effort to make the sector more productive. They have specific guidelines on how to do public procurement, for example. According to the Finnish Constitution, the municipalities have a dual function. Firstly, they function as the basic regional administrative units of the country, and secondly, as the basic units of the self-government of the citizens. The municipalities have a long tradition of self-government, and thus, the municipal system provides an important arena for political participation. In addition, the municipalities play a central role in society by organising most of the welfare services, such as education.

Prior to 2007, the ICT services used in schools were supplied by the City of Kauniainen's own information management unit. The unit was in charge of workstation procurement, installation and disposal; maintenance of workstations and applications installed on them; maintenance and development of internal school networks and the fibre network connecting city offices; and maintenance of the server environment for school networks. The city's budget included the costs of annual computer and ICT appropriations for individual schools, and it was used to pay for, among other things, new servers, workstations and network equipment, as well as for spare parts for existing equipment. The budget for the schools' computer and IT appropriations was also used to pay for operating system and software package expenses as part of the price of workstations with which the systems and packages had been mated.

In the traditional model, the municipality's own information management unit supplies IT services to schools. The unit makes the required purchases from private companies and puts together the service it offers the school. The content of services offered by the information management unit is often decided in negotiations between the schools and the unit. The services that the information management unit produces itself or outsources to other companies are often selected on the basis of decisions made in the information management unit or in line with the municipality's ICT strategy. In this model, the school may not be able to influence the features or prices of services offered by the information management unit. If IT service expenses are not fully visible at the level of individual schools, it is difficult for those making decisions in the schools to formulate a

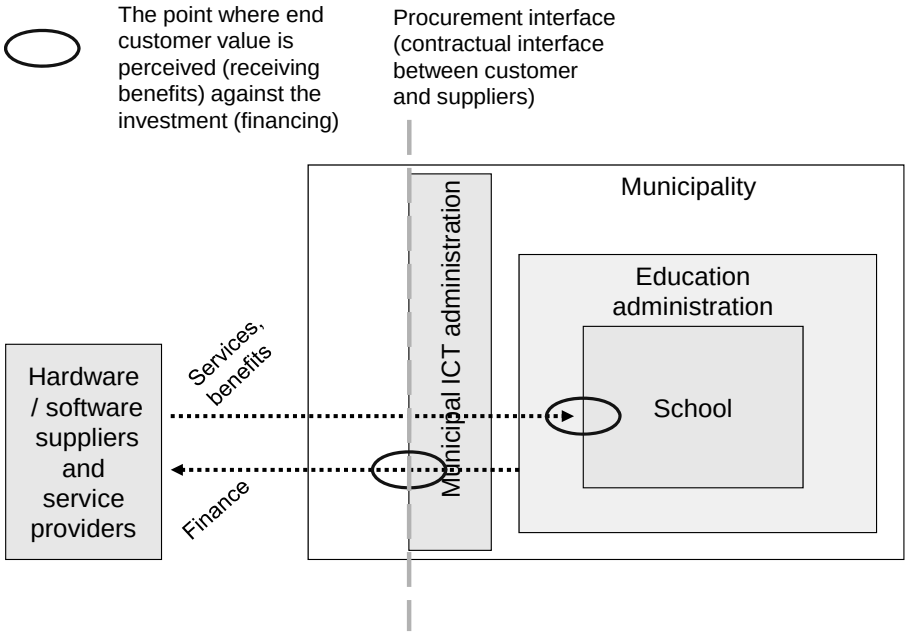
reliable assessment of the cost-effectiveness of services and the cost of operations in relation to the benefits achieved.

There was a general discontent concerning the ICT services and hardware received by the schools. According to interviews in Kauniainen (but also elsewhere), the teachers and rectors felt that their needs were not met and that the equipment and services provided were based more on other facts than on their stated preferences. To put it in plain words, the school staff felt that the information management unit of the city of Kauniainen was making the procurement decisions and dictating the functional specifications without listening to them. In Kauniainen, the information management unit's costs of procurement of both equipment and services were allocated to schools while the budgetary responsibility within the unit was still maintained by the city.

The traditional model, illustrated in Figure 2, springs from a past outsourcing trend, where a number of municipality and city functions were centralised and outsourced as "semi-business" units offering their services to their main client either exclusively or through competition. All forms of entities are to be found when looking at ICT services: completely traditional in-house units, semi-corporatised profit centers, corporatized profit centers owned by the municipality or city, and completely privatised units. The vast majority of Finnish municipalities' and cities' ICT service units belong to the first two categories. These ICT service units are hence still somewhat part of the local political system. However, it is noteworthy, that the City of Kauniainen did not touch the existing traditional governance and ownership model, just re-defined the roles and tasks.

Most of the hardware consisted of stand-alone workstations, desk stations and portables using Windows operating systems. Two logically separated networks existed in Finnish-speaking schools: the administration network that was mostly used by teachers and which connected them to school administration's and city's internal systems, and student network which allowed pupils to connect applications used for their identification administration and personal folders and to retrieve and use electronic learning / teaching materials. Many of the used applications required a significant amount of workstation processing and the updating of the workstations was typically a time and resource consuming effort. Yet,

FIGURE 2
Traditional Procurement Model Where Municipal ICT Administration Is Responsible for Procurement, and Financing



a strong emphasis was put on keeping the workstations modern and they were renewed every three years through a leasing contract negotiated by the information management unit.

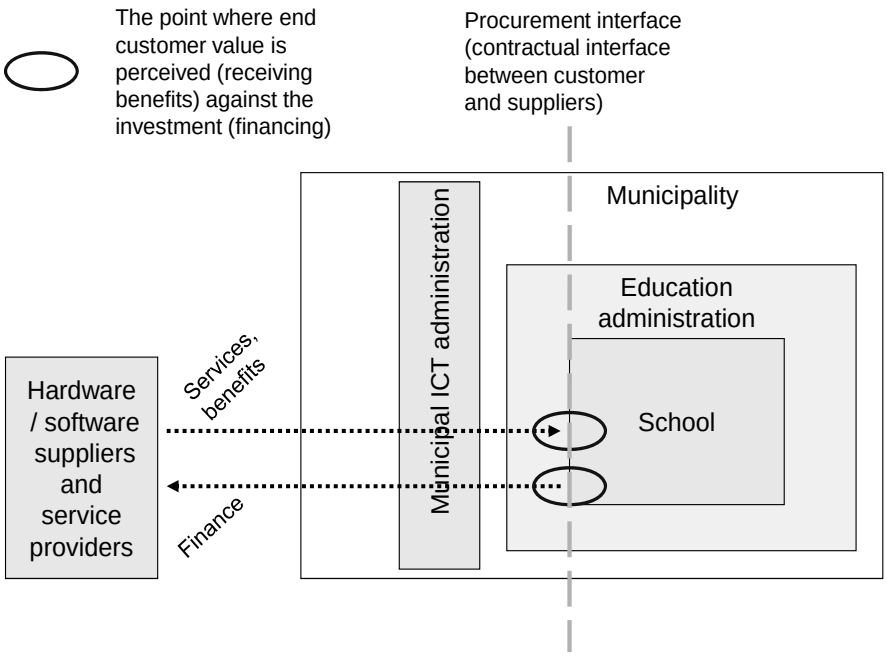
New Procurement Model and Its Deployment

In 2007, basic education provided in Kasavuori and Mäntyvuori Schools in Kauniainen underwent a process change in which the procurement of ICT equipment and services was transferred from the information management unit to the schools. The main difference compared with the traditional model is the schools' strong role in defining their own needs and planning procurement. A school-specific ICT team presents its proposals concerning the school to the steering group of the Finnish- speaking school administration, which decides on procurement and development including coordination and harmonisation of needs. The school administration procures the

services and equipment needed by schools from companies following a competitive tender procedure and negotiates the agreements concerning the purchases. The municipal information management unit was also released of its budgetary responsibility for purchases. Service and equipment expenses are now paid directly from the schools' own assets instead of being managed by the information management unit. This has resulted in more active cooperation with private companies as concerns the organisation and management of ICT in schools. The new model is shown in Figure 3.

The new model incorporated a server-oriented architecture where the majority of the applications used by both students and teachers were positioned on LTSP-server (Linux terminal server project) and

FIGURE 3
New Procurement Model
(where the end customer interfaces directly with suppliers and providers; perceived value is measured at the same interface as the investment is financed and procurement made)



quite many applications were renewed based on open source codes. Key roles in this change were played by the school and a selected service provider who collaboratively designed a new architecture that minimised the operating costs and expanded the life time of workstations. In this Linux operating environment the processing is shifted from workstations to the server, hence relaxing the workstation performance requirements (Balneaves et al., 2009). Open source applications were further developed by other service providers and some of the teachers.

The server and network-oriented deployment approach adopted in autumn 2007 differed considerably from the previous solution in which applications launched by users were run on Windows-based workstations. In the current system, most of the workstations start up online via servers. Essentially, the new deployment approach makes more efficient use of old equipment stock which does not have to have substantial processing capacity.

New System Architecture and Hosting

Prior to 2007 the architecture relied on workstations which had standard connections to the internet and local network via fiber-optic cables. There were some servers in the schools that offered printing services and server disks for the the workstations. Both the teachers' and pupils' workstations were connected through fiber-optic cable to the routing server that was located in City Hall. There was also a wireless local network in the school. The maintenance of the workstations was handled manually on a machine-by-machine basis as no remote maintenance tools were used by the city's ICT service unit.

The life span of workstations was a maximum of 4-5 years, typically 3 years, after which the stations had to be replaced by more efficient processing capacity and a more modern workstation operating system. The maintenance of workstations became very cumbersome due to limited monetary and human resources and the ICT service unit was considered unable to provide the expected level of service. The start-up times became long with older workstations, taking sometimes up to 10-15 minutes, hence wasting efficient working time of both teachers and pupils. Also the workstation fleet became rather heterogenous in terms of software and operating systems - each station had to include certain applications and hence

machine-by-machine maintenance became a burden. And the systems the pupils used during class were not always of the same generation which required extra effort from the teachers. Moreover, the teachers felt that the system's security was not up-to-date with current system architecture and services. Teachers and pupils, for example, lacked their own user identifications and passwords as these were impossible to maintain and manage with the existing architecture.

The new service provider – a small domestic ICT company specialised in educational systems and services –introduced new server-oriented architecture as a part of their service package. The former operating system was completely replaced by Linux for all equipment, servers and workstations. In this architectural solution the users' (teachers' and pupils') applications as well as the operating systems are not run in the workstations but centrally in the servers. This was a typical thin-client solution.

As a result, the workstations started to run faster as the processing capacity was centered on the servers and most applications were run from these servers. Also the new architecture enables much faster and less time-consuming maintenance with most of the maintenance now focused on servers and done by the service provider. In the contract between the service provider and the school, only the level of service of loosely defined and technical specifications were kept to the minimum.

The security of the system was improved since it was now possible to centrally manage user identifications and passwords – and this management was part of the service contract. All teachers and pupils were now able to have their own secured virtual work space and e.g. the internet site access control was now performed in a much stricter manner than it had been previously.

OUTCOMES OF THE PROCUREMENT PROCESS TRANSFORMATION

Experiences in School

According to school teachers and the municipal education administration, the new procurement model led to a server-oriented architecture and a clear improvement in ICT services. The services offer a better match with user needs, the devices work more reliably, the proportion of devices out of use due to malfunction has

decreased, delays in the installation of new equipment have shortened and workstations are quicker to start up.

Prior to the adoption of the new operating model, teachers found the biggest problem to be the large proportion of faulty or defective workstations, which led to a considerable amount of wasted time in teaching. The long time (up to 15 minutes) required to start up a workstation or log onto it at the beginning of each lesson would sometimes affect the same teacher and students several times a day. Following the adoption of the new server- and network-based deployment, the cold start-up (first start-up in the morning) of workstations takes a maximum of two minutes and all subsequent start-ups are performed in a matter of seconds. That is to say, the amount of wasted time has been reduced considerably - by as much as 13 minutes for cold start-up.

The experiences of the teaching community of Kauniainen's Finnish-speaking schools are summarised in Table 1.

TABLE 1
Problems Identified by the Teaching Community of Finnish-Speaking Schools of Kauniainen

Identified problems prior 2007	Improvement after new procurement model and architecture
Number of workstations not actively in use or non-usable; this number was quite high prior the new architecture	The number of faulty workstations has decreased
Replacement of faulty workstations	The equipment fleet in active use has increased in numbers; previously the procured new equipment only replaced the faulty units
Lack of money for proper workstation maintenance	The total budget has remained approximately the same but a greater number of workstations are now in use
Listening to user needs in procurement	Now the schools have a possibility to say what they need

TABLE 1 (Continued)

Identified problems prior 2007	Improvement after new procurement model and architecture
ICT service level and quality of service	Teachers consider an improvement has taken place
Teachers' and pupils' waste time on non-functioning ICT equipment and applications	Teachers consider a clear improvement with significantly less problems
Long time lags to have new workstations installed up and running	The problem has practically vanished
The constant lack of human resources to maintain a functioning ICT environment in schools	Teachers' perception was that their burden has decreased

Economic Impacts

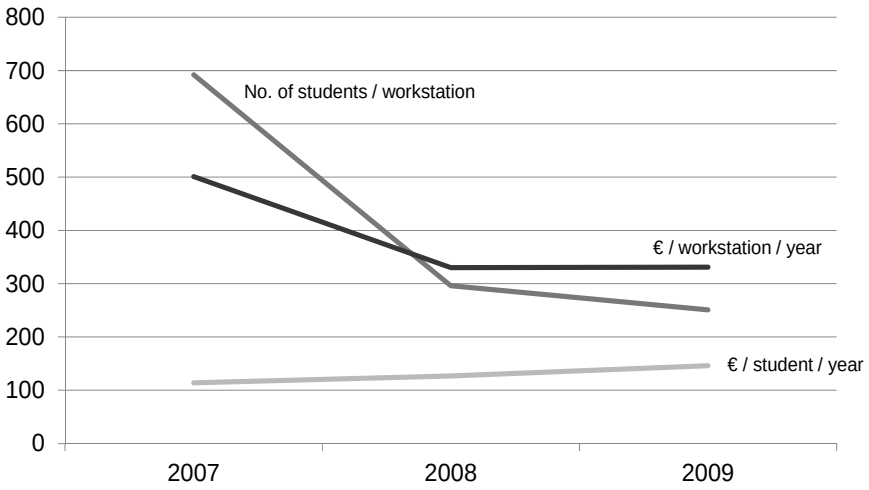
The economic impacts of the schools' ICT services were examined by analysing the development in expenses and number of services in the current procurement model from 2007 to 2009 in Finnish-speaking schools in Kauniainen, as well as by comparing these figures with the IT service expenses and the number of services produced in Swedish-speaking schools, which kept to the traditional model, in 2009. Before-after study was not possible since the accounting for costs and equipment fleet prior to 2007 was not available. The last mentioned approach would have produced somewhat more information although there would have been many difficulties on that path too, one being the different time series development of cost items. Typically, work time costs have had a rising trend whereas hardware purchasing costs have declined, obviously because of the increasing level of maturity of ICT technology.

The expense calculations focused on the proportion of expenses generated by workstations in the pupil network. The basic data used in the expense comparison and the calculation proper are presented in greater detail in a separate VTT research report (Hautala et al., 2011a).

Despite the rise in overall ICT expenses and even in the unit costs per pupil, the number of workstations in relation to the number of pupils has increased and the unit expenses calculated per workstation have decreased in Finnish-speaking schools (Figure 4). To express the outcome in plain words, the service level of ICT in schools measured by the number of available workstations has almost doubled, from 700 pupils per workstation in 2007 to about 250 pupils per workstation in 2009. Some of the change can of course be explained by general distribution of ICT hardware to class rooms but the difference that occurred in three years is remarkable. The unit costs per pupil have slightly increased though, but this is no surprise given the sharp increase of workstation numbers. The details of the calculus with all assumptions and data sources are presented in Appendix B.

The survey of ICT expenses and service level indicators as a time series is one way of measuring the impacts "before and after". Verifying data was collected from the Swedish-speaking schools of Kauniainen using identical data for 2009, which showed a clear difference in cost effectiveness in favour of Finnish-speaking basic education compared with Swedish-speaking basic education. The

FIGURE 4
Number and Unit Expenses of Workstations from 2007 to 2009 in Finnish-Speaking Schools in Kauniainen



latter-mentioned kept to the traditional procurement model and relied on the municipality's ICT unit's services. The expenses per workstation in Finnish-speaking schools were about 37% lower than those of Swedish-speaking schools, which still follow the old procurement model. This translates to an annual savings of €100,000 in the productivity of workstation services (in 2009). The savings are likely to be even bigger, as the cost calculation for the new model also includes the expenses for system set-up but does not take the achieved reduction in wasted time and environmental load into consideration.

The Finnish-speaking schools' capital costs for workstation fleet are lower than the Swedish-speaking schools' even though the number of workstations is higher. This is due to the fact that in Finnish-speaking schools there are significantly older workstations still in use. The results of the verifying comparison between Swedish-speaking and Finnish-speaking schools is summarised in Figures 5 and 6. The detailed data description on which the calculus is based is presented in Appendix B.

FIGURE 5
Unit Cost Comparison for Year 2009 for Swedish and Finnish Speaking Schools of Kauniainen

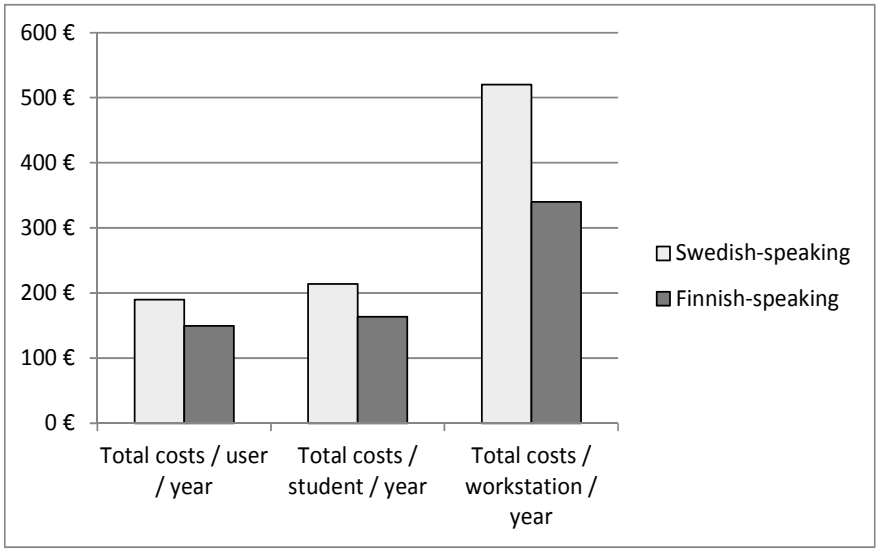
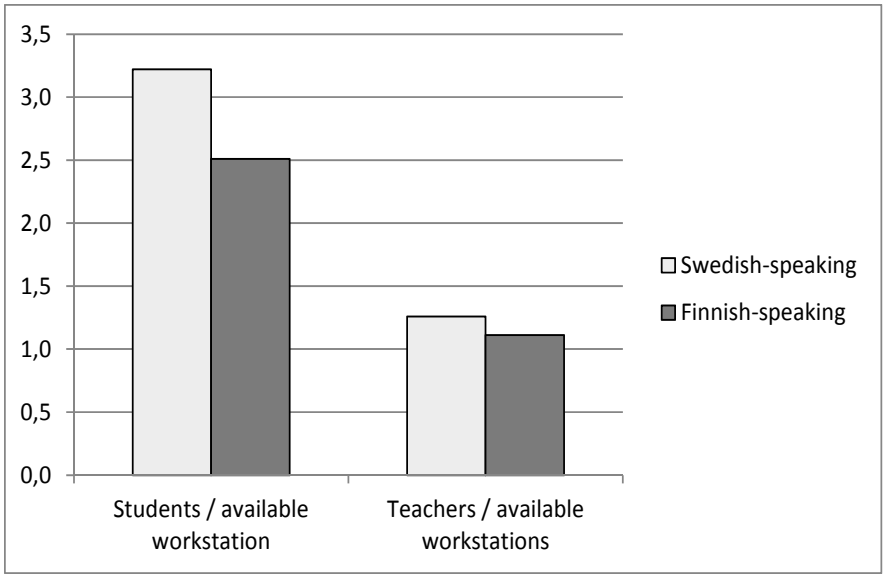


FIGURE 6
Level of Service Comparison between Swedish and Finnish Speaking Schools for 2009



A procurement model based on the purchase of entire service packages combined with a server and network-based deployment model have generated clearly measurable benefits. After basic investments, the server-based architecture offers even greater savings potential in the long term. In the past year, for example, Finnish-speaking basic education has received workstations from health centres free of charge and also used workstations from Opinsys Ltd at €80 per workstation. The two sources have each provided approximately the same number of workstations. The estimated useful life of these workstations is around four years, which means that future equipment expenses could drop to as low as €10 a year (average acquisition price of €40 and useful life of four years).

Ecological Impacts

The increased average life cycle of workstations has also reduced the environmental load. To give an example, the manufacture of a

single laptop is estimated to result in 500 kg of net waste without recycling and 93 kg when recycled (Vereecken et al., 2010). According to another example (Herrmann, 2008), the carbon footprint (CO2 equivalent) of a single laptop is 150 kg for manufacture, around 20 kg for transportation and some 65 kg/year for use. If the Finnish-speaking basic education in Kauniainen (with 529 workstations in 2009) were to follow its previous operating model, it would purchase an average of 176 new computers a year, which would result in an annual minimum of 16 tonnes of recycled waste and a 30-tonne carbon footprint (CO2 equivalent; CO2eqv) in terms of the manufacture and transportation of workstations. The current deployment model doubles the life cycle of workstations and thus halves the environmental load described above. The environmental load caused by workstation use is more or less the same in both models.

The above-mentioned source discussing the carbon footprint does not indicate how far back in the manufacturing chain the calculations extend. Another interesting question is where equipment leased on a three-year contract ends up after the contract terminates. Workstations that have served Finnish-speaking basic education in Kauniainen for six years are delivered to an environmental waste management company for disposal/recycling.

Environmental expenses can be calculated using different kinds of unit prices per tonne of CO2 equivalent. The Nord Pool (the Nordic electricity stock exchange) spot price ranged from €10 to €15 in 2009 emissions trading (Sillanpää, 2010). The unit price used for estimation purposes in Finnish traffic projects is €37/tonne of C02eqv (Ristikartano, 2010). Using the latter unit price for calculations, the deployment solution currently used in Finnish-speaking basic education in Kauniainen has resulted in annual savings of some €1,100 in emission costs.

Even though external expenses only account for a minor share of the overall benefits, they should still be emphasised, since their pricing is largely related to valuations and affected by, among other things, climate change issues – and this result is also symbolic, as goes without saying.

The server and network-based deployment model has also reduced the use of electricity: the consumption per workstation (when

running) has dropped; the automatically scheduled, centralised workstation shutdown system saves power (and relieves the school staff from checking classrooms and turning off workstations), in addition to which the need for air-conditioning in teaching facilities has reduced. The power consumption of servers has increased slightly, but the impact of this is small on the whole. Moreover, only half of the servers are kept running during holidays.

The working time savings are more substantial. For this calculus we made the following assumptions with the help of statistics from the National Board of Education (2004):

- The cost of an average class hour (45 minutes) in primary schools was about 50 € (roughly estimated in 2009 price level) comprising mainly the teachers' salary costs
- There were on average 25 full weeks of teaching in a year
- There were on average 38 teaching hours per week.

This translates into a very rough estimate per average school in Finland (Kauniainen's Kasavuori School and Mäntyvuori School are fairly close to this average) as follows:

50 €/h × 25 w/a × 38 h/w = 47,500 €/a

Furthermore, there are about 3200 primary schools in Finland and on average there is one ICT classroom per school, which leads us to conclude that if this concept could be adopted nation-wide, the total work time savings with the above assumptions would yield to 47,500 €/a/school × 3,200 schools ≈ 150 mill. €/a.

Summary of Impacts

The summary of results can be presented both in qualitative and quantitative terms. The first obvious result was the increased level of satisfaction among the schools' personnel in Kauniainen. This was surely partly due to the fact that teachers could utilise their working time more efficiently for teaching instead of trying to persuade ICT to work. We can safely assume that all work time that is not used for teaching and learning in schools is more or less an economic loss. The external impacts do matter as well: reduced carbon footprint, electricity savings, and extended life cycle of hardware represent environmental sustainability in its purest form.

Even if a benefit-cost calculus is perhaps challenging to apply decently in this context, it is possible to capture some of the magnitude of the benefits in relation to costs. For annual savings we have the following monetary estimates at 2009 price levels:

- time savings, c.a. 47,000 €, and
- CO2eqv cost savings due to duplication of workstation life cycle, c.a. 1,100 €

The total cost savings can be roughly estimated to be 48,000 € per year. It is noteworthy, that the inevitable splitting of the workstation investments is not counted for. This potential was used in Kauniainen so that the workstation fleet was doubled.

If we compare the savings of 48,000 € per year to the difference in nominal total annual costs between years 2007 and 2009

124,649 € – 174,865 € ≈ -50,200 €

we see that the end net result is practically zero, taking into account the time value of money between 2007 and 2009 which would make the negative figure slightly smaller. In essence, the service level for pupils was doubled from 6.9 pupils per workstation to 2.5 pupils per workstation without increasing the total budget practically at all.

CONCLUSIONS

The procurement of services rather than hardware has proved to be the right decision in Kauniainen. Due to the new architecture solution and service-level definitions, service quality has been improved, costs have been reduced by about 40% and, due to the longer life cycle of workstations and reduced electricity consumption, the environmental load has been cut by about 50%. The traditional procurement model did not facilitate the above-mentioned solution and benefits. These impacts come from the technological solutions, not from the contractual arrangements as such, but the key point is that service contract definitions allowed these technological choices to be made.

The model adopted in Kauniainen, however, requires the schools and school administration to have the skills and expertise to define their needs for the service providers and the competencies to prepare and execute the procurement process, which still has to follow public

procurement rules. The most important prerequisite seems to be the political will at local level to grant the school administration the freedom to choose the right kind of ICT service system to fit their needs. Therefore, clever use of ICT does not necessarily mean more ICT or the most advanced ICT. This depends, of course, greatly on the procurement skills. What is of course of paramount importance in the Kauniainen case is the fact that students of schools got obviously better value for tax payers' money and environmental externalities were reduced to half. Any public sector authority should be satisfied with such results, may it yet mean some reduction in management control.

There needs to be a shift in not only responsibility but also skills. In the long run, this will increase innovative individual solutions in different schools. It is the role of the national educational authorities to make sure that such innovations are spread across the country, rather than to try to exert too much control over the models of how ICT is deployed in different schools and parts of the country.

Decentralised procurement also has strategic consequences if adopted widely. Small service-providing companies are in a good position to find a new market in the educational field. On the downside, a lack of transparency presents a risk when schools make their own decisions on ICT equipment and service procurement. A decentralised approach could be ideal for small markets and in, e.g., a developing country environment. It creates a small market of its own and relies on small service providers and retailers. Economies of scale are largely lost, but quality control and level of service are enhanced. Also the necessary skills might not be available for decentralised procurement, and then the risks for downside effects increase.

The model adopted in Kauniainen requires schools and school administrators to have the necessary skills and tools not only to procure but also to react to contract administration problems which can be anticipated when procuring ICT services such as delays, cost and definition of acceptance. Contract administration problems related to different types of contracts encountered by public authorities have been analysed by Davidson and Sebastian (2009).The authors concluded that the public sector contract types most commonly perceived to be affected by contract administration problems were construction aned contracted services. The contract

types having least perceived occurrence of problems were found to be leases, small purchases and capital outlays, which can be regarded as the categories for school ICT as well. Hence, from top-down perspective, the schools' challenges were perhaps not considered as first priority and were not addressed until the schools took the matter in their own hands, so to speak.

Another conclusion, which is quite obvious, is the need for pre-commercial and service-oriented procurement models as described in the case of Kauniainen. The old style "Taylorism" where functions are split into sub-functions and then often optimised separately does not apply to new territories where learning curves are still in their early phase, such as application of ICT in schools, or in situations where end-user value is pursued. An example can be found also in the field of intelligent transport systems (ITS) where ICT is piercing its way through the conventional functions (see e.g. Haon & Dobberstein, 2010) and where the old procurement practices are hard to apply. Procurement seems to be becoming a co-creation process rather than a "I define - you supply – I pay" simplified process. Especially when procuring services rather than hardware, like City of Kauniainen did, the co-creation component in the process becomes a necessity as proved by this particular case – once again. An analogy can be found anywhere when considering infrastructures for education: not only ICT infrastructure, but also buildings (see e.g. Ornstein et al., 2009), facilities, other types of educational hardware, etc. It is the functional capability and meeting of user needs that matter, not the physical or technical specification. Sometimes the functional capabilities and user needs are not "just the nice things we want", but they can be restrictive and controlling characteristics, such as is the centralised website access control exercised in Kauniainen. No doubt, not all pupils appreciated the stricter practice.

The new procurement model can also be understood as an example of procurement of technological innovation by a public sector organisation. A taxonomy of public procurement and innovation was proposed by Hommen and Rolfstam (2009). Their taxonomy makes a distinction between direct procurement, catalytic procurement and cooperative procurement as well as different stages of technology and market evolution. The model adopted in Kauniainen and related market situations mostly correspond to a

case with direct procurement in a late or middle stage of technology and market evolution.

The service system architecture was changed in Kauniainen first and foremost by changing the roles and tasks of actors in the value chain and not really restructuring the chain or the whole architecture. What was then changed was the physical ICT architecture from a traditional workstation-oriented architecture to a modern thin-client server based structure. Hence the news is in fact good when thinking of public sector restructuring challenges in more general terms: we might be able to achieve good results only by setting the roles and tasks of value chain actors in a different mode and not necessarily to enter a painful full-scale restructuring process where the end results can be uncertain. This is probably especially valid for ICT-driven services, and some examples already exist from banking and the retail sector, some of which was described in a structured manner by Patrício et al. (2011). The authors believe that one of the next big steps could happen in social services in the public sector – education, health, elderly care, etc. – where the value of these services does not necessarily come from purely cash-based benefits but, to an increasing extent, from externalities (e.g. environment, social benefits) and users' willingness to pay. These sectors could benefit significantly when applying socio-economic appraisal methods already applied, e.g. in the transportation sector. Social return on investment was discussed also by Ryan and Lyne (2008) but we claim that good practices and benchmarks could already exist.

The technological evolution does not of course stop here. The next obvious step is to remove the physical ICT processing capacity as well as applications and services to the "cloud", where service providers are able to offer their services over the internet. This vision – or rather near future insight - offers tremendeous possibilities for both private and public services. Open source applications offer great potential for the users to participate in the development of future ICT-based services. These "innovation platforms" are about to emerge to a larger extent, and they will place pressures on education administrations (and all other administrations for that matter) of how to keep up with the development. The case of Kauniainen shows that administration structures can in fact become a bottleneck for technological advancement unless governance principles quickly react to changing contexts. The Finnish-speaking education

administration of Kauniainen did not actually restructure anything but the procurement processes and principles were adequate response obviously.

However, the ultimate reason to explain the good results in Kauniainen's schools could be the fact that the end users refused to treat ICT in schools as a technological system and started to view it as a service system, upon which quality requirements could be placed and of which customer satisfaction could be demanded. Another point to be finally raised is the cultural preparedness to share leadership and managerial responsibility, as discussed by Hargreaves and Fink (2008): the meaning of trust that springs from deeper cultural characteristics cannot be overestimated. Obviously the municipal decision makers of Kauniainen trusted their professionals at schools.

The model adopted in Kauniainen is to be tested in 12 other schools in different parts of Finland during 2012-2013. The authors will be responsible for the evaluation of any impacts. These evaluations will not be as detailed, but based on structured questionnaires.

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APPENDIX A
Interviews and Feedbacks

Actor / Organisation	Interviewee(s)	Time	Notes
National Board of Education	Mr Timo Lankinen, director general Ms Kaisa Vähähyyppä, director	23.8.2010 7.4.2010	
Ministry of Culture and Education	Ms Heljä Misukka, secretary of state	12.5.2010	
Ministry of Transport and Communications	Ms Aleksanda Partanen, councsellor	11.5.2010	
Ministry of Finance	Mr Tommi Oikarinen, counsellor	21.5.2010	
Confederation of Finnish Industries	Mr Veijo Turunen, chief expert (innovations) Ms Marita Aho, chief expert (innovations)	7.5.2010	Group interview
The Association of Finnish Municipalities	Mr Heikki Lunnas, director (information society) Ms Lieselotte Eskelinen, special expert Mr Kurt Torsell, special expert	20.5.2010 28.5.2010	Group interview

APPENDIX A (Continued)

Actor / Organisation	Interviewee(s)	Time	Notes
The Finnish Innovation Fund	Mr Teppo Sulonen, chief expert	26.5.2010	Telepohone interview
Trade Union of Education in Finland	Mr Olavi Arra, special expert	14.6.2010	
City of Helsinki	Ms Liisa Huovinen, project manager (economics and planning) Ms Kaija Fredrikson, specialist (Media Centre for educational administration)	27.5.2010	Group interview
City of Hämeenlinna	Mr Markku Rimpelä, direcotr (services for childrens' and youth quality of life)	31.5.2010	
City of Hyvinkää	Mr Pentti Halonen, director of educational administration	Aug-2011	Written feedbacks and review of the final report
City of Oulu	Mr Jukka Miettunen, specialist Mr Pasi Mattila, project manager(future learning environment) Mr Sakari Ansamaa, rector, Shool of Herukka	19.5.2010 21.5.2010 Aug- 2011	Telephone interview Telephone interview Written feedbacks and review of the final report
City of Naantali	Mr Kimmo Kuusimäki, pedagogical rector, school of Maijamäki Mr Markus Mattila, IT-specialist Mr Seppo Pukonen, vice rector, high school of Naantali	24.5.2010 24.5.2010 24.5.2010	Group interview
City of Kauniainen	Mr Antti Rönkä, director of education, Finnish-speaking schools Ms Riitta Rekiranta, rector, Kasavuori School Mr Allan Schneitz, teacher, Kasavuori School Mr Seppo Rusama, head of IT Mr Christian Buss, IT specialist	2010-2011 1.11.2010	Several discussions, interviews and written comments Group interview
IBM	Mr Jyrki Koskinen, director (university relations, external relations)	10.5.2010	Several separate discussions
Opinsys Ltd	Mr Mikko Soikkeli, director (marketing)	2010-2011	Several discussions, interviews and written comments

APPENDIX B
Service level and costs of ICT services

Primary Schools of Kauniainen	Finnish-speaking schools			Swedish-speaking
	2007	2008	2009	2009
Workstations (ws)				
Number of ws (excluding administrative staff)	249	461	529	366
Depreciation of ws available to students	52,763 €	65,831 €	59,052 €	90,491 €
Opportunity cost of capital (ws available to students)	5,378 €	6,449 €	5,877 €	9,937 €
Capital cost (only student ws)	58,141 €	72,279 €	64,929 €	100,428 €
Capital cost / ws / a	233 €	157 €	123 €	274 €
Servers				
Depreciation of servers and equipment	7,373 €	8,498 €	8,498 €	1,500 €
Opportunity cost of capital (servers and equipment)	1,290 €	1,006 €	694 €	150 €
Capital cost (servers and equipment)	8,663 €	9,504 €	9,192 €	1,650 €
Capital costs of servers and equipment / student / year	7.88 €	8.64 €	8.36 €	1.85 €
Communication networks				
Development of LAN and WLAN	12,541 €	13,178 €	13,298 €	12,838 €
Other network operating and maintenance costs	6,841 €	7,188 €	7,253 €	7,003 €
Data communication costs (Internet connection)	1,360 €	1,360 €	1,360 €	1,270 €
Costs of communication networks	20,742 €	21,726 €	21,911 €	21,110 €
Costs of communication networks / user /year	17.28 €	18.11 €	18.26 €	21,05 €
Workstation (ws) and server operating and maintenance and user support				
Costs of ws user support and helpdesk services	40,000 €	40,000 €	40,000 €	67,224 €
Operating and maintenance fees of servers	4,995 €	13,480 €	43,704 €	0 €
Operating, maintenance and user support costs	44,995 €	53,480 €	83,704 €	67,224 €
Operating, maintenance and user support costs / user / a	37.50 €	44.57 €	69.75 €	67.00 €
Operating, maintenance and user support costs / a / ws	180.70 €	116.01 €	158.23 €	184.00 €
Realised costs				
Total cost / user / a	110.45 €	130.82 €	149.78 €	189.84€
Total cost / student / a	120.49 €	142.72 €	163.40 €	213.95€
Total cost / ws / a	523.29 €	340.54 €	339.77 €	520.25€
Total amount of costs	132,541 €	156,990 €	179,736 €	190,413€
Achieved level of service				
Ws available to teachers	90	90	90	90
Ws available to students	159	371	439	276
Total number of ws available	249	461	529	366
Students / available ws	6.92	2.96	2.51	3.22
Teachers / available ws	1.11	1.11	1.11	1.26