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OPEN-SOURCE SOFTWARE IN GENERAL EDUCATION SCHOOLS

ON THE CASE OF GYMNASIUMS IN TALLINN

Master's thesis

Supervisor: Dr. Tarmo Kalvet

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I hereby declare that I am the sole author

of this master's thesis and it has not been

presented to any other university for examination.

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Abstract

The confrontation of open and closed source software has been an important topic since the wider use of personal computers, but factors which lead to the preference of one or the other are under researched. Using technology acceptance theories and complementing them with what is known on factors leading to preferring open source software, IT support functions in gymnasiums in Tallinn are studied. The results confirm that interface user friendliness, compatibility and functionality are the three most important factors. Security issues were not found to be relevant; this conflicts with what is proposed in literature. Policies and attitudes on the city and government level have also significant impact, showing the need to complement the technology acceptance theories with policy environment perspective.

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1 Introduction

In February 2014, 91% of desktop and laptop computers connected to the Internet had Windows, 7.5% OSX and 1.5% Linux installed (Net Applications.com, 2014). In Estonia, the ratios were similar, but both Windows and Linux gain a slightly larger share from OS X's loss (StatCounter, 2014).

A discussion over whether replacing Microsoft Windows with the open-source alternative Linux is cost efficient has been a popular topic in the last decade (Hauge et al., 2010, p. 2). Different distributions of Linux have shown rapid development and more user-friendly interfaces offering a more gradual learning curve with improved system stability (Hess, 2010). Furthermore, there are free alternatives to Microsoft Office, Adobe PhotoShop and numerous other popular software for which organisations pay vast amounts of money.

Open source software (OSS) is defined as software for which the source code is made publicly available. In other words, the creator allows for studying, change and distribution of the software. It can be opposed to closed source or proprietary software. The opposition of the two is visible on different levels. For example, it is possible to use open-source office software, e.g. Libreoffice, on closed source operating system, such as Microsoft Windows (LibreOffice, 2014).

Most public and private organisations are reluctant to abandon closed source software. No comprehensive theory or model currently exists which could explain the situation, yet various reasons are named for avoiding the change. The most common argument is that the decrease in software costs is accompanied by an increase in expenditures on staff training and support service (State information systems department, 2007, p. 27). It is also obvious that due to rather large differences in user interfaces between, for example, Windows and Linux desktop environments, personnel needs to be retrained (Clark, 2004). Yet the actual numbers are likely to vary greatly due to the extent of which people need training based on their tasks on the computer.

The possibility of using Linux in Estonian public organisations has also been brought up several times by the media. For example, the dependence on Microsoft is seen as a problem without a clear solution (Aasmäe, 2013). The issue is acute, since the official support for

Windows XP ended in April 2014, yet the operating system is currently still used. But test periods are ongoing for Linux trials at schools and nurseries (Tammeorg, 2014a).

In the end of 2008, the Estonian Green Party proposed a bill according to which OSS would have gradually been mandatory in public organisations. Argumentation was based on the need for a standardised file format as recommended by the European Union and cost savings (Riigikogu, 2008). The act was however not passed in the parliament.

Research regarding the proportions of open and closed source software usage is scarce. However, data is available from 2004 which shows that 9.1% of public institutions used OpenOffice.org[1] as main office software (Odrats, 2005, p. 89).

Data from 2007 showed that different versions of OpenOffice sum up to about 5 or 7% (State information systems department, 2007, p. 19). Yet interestingly, a look into used office software in private organisations in 2011 showed that roughly half of companies used opensource software (State information systems department, 2012).

It is difficult to say whether the results are significantly different in public and private organisations or whether 4 years caused a considerable change in the paradigm, but the former is more probable. Still, the recent economic downturn might also have had an influence on the budgets and thus the software selection. The use of open-source operating system is, as expected, lower. Yet surprisingly, a survey from 2011 shows that 23% of Estonian companies use OSS in their workstations (State information systems department, 2012). The results from the public sector are below the European average (Põldmaa, 2009, p. 11). Consequently, it is interesting to research the perceptions towards switching to free software. However, in order to analyse the attitudes, the barriers to adoption need to be looked at first. In other words, it is important to understand the requirements that are set for software in the analysed organisations and compare these to both the features and the shortcomings of open-source software.

Consequently, it is interesting to research the perceptions towards switching to free software. However, in order to analyse the attitudes, the barriers to adoption need to be looked at first. In other words, it is important to understand the requirements that are set for software in the analysed organisations and compare these to both the features and the shortcomings of open-source software.

This thesis focuses on the aspect of using open-source software in the general education schools in Estonia. More specifically, the focus is on gymnasiums in Tallinn. The paper focuses on the software used in the support and administrative functions of the schools and disregards OSS as a subject of teaching. The aim is to bring out and emphasise the distinct needs and

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[1]OpenOffice.org was the most popular open-source office suite at the time, but was discontinued in 2011. It is now succeeded by Apache OpenOffice and LibreOffice which are based on the original code.

limitations the selected schools have to take into account in their software selection and analyse the current situation and possible future developments.

The thesis aims to find answers to the following research questions

- What are the drivers and barriers to switching to open-source software?

- Which barriers are more, or less, important in the Estonian general education context?

Based on the research already carried out on open-source software and its adoption barriers, the following hypothesis is set for the given paper: *functionality and compatibility aspects of software, emotional perception of it and financial cost considerations have equal weights on determining the used software.*

The data collection process for the paper can be divided into two phases. Firstly, the emphasis is on analysing the research done by scholars about similar topics. Preferred publications regard open-source software in the public sector or schools, but relevant information about private companies is not discarded. Moreover, research done in the Scandinavian countries, but also Europe in general, is prioritised, since the ICT environment is similar to the Estonian one (e.g. according to World Economic Forum, 2014).

The second phase of data collection contributes to the core of the analysis. When the aim is to carry out qualitative research, methods offering first-hand knowledge are needed. The materials are gathered through semi structured interviews with key decision makers and experts within the selected institutions.

In order to present the analysis, the paper is divided into five chapters. The current chapter offers reasoning for the selected topic and an overview of the paper. The second chapter presents the used methodology and theories focusing on the most relevant ones.

The core chapter of the paper is divided into analysing the background of the Estonian OSS policies and data analysis gathered from interviews with IT managers at schools in Tallinn. The fourth chapter contains a discussion over the validity of the results from the paper and also links the theoretical and empirical parts. Finally, the main points are re-emphasised in the last chapter.

2   Theoretical Framework

2.1   Research Methodology and Limitations

The research strategy is to use the *exploratory research* method. This means that the aim of the thesis is not to develop a comprehensive model and caution must be taken when generalising. As a result of this paper, there are better possibilities for further research and establishing hypotheses. Yet, as stated above, it is still essential to utilise the knowledge gained from existing research.

Qualitative research is used as the core of the paper to gain understanding of the software selection process and the reasoning behind choices. Qualitative methods can be described by opposing them to the quantitative ones. For example Mahoney and Goertz (2006) have analysed the main juxtapositions between the methods. In short, qualitative research, in comparison to quantitative, allows for a deeper understanding of a few selected cases.

Thus, selection of the samples needs to be cognizant. Patton (2002) describes a method that he calls *a typical example*. Flyvberg (2006) named a similar method *a pragmatic case*. An approach based on those terms is also sought in this paper. Additionally, the method is idiothetic as the analysis focuses on a small number of cases.

Interviews are often used for in-depth analysis, as also confirmed by Patton (2002, p. 13). He also brings out that due to their cost and time consumption, interviews cannot be used on large selections (p. 16).

Regardless of the used method, the conceptual validity needs to be attended. It means that the correct variables are measured, i.e. elements defined under problem statement. This connection was emphasised by Bryman (1988, p. 47) who also argued that the method is highly dependent on the types of questions asked.

Marsh and Furlong (2002) divide researchers into three categories — positivists, realists and interpreters. Furthermore, they argue that migration between these categories is unlikely. In the given paper, realist approach is taken. Meaning, it is believed that the external world exists independent from the researcher, nevertheless it is acknowledged that not all causal linkages are observable (p. 30).

Due to the chosen narrow focus, only certain aspects of the issue are covered. This focus allows for a deeper analysis and for a better understanding of the topic.

Firstly, the paper looks at the situation in Estonia. It is unlikely that conclusions from the research here can be extended to other countries or regions. However, the results of the analysis could propose hypotheses for further investigation in other papers regarding countries in a similar phase of development.

Secondly, the analysis focuses on the public sector and discards the private one. Moreover, only a few Estonian organisations participated while collecting data. Again, it is not probable that the results can also be used in private companies.

Additionally, schools offering general education, i.e. up to the gymnasium level[1] , are analysed. Results from universities and colleges are likely to be different due to funding, competence and other peculiarities. The analysis will also focus on the support functions in the schools and not the content of the teachings. Examples of support functions are secretary work, logging students' marks and activities and creating reports, but not teaching students how to use OSS or about the concept of OSS.

Furthermore, there are also methodological limitations. Mostly the qualitative research method is used. The main tool for collecting the needed information was carrying out interviews with the key decision makers.

Finally, the paper concentrates on differentiating open and closed source software. Thus, OS X by Apple lies in the same category as Microsoft Windows and Microsoft Office. Cloud-based solutions, such as Google Drive or Microsoft OneDrive, do not run on user's computer and are difficult to categorise. Yet by the methodological view, the source code is not public and these services are considered opposing to OSS.

2.2 Research on Technology Acceptance

In order to gain the position for analysing the current situation in Estonia, research already carried out on similar topics needs to be scrutinised. Due to cultural similarities, publications in EU countries close to Estonia have been given more weight, but they are also scarce. The number of academic publications containing the term open-source almost twelve-folded from around 10 to about 120 between 2000 and 2005 and stabilised around 110 per year (Hauge et al., 2010).

The existing research papers are analysed through the lens of unified theory of acceptance and use of technology (UTAUT) model. The framework was presented by Venkatesh et al.

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[1]comparable to US preparatory high schools

(2003) and it was based on merging multiple previous models. The authors emphasised four groups of factors that directly influence the intention or usage — performance expectancy, effort expectancy, social influence and facilitating conditions. Each of these will be presented in more depth in the beginning of the respective subsections.

It is important to note that the model was originally meant for an individual-based approach, but is in this paper used more broadly to capture the attitudes on an organisational level. The factors however are suitable for analysis on different levels.

The goal was to use the conclusions made by existing publications and synthesise a model which can be tested in the Estonian setting. The model would then be used as the basis for preparing and carrying out the interviews.

Technology acceptance model (TAM) was the basis for the UTAUT model. However, the original model only contained perceived usefulness and perceived ease-of-use factors (Davis, 1989, p. 324). Rogers (2003) too investigated the adoption process, which he named diffusion of innovation. However, the model he proposed is too robust and not suitable for the current paper.

Several extensions and modifications to the UTAUT model have also been submitted. For instance, Lin and Anol (2008) postulated a model of online social support. The model was used to investigate undergraduates in Taiwan regarding their usage of instant messaging.

Sykes et al. (2009) added the dimension of acceptance with peer support to understand employees' information system use. The authors argued that "an employee's social network characteristics, capturing his or her structural position in the peer help network, aids in our understanding of new information system use" (p. 390). In other words, they saw that the peer support aspect was relevant, but missing from the original UTAUT model.

Emphasis has also been put on the consumer behaviour related aspects, such as hedonic motivation, price value, and habit (for example Venkatesh et al., 2012). The addition of these factors significantly increased the effectiveness of the model and correlation between the results in certain cases.

However, none of the previously mentioned or other found extensions to the UTAUT model were seen as relevant to the research questions set in the problem statement. Therefore, the model is used in the form as put forward by Venkatesh et al. (2003).

2.2.1 Performance Expectancy

The first of the four categories is performance expectancy. Venkatesh et al. (2003) formulates the definition as "the degree to which an individual believes that using the system will help him or her to attain gains in job performance" (p. 447). In certain previous models, this set

of influencers has also been called perceived usefulness, extrinsic motivation, job-fit, relative advantage and outcome expectations.

In the case of software comparison, performance is often determined by functionality. OSS can be considered a viable alternative to currently popular software only if it manages to match the performance of its competitors. Assumption that OSS would have a wide diffusion, if OSS had "high quality, wide capabilities and flexibility" was argued by for example Gallego et al. (2008, p. 2213). The authors carried out an analysis where they identified that perceived ease of use (alternative to performance expectancy in TAM) was a significant factor in determining the behaviour. The same was confirmed by Lee et al. (2007) who carried out their tests in South Korea.

Several papers have been published in Great Britain which argue both for and against switching to open-source software in the British government. A widely cited report already from 2004 analyses the implications on desktop users concluding that it "[meets] the requirements of the majority of desktop users", but also admits that "desktop deployments are still limited by lack of complex functionality" (report analysed in Lettice, 2004).

Next, the concept of collaboration can be pointed out. In other words, the possibility to collaborate on software development with other organisations is facilitated by the use of OSS. However, this requires multiple adopters of the principle (Colannino, 2012, p. 909). Moreover, Crowston et al. (2012, p. 18) found that collaboration is often difficult with and between open-source projects since many project leaders work without contracts and in virtual environments.

The idea of collaboration can be developed even further and thus, gain for the whole society may be seen. For instance, Colannino (2012) underlines the benefits to the society and claims that "software, if made available publicly, permits the general public to study and build upon the solutions produced by municipal spending" (p. 910).

In contrast to the benefits of collaboration, there is an issue of incompatibility with older legacy systems. Yet, the importance of this barrier varies even among organisations on the same field of activity, depending on the specific software used.

This was for example brought to attention by Nagy et al. (2010, p. 150). However, the problem is diminishing for two reasons. Firstly, an increasing number of environments is moving to cloud-based solutions in which only a supported Internet browser is needed on the client computer. The operating used system is thus irrelevant. Secondly, emulation software which allows software made for Microsoft Windows to run on computers using Linux has also improved and can now offer a seamless adoption in many cases.

Compatibility can be also discussed from the angle of interoperability. The importance of open standards which allow data and document exchange between different open and propri-

etary closed source software applications was emphasised by Simon (2005, p. 228). He even claims that open-source software adaptation can to a large part be attributed to the spread of open standards.

The same pattern has been observed in Denmark. The Danish government issued a resolution in 2006 which introduced open standards in the public sector. As analysed by Federspiel and Brincker (2010), the results of the legislation were decreased vulnerability security wise and also improved data exchange (p. 44). Additionally, the competition between local companies was promoted, allowing for more competing solutions and less reliability on monopolistic vendors. It was hoped that the move would also give the Danish companies more experience and make them more competitive on the international market.

The utilisation of open standards can be seen as an intermediary stage for the adoption of open-source software and thus diminishment of the barriers. The idea behind this is that the overall switch then consists of two less radical changes separately — to use open standards (e.g. .odf, .pdf, .svg files which are supported by both OSS and proprietary software) and OSS applications adoption. West (2003), on the other hand, analysed the matter and concluded that successful proprietary standards are still successful and see little pressure to adopt an open strategy (p. 1278).

Another performance matter is hardware requirements. OSS can further lower the cost of IT services in general by lowering the need for new hardware. This argument was among others brought forward by Ven and Verelst (2012). The authors saw in their research that several organisations had used decreased hardware costs as an argument to switch to OSS — in the analysed cases, especially operating system Linux (p. 178).

Occasionally the question of security and timely deployment of patches has been brought up in relation to OSS and it is claimed that software with open-source code receives slow updates and has more severe vulnerabilities. Interestingly, Schryen (2011, p. 139) found no such correlation. He analysed 17 widely used software applications and concluded that the type of software development does not affect the number of unpatched vulnerabilities nor their severity.

For a while, OSS such as Linux was limited by its ability to do large scale calculations and utilise the possibilities of the latest hardware. This has not been the case any more in the current decade. For example, Yalta and Lucchetti (2008) argued that hardware compatibility is not an issue with modern distributions of Linux (p. 282). The authors also saw no OSS adoption problems in the academic setting, if migration was to be carried out gradually (p. 285).

2.2.2 Effort Expectancy

The second group of influencers is summed up as effort expectancy. The authors of the UTAUT model describe it as "the degree of ease associated with the use of the system" (Venkatesh et al., 2003, p. 450). The alternative names from previously existing models are perceived ease of use, complexity and ease of use. Since performance is often greatly influenced by effort, the influencers in this group are tightly related to the ones in the previous set.

For the end users, the interface of the system that they daily use needs to be user friendly. It was also pointed out in multiple research papers that users are sceptical toward the practical use of open-source software. This type of risks of the switch were discussed in, for example, the already mentioned analysis in the UK (cited in Clark, 2004). It is argued that due to "risk, cost and product familiarity" desktop users will most likely show slow adoption.

It is very likely that certain retraining is needed both before and after the potential switch to OSS, but the question is in the extent of it. Yet it is apparent that open-source alternatives have significantly closed the gap in user friendliness in the last decade. Still, new software adoption is often tied to a steep learning curve, since significant differences may exist compared to previous applications. Learning barriers of OSS were analysed by Nagy et al. (2010) who saw that considerable differences exist and the matter is worsened by lack of available support and in-house knowledge (p. 149). Goode (2005, p. 676) also concluded that managers presumed significantly increased training costs after the potential migration.

Another salient matter is the question regarding the total cost of ownership. This was for example discussed by Colannino (2012). Although he looked at the United States context, many of the conclusions can be used also in the paper in hand. One of the benefits that the author identified, and which is also relevant to the current research, is cost savings (p. 906). He argues that in most cases the total cost of ownership is likely to decrease as the licence cost is zero and the increase in training costs does not exceed the previous licensing cost.

Nevertheless, opposing results have also been published. Although, the report discussed by Lettice (2004) states that "Open Source Software is now a viable and credible alternative for government" in the beginning, the overall evaluation is not inordinately positive. It is noted in the report that after considering the whole cost of ownership, open and proprietary software are rather similar. Admitting that the report does not argue for a radical switch, it emphasises the cost-effectiveness of open-source in several areas.

Colannino (2012) directs attention to more challenges regarding the use of open-source software. Although the decreased cost of licensing was argued to be a strength of OSS, the switch may still be rather expensive. The vendors of proprietary software use this to their advantage and have offered discounts to organisations which have showed interest in alternative

vendors (p. 920–921). Secondly, challenges are likely to arise from current procurement structures. As said above, while OSS decreases licensing costs, it increases expenditure on services and therefore software procurements plans need changing, which in turn needs approvals and presents a boundary for the change.

Lack of knowledge of the alternatives can be considered an issue of effort expectancy. Besides low level of knowledge about the applications themselves, low awareness regarding support services and consultants who could assist with the switch to OSS can also be seen. These two barriers were among others analysed by Nagy et al. (2010). The authors point out that OSS projects are often led by volunteer organisations and do not have the possibility to spend money on marketing and awareness raising. This means that greater effort is needed by the potential users of OSS to find and select suitable vendors.

The issue of low awareness is tied to the confusion that is caused by so-called forking. In essence, forking means creating several versions of the same original software or source code. This can mean software tailored for very specific needs, but it also tends to confuse users. As argued by Nagy et al. (2010), the fragmentation of the BSD-Unix community in the beginning of 1990's was one of the reasons why Microsoft Windows was able to gain the dominating position on the market (p. 150). Fortunately, developers are urged to write more cross-platform and version compliant software because of several strict standards.

Vendors for OSS can still of course be found. However, certain organisations need support availability, e.g. over the telephone, for their core systems at all times. For the proprietary currently in use, this possibility is also provided. But because of small user base of OSS, only a few major organisations can provide 24/7 technical support availability for their products. The same problem was pointed out by Palanisamy and Mukerji (2013, p. 14) who also argued that although the whole OSS community is willing to help and someone is always available, no one is in any way bound to help with urgent matters without a contract.

Besides availability, the quality of the service also significantly impacts the user satisfaction with OSS. Nevertheless, a research by Lee et al. (2007) found that "community service quality has no significant effect on OSS use" (p. 433–434). These results were not consistent with the ones by DeLone and McLean (2007) who saw a tight connection between service quality and OSS use. Two potential reasons for the mismatch can be argued for. Firstly, regional differences might have an effect since one was done in America and the other in Asia. Secondly, while Lee et al. looked at the individual level, DeLone and McLean analysed the organisational level, which is also more important in the current paper.

Open source software development and support communities are, as apparent in the term, accessible to everyone. However, criticism has been made that users outside the community

might not receive the needed support and are unlikely to influence the projects. This issue might propose a barrier to OSS adoption for users or organisations unwilling to became a part of the communities. The matter was investigated by Nwankpa and Roumani (2011) who concluded that "while many OSS projects may meet the needs of the few developers and contributors of the project, the same cannot be said of potential external end-users" (p. 735). In order to influence the direction of the project, considerable donations in terms of "technical advice and high-quality software files" need to be made (von Krogh and von Hippel, 2006, p. 980).

The needed effort to use open-source software can in some cases be increased by limited or poor documentation. Since most of the OSS is rather new, they lack comprehensive documentation and knowledge base which means that users need find solutions on their own or contact the communities often. This issue was among others brought up by Farooq and Quadri (2011). The authors considered this as a reason why new users or contributers might be reluctant to test and add value to the software.

A barrier to adoption might arise from the short average life of OSS projects. Although some, e.g. Linux, MySQL, Apache and PHP, have gained remarkable success, they are outnumbered by others which lose attention and active development after core members leave the project. These results were among others reached by Ho and Richardson (2014) who analysed the motivation of developers, but also pointed out potential issues such as rejection by users and short average lifespan (p. 90).

2.2.3   Social Influence

Next, social influence gives an overview of "the degree to which an individual perceives that important others believe he or she should use the new system" (Venkatesh et al., 2003, p. 451).

Media constantly monitors the spendings and investments of the public sector. Therefore, the matter of cost can also be discussed under social influence. Organisations which have chosen to use proprietary software at some point face path dependency in their later decisions. Besides the incompatibilities mentioned under performance expectancy, large investments in the past on proprietary software also propose a barrier to adopting OSS. Discarding the systems bought before would mean an increased sunk cost, i.e. prior investments on software and trainings would be rendered useless.

Nagy et al. (2010, p. 151) saw two possibilities how organisations can react to the issue. Firstly, a partial adoption or adoption in areas where no significant investments have been made is possible. Secondly, and as a more sustainable solution, organisations should analyse the future costs and compare continuing with proprietary software to switching to OSS in the long term.

Research has in addition shown that companies using OSS show better financial results. Spinellis and Giannikas (2012) found that companies using an open-source browser have higher profits and server operating system users have higher gross margins (p. 677–678).

Nevertheless, interviews carried out with 151 managers in different countries surprisingly revealed that economic factors have lost their significance (del Bianco et al., 2011, p. 74). Return on the investment is still important, but the total cost of ownership has much less impact on the software selection than interoperability and usability.

Emotional barriers to adoption should not be understated either. Researchers have found that OSS adoption is also hindered by vague misconceptions. For example, Nagy et al. (2010, p. 151) discovered that some organisational managers think of open-source solutions as "probably of inferior quality than those that are paid for, such as proprietary software" (p. 151).

Moreover, there is an understanding that OSS is immature in comparison with proprietary software. Goode (2005, p. 676) noted from the interviews conducted in Australia that some managers believe that OSS is not yet ready for commercial use. The same idea is often also formed by arguing that the volunteer developer groups are unreliable and may suddenly end development. For instance, Nagy et al. (2010) encountered these perceptions, but made a counter argument by writing that already the current number of adopters and large investments made by organisations such as HP, IBM and Sun should show the sustainability of OSS (p. 151).

Social pressure is also put on organisations by the need to follow the existing laws. There has been, especially in the developing countries, a problem with illegal or so-called pirated software. Because widespread proprietary software is rather expensive and open-source solutions have not always suited the needs either, organisations have installed proprietary software without buying the needed licences. However, there are signs that the improvement of OSS is also diminishing the aforementioned problem.

For example in Cuba, pirated software in public institutions was a great issue during the change of the millennium (Garcia-Perez et al., 2006, p. 9). But the improved functionality and user-friendliness of alternatives has helped poorer countries, but also organisations with very limited resources, to use legal software and gain acceptance by society. Lee (2006) too considered OSS as a solution to the pirating problems in less developed countries (p. 135). Curiously it is the United States and lobbying of American corporations that aim to enforce strict policies against illegal software in the third world countries, but are thus effectively increasing the migration to open-source software.

Relating to legislation, society is interested in avoiding monopolistic market situations. Microsoft is, without a doubt, currently a monopoly on the private computer operating system market. The matter is discussed by Lee (2006) and it is pointed out that some proponents of

open-source recommend subsidiaries to facilitate the OSS adoption in the private sector (p. 124). It is furthermore argued that without governmental support to OSS, the market will continue to be dominated by a small number of companies. Yet the situation would be likely to change, if governmental organisations would show an example and create the original market for new vendors. These aspects might also affect users considering switching away from proprietary software.

Although OSS as a teaching object is discarded in empirical part of the paper, it should be noted that the society expects all students to receive an education which prepares them best for colleges, universities and the labour market. It is easy to claim that introduction to alternatives of Microsoft's software should be included in the curriculum. Kotwani and Kalyani (2011) are advocates of this idea, when they argue that "teaching OSS from the elementary years of education adapts the child for future market and job requirements" (p. 210).

2.2.4   Facilitating Conditions

Finally, according to the UTAUT model, intention or usage is determined by facilitating conditions. The essence of these lies in "the degree to which an individual believes that an organizational and technical infrastructure exists to support use of the system" (Venkatesh et al., 2003, p. 453).

The most important facilitating condition is the availability of support for OSS. The matter was briefly discussed under effort expectancy too. Several publications point out that one of the main barriers for adopting open-source alternatives is lack of vendors for installation and later support of the workstations. In other words, effort for switching to OSS is also increased by the issue of finding software vendors and support technicians for the work stations.

Colannino (2012) also analyses the scarcity of OSS and support vendors, who have the necessary competence and would be interested in participating in the procurements (p. 922–923). The same ideas became also apparent from interviews carried out by Goode (2005, p. 675).

The matter is made worse by lobbying and marketing efforts by proprietary software vendors. Nagy et al. (2010) has found that providers of closed source software use "fear, uncertainty and doubt to undermine and cut the market potential of their open-source competitors" (p. 149).

Moreover, vendors who have won previous procurements have a comparative price advantage at next offerings. This is especially the case if proprietary standards are also used. Utilisation of open standards makes it rather easy for competitors to offer alternative solutions with the same functionality that can be used as so-called drop-in replacements.

The matter mentioned above was analysed by Simon (2005). He saw that software procurements are high financial risks due to vendor lock-in and the risk is increased when closed standards are used. Furthermore, the long term total cost of ownership is difficult to evaluate, because price is "likely to increase as more customizations [to the software] are needed" (p. 229). The same author saw the trend of governments moving toward using more open standards and also OSS to avoid vendor lock-in (p. 232), but admitted that "neither proprietary software nor OSS is a panacea" (p. 234).

The same results have also been seen by Cassell (2008) who interviewed city leaders in Europe. The most mentioned reason for switching to OSS was independence (p. 204). The freedom of multiple vendors was seen as liberation from being steered by strangers.

It is interesting to note that the lock-in strategy has been condemned also for proprietary software vendors. An analysis by Zhu and Zhou (2012) suggests that if closed source software vendors decrease the price, they acquire new clients who are out of their actual target market segment, i.e. high-reservation-utility customers as named by the authors (p. 9). In the long term, however, the vendors would damage their business and the only possible beneficiaries are certain low-reservation-utility customers.

In the case of private organisations, policies might be set to guide or limit the available options. A research conducted in Quebec with local health care institutions' CIOs showed that ministry level policy makers can affect and may limit the adoption of OSS (Paré et al., 2009).

Another influencer in the organisational structure is the availability of internal OSS human capital. In other words, organisation with IT members already familiar with OSS and its properties are more likely to migrate and have better chances of succeeding (Li et al., 2013).

Finally, culture has been noted to influence the adoption process too. Meaning, different barriers gain more attention in different cultural environments. Research suggests that "the impact of open IT-based networks becomes weaker when uncertainty avoidance is high rather than low" (Qu et al., 2011, p. 1002). Furthermore, high power distance was found to negatively impact the adoption (p. 1003).

2.3   Framework

For performance expectancy, there were three most important factors. Firstly, the functionality of OSS needs to match the one offered by its closed source competitors. Organisations are not willing to adopt, if it means losing any ability to carry out daily tasks. Secondly, several papers also emphasised the importance of interoperability and compatibility. That is, barriers can be proposed by currently used standards and formats which are deeply rooted within the
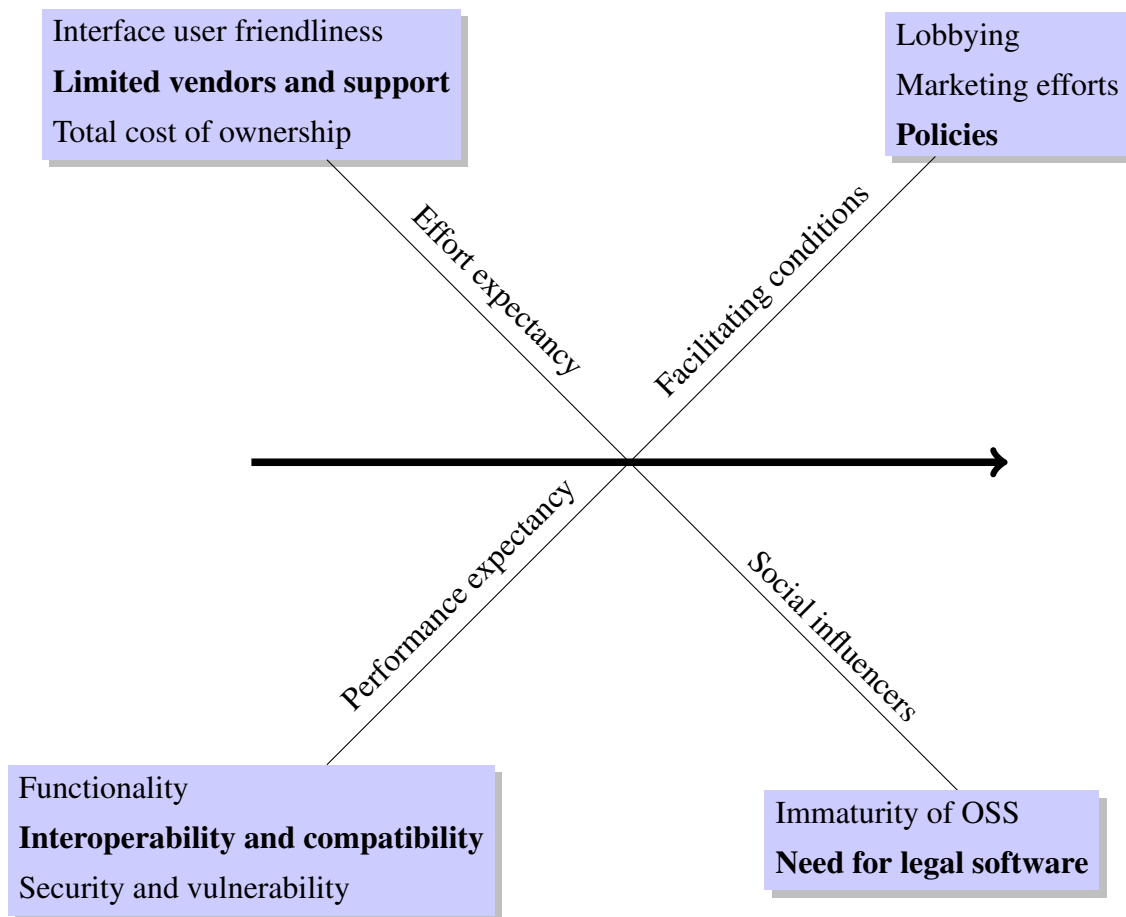
Figure 2.1: Barriers to OSS adoption. Model based on Venkatesh et al. (2003)

set processes. Finally, performance of OSS was analysed from the security and vulnerability perspective. Although perception of slow updates was not confirmed by research, it was named as a significant barrier (Schryen, 2011).

Next, effort expectancy showed the strengths and weaknesses of OSS in terms of ease of use. The most important factor was identified as the user friendliness of the programs' interfaces. Although some differences from proprietary software are expected, too radical changes would propose a barrier to adoption. In addition, the financial matters related to effort expectancy are shown by the total cost of ownership. The most important components of the total cost were training and licences. Nonetheless, the existing perceptions and results found regarding financial matters were contradicting and dependant on specific situations.

Moreover, barriers for organisations can arise from issues with vendors. It was pointed out that OSS tends to have fewer vendors and thus more effort is needed to find them. Furthermore, switch to OSS was seen to be hindered by concerns of support service but also official documentation quality and availability.

Social influence factors from the UTAUT model directed attention to the general perception

of OSS in the society. It became apparent that in some cases, OSS is seen as immature and not ready for commercial use, which causes emotional barriers. The second social influence factor was the need for using legal software. Poor countries and organisations might be forced to use free and open-source software, since they cannot afford software under proprietary licences.

Finally, the existing organisational and technical infrastructure was analysed under facilitating conditions. Competition and lobbying by proprietary software vendors was too seen as hindering the spread of OSS. Also, research revealed that governmental or regional policies can affect the decision to use OSS in both directions. There are various tools that can be used in policies to positively affect the diffusion of OSS, such as subsidiaries and public institutions that create the market for OSS vendors.

The most important ones in Estonian public institutions are probably compatibility with currently used file formats and standards, the need to avoid illegal software, lack of competent support providers and governmental policies. The following chapter aims to test the framework against the situation in Estonia and analyse the results.

The UTAUT model provides a solid framework for the OSS adoption analysis in the Estonian general education schools' context. Nevertheless, performance expectancy and facilitating conditions probably contain the most important set of influencers. Yet factors from all categories were seen as important in the analysis.

3 The case of Estonian Gymnasiums

3.1 Open Source Software in Estonian Education

Estonia's aim to be on the technological frontier can be seen already from 1996 when the Tiger's Leap (Tiigrihüpe) project was proposed (Runnel et al., 2009). The goal was to heavily invest in the IT infrastructures and a part of the project was connecting all schools to the Internet.

Tiger's Leap and following similar initiatives have largely relied on Microsoft's software. This proneness could be seen as path dependency. The yearbooks of the project from 1998 until 2001 reveal that Microsoft's software dominated in Estonia. For example, the company offered a reduced price for its learning software Encarta (Tiigrihüppe Sihtasutus, 1998, p.11). Moreover, all other software for studying was made for Microsoft Windows (pp. 12–13). Yearbooks from 1999 and 2000 point out that the initiative included several purchases of Microsoft Excel and PowerPoint courses for teachers (Tiigrihüppe Sihtasutus, 1999, 2000). Although focus on proprietary software was probably the only viable option at the time, it still limited possibilities to adopt OSS later.

The successor of Tiger's Leap was Learning Tiger. Its action plan for 2006–2009 regards among other aspects strategies for software selection in schools. It is stated that the goal is to continue negotiating favorable conditions for commercial software, while deploying OSS according to user readiness (Õppiv tiiger, 2006, p. 4). The tasks show concern for cost of software while prioritising the user point of view and somewhat limited competence. Tallinn City Educational Department was able to reach agreements on significantly lower prices compared to schools in Scandinavia and Central Europe, but the price will be increased tenfold in the years to come (Ernst & Young, 2014; Teder, 2013).

The following key recommendations regarding OSS in Estonian education are based on several analyses which have been put forward in papers published by RISO (Riigi infosüsteemide osakond — State information systems department). The reviews compare various proprietary and open-source software solutions and recommend the use of OSS alternatives in most cases. Although the papers discuss the Estonian public sector in general, the conclusions can be put in the context of schools as well.

Factors such as cost saving, sustainability and security which became apparent in academic research were also emphasised in the Estonian context (Põldmaa, 2009, p. 12), but the research papers add several facilitating factors which are specific to the local environment.

A suggestion to extensively deploy OpenOffice in 2003 was given by Tammet (2002). Data shows that in 2004 around 9% of public institutions used OpenOffice.org (Odrats, 2005), but the measure fell slightly in the next years and was 5–7% in 2007 (State information systems department, 2007).

A thesis written in 2012 gives an overview of the software used at certain schools in Tallinn. The results show that 65% of schools use Windows exclusively and 29% do the same for Linux (Horm, 2012). The remaining 6% have set up a system where they either have both Windows and Linux installed on the same computer, or separate computers for each operating system. The low proportion of combined method users is surprising as it shows that few are willing to test OSS, but the ones testing have decided to dedicate or move back to Windows.

A research for more precise and recent data was ordered by the Tallinn city council. The results show that a majority of users utilise Microsoft Windows and Microsoft Office in their daily tasks (Ernst & Young, 2014). It is surprising though, that only 1% of surveyed schools used Linux and more than every third still had Windows XP on the computer. The situation is similar in office suite selection, as LibreOffice and OpenOffice sum up to around 4% while 88% have a version of Microsoft Office. The remaining 8% are on either Apple's software or use an online service for document processing. The results are different from the ones obtained by Horm (2012), but should be considered more precise as the number of surveyed schools is larger and the data is more recent.

The recommendation to migrate to open-source office suite should be made while keeping in mind that alternatives to specific purposes, e.g. account and human resources management, may not exist. Therefore, Tammet (2002) points out that organisations should continue using proprietary software for accounting and other more specific purposes (p. 8). Interactive smart boards and the Estonian ID card turned out to show incompatibility issues with Linux in the educational context (Tammeorg, 2014b).

Moreover, Windows should remain as the main operating system, while allowing more competent users to migrate to Linux. The argument was made by Tammet (2002, p. 17). The reasoning behind the suggestion is that firstly, the user interfaces might be too different and secondly, re-installation of operating system is a time-consuming task.

However, the same obstacles arise when upgrading Windows to a newer version which would mean more sensible time to consider migration to Linux — especially for the more competent users. Therefore, Tammet recommended to avoid upgrading current Windows licenses,

yet the operating system should be determined by the software that the user needs to use and not vice versa.

Next, the use of OSS supports the local IT sector by shifting emphasis from mechanical selling to high value added development. The benefits of this aspect were described by Põldmaa (2009, p. 11). He argued that the money spent on software is in the case of OSS more likely to stay in Estonia, since increased training costs would be directed to the local economy.

Additionally, limited experience in local public sector institutions can negatively affect the confidence in successful migration. The idea was discussed by State information systems department (2010) which published an analysis of the Estonian IT infrastructure. The consequences of limited experience are uncertainty in choosing the software, and estimating the cost of ownership over the product's life cycle. Moreover, issues and confusions with legislation can arise (p. 9). Due to the recommendations and offers provided by the education department centrally, these threats could be seen as diminished for educational institutions.

Furthermore, the aspect of transparency in contracts is important in the Estonian context. It was stated by Põldmaa (2009) that the use of open standards and software in procurements significantly decreases the danger of corruption. He continues by arguing that the increased transparency is related to better compatibility and leads toward improved cooperation between public sector IT systems. This aspect is important in the educational context as it allows teachers to share info more easily.

Transparency and open standards can lead to a larger scope of procurements. In other words, there are benefits to be gained from reusing and developing open-source applications from one procurement in the following ones (State information systems department, 2010, p. 9).

On the other hand, it is pointed out that while a clear resolver exists for taking care of problems with proprietary software, open-source software is most often supported by communities (State information systems department, 2010, p. 9). It is suggested that the public sector should also participate in the community and help other users in the country.

Finally, there is a need for harmonising IT policies within the European Union. Currently, the Estonian public sector lags behind of the European average. The cause lies most likely with the absence of clear policies related to the new paradigm (State information systems department, 2010, p. 9). RISO aims to improve the situation. A widely cited example from Europe is Iceland which started to migrate its schools to Linux 2008 (Adhikari, 2012)

Neither proprietary nor OSS is superior and the decision should be based on financial and need-based considerations, while avoiding emotional influencers. Although there are recommendations to migrate to OSS, the decision requires careful planning (Tammet, 2002).

OSS in Estonia can also be analysed through most important barriers to migration. This was done in a paper which carried out interviews with IT managers (State information systems department, 2007). The dominant reason is difficult and costly training of personnel (p. 27). Next, compatibility issues are given as the second most influential barrier. The final of the top three is difficulties in changing the habits of the users. All these findings are consistent with many others which were identified by academic research analysed above and are very likely to apply to schools as well.

Besides the State information systems department, also the Estonian Ministry of Education and Research has interest in directing schools in their software selection. An example of this is information on the ministry's web page introducing an offer by Microsoft (Estonian Ministry of Education and Research, 2014). The article promotes the possibility for general education schools to use Microsoft's products, namely Windows and Office, at a reduced price by signing Microsoft's Enrollment for Education Solutions licensing agreement. The offer is valid, if the contract is signed within 2014.

It is important to emphasise that the offer is for general education schools only, i.e. excluding higher education institutions. The conclusion that can be made is that Microsoft is interested in accustoming the youth with its software in the hope that they are more likely to continue using the familiar Microsoft's software in the future as well. Secondly, the timing of the article is also noteworthy since it was published two weeks before the official end of support day for Windows XP. Most likely, the goal was to attract the attention of those who are still on the now obsolete operating system and in doubt about how to modernise the operating systems.

Nevertheless, a quick analysis of the published articles by looking up different OSS related keywords such as "linux", "openoffice", libreoffice" and "source code" ("lähtekood" in Estonian) give no relevant results on the ministry's home page. Furthermore, out of the several development plans available on the site none give direct guidelines on how to build the IT infrastructure and which software should be favoured. Thus, the Estonian Ministry of Education and Research has chosen to take a narrower approach on educational institutions and does not provide information relevant to the current thesis.

In summary, there is considerable interest toward software in the Estonian public institutions, including general education schools. Analyses and research papers gathered and made available by the State information systems department argue for a more extensive migration to OSS. Statistics from the same source show an increase in the spread of OSS between 2007 and 2011, yet recent and specific data for schools was scarce. Somewhat surprisingly, the article database and development plans of the Estonian Ministry of Education and Research showed little concern toward the investigated matter.

3.2 Empirical Research

In order to test the framework put forward in section 2.3, interviews were carried out at five general education schools and with representatives of the education department in Tallinn. The semi structured interviews were based on a questionnaire developed on the basis of the UTAUT model and on what is known regarding factors from earlier research.

It is important to note that in order to tackle the issue of exclusive dependency on Microsoft's software, Tallinn City Education Department has already started a pilot programme and is testing Linux, namely Lubuntu operating system, on 5 educational institutions in Tallinn. The long-term goal is to migrate all schools in Tallinn and create a central management system for all PCs. School D is one of the three schools in the pilot.

The results are anonymised with the aim to increase the willingness of the interviewees to share more specific details. Table 3.1 gives an overview of the schools' sizes by presenting the number of teachers and pupils at each institution.

In all of the cases, it is the IT manager at the school who is also the IT teacher. The attitudes of the interviewees are summarised in table 3.2. Three factors proved to be more significant than others in determining the software selection. All factors are discussed by moving from more to less important.

Firstly, user interface dissimilarities are an issue and can hinder smooth migration to any piece of OSS. The matter was pointed out by all IT managers that participated in the interviews. Most users are now used to the toolbars offered by Microsoft since Office 2007, and LibreOffice seems like a regression. The reason why Microsoft decided to make more functions visible was that users would be able to find the needed commands more quickly and that commands would be organised (Microsoft Corporation, 2014). According to the IT manager at school D, the users have grown accustomed to the change. Moreover, interviewees at the city's education department referred to a survey which analysed teachers' ability to use computer and result from Estonia were below average (Valk, 2013).

Reference name	Teachers	Pupils
School A	82	854
School B	64	885
School C	62	820
School D	60	591
School E	57	859

Table 3.1: Schools that participated in the research. Ranked by the number of teachers. Source: author based on interviews.

However, the differences cannot be overemphasised. As formulated by the interviewee at school D,

> *all users can do what they need to do [on OSS], if they just put a little effort into it*

User interfaces regardless of how the software is distributed are created with the goal of being user friendly and as easy to learn as possible.

Moreover, the IT managers at schools A and E suggested that there is a difference of importance between the operating system and office suite interface consistency. He proposed that a movement away from Windows is more troublesome than an adoption of another set of office programs. The argumentation here is that the operating system is used for more functionalities and determines a greater part of the overall interface.

The preference of Microsoft Office is clear since computers at all schools have had OpenOffice or LibreOffice installed for a while already, yet users tend to clearly use Microsoft's suite, if it is available. From the interviews, it was unclear why this favouring takes place, but most likely the reasons are the same as complaints that have come about OSS after removal of Microsoft Office.

The IT manager at school B made an interesting note regarding the discussion over whether open-source operating systems and programs are suitable for novice users. She said

> *it makes little difference for beginners, but for average users . . . there's a difference.*

The implication of this, however, is that most teachers and managerial employees at the schools are not beginners and thus they might find it difficult to get used to new software.

Secondly, the most important barrier in the performance expectancy set turned out to be interoperability and compatibility. Fear of or experienced issues with files not opening or being displayed wrongly after using a different programme to open the files were apparent in most interviews. There are two reasons for the problem.

School	Effort expectancy			Facilitating conditions		Performance expectancy			Social influencers	
	Interface user friendliness	Vendor availability	Cost	Lobbying	Policies	Functionality	Compatibility	Security	User's perception of OSS	Need for legal software
A	✓✓✓	✓	✓✓✓	—	✓✓	✓✓	✓✓✓	✓	✓✓	✓
B	✓✓✓	✓✓✓	—	—	✓✓✓	✓✓✓	✓✓✓	✓	✓✓✓	✓✓
C	✓✓	—	✓✓	—	✓✓	✓✓	✓✓✓	—	✓	✓✓✓
D	✓✓	—	✓	—	✓✓	✓	✓✓	—	✓	✓
E	✓✓✓	✓✓	✓✓	✓	✓✓	✓✓	✓✓	—	✓✓	✓

Table 3.2: Visualisation of the interview results. Ticks show the level of importance for each aspect from "—" to "✓✓✓". More ticks means more important

The files may not open or open differently than originally created, if created in another software, e.g. LibreOffice documents in Microsoft Office and vice versa. Compatibility issues can also arise from the use of different file formats or standards. An example of the result is .doc files which open in compatibility mode in newer Microsoft Office versions and may be displayed incorrectly. Nevertheless, the former issue is more salient and more relevant to the paper in hand.

These issues do not arise only due to migrations of software at schools, but also since employees wish to work on their private computers at home. Examples of this were pointed out in some interviews.

On the topic of Microsoft Office and its open-source competitors, several IT managers wished to differentiate teachers and managerial workers. More precisely, an opinion became apparent that school's management should continue with Microsoft Office, if they wish, but teachers should be forced to migrate to LibreOffice for cost saving purposes. The reasoning for this lies in the need for the management to communicate with external parties and avoidance of any incompatibility issues is essential.

Most of the interviewed schools agreed that issues with specialised software are either likely to arise or have already been experienced while testing OSS solutions. Challenges could also emerge from incompatibilities between add-ins for office suits, but software designed for the Windows operating system was identified as the main barrier.

The most acute software incompatibility challenge was with the Qomo smart board. This was emphasised in interviews at school D and with the city's education department represen-

tatives. The institutions in the pilot project had difficulties in utilising the smart boards which the teachers already had been using in their daily work. The issue was solved by contacting the vendor directly and asking for advice.

Furthermore, interviewee at School A saw a potential problem in the portability of their library software to Linux if they were to migrate. The IT manager at school E saw potential risks in incompatibilities with printers. Interestingly however, accounting or human resources software were not pointed out, as was suggested in the academic research. As argued by city's representatives, the issue of software incompatibilities is not acute, since most are web-based and work well on all platforms.

Lastly, the general perception regarding functionality was that despite, this dissatisfaction with changed or potentially changing interface, user would not lose the ability to carry out their daily tasks on the computer. Although the interviewed IT managers suggested that there are no significant shortcomings in functionality of OSS, it was considered important in the decision making process. This applies both to operating systems and office suites.

However, potential challenges in the matter were also pointed out. The IT manager from school B saw a possibility that user would reject software and thus daily work would be affected. School C had a multimedia-oriented study programme and saw potential shortcomings of open-source video editing and 3D modelling software.

Besides the top three factors, policies were considered important. The interviews revealed that although the schools are able to choose their own software, it is not reasonable to differ from others and oppose the initiatives made nationally or by Tallinn City Education Department.

According to the interviewees at all schools, there is currently an ongoing contract which enables schools in Tallinn to rent Microsoft Office and Windows at a greatly reduced price of €3 per computer per annum compared to the regular price of around €30 (Teder, 2013). This discounted price diminishes the financial gain of switching to OSS. This agreement is also the likely reason why so few schools have currently switched to Linux as the operating system. On the other hand, there is no guarantee that the contract will be prolonged with the same conditions in the future. Interview at School D suggested that Microsoft has shown intentions to discontinue offering Estonian schools a cheaper rate compared to more developed European countries. The threat has put more pressure on finding alternatives for Microsoft's software. The contract was signed in 2013 and allows the Estonian schools to procure software at the subsidised price until mid-2017 (Teder, 2013). The Ministry of Education and Research was able to gain these terms by appealing on the country's effort in supporting and developing IT education.

Other aspects received varying mentioning in the interviews. The majority saw OSS as a cheaper option compared to Microsoft's proprietary software. This view is also shared by the department of education. In other words, the cost of licensing is seen as significant and OSS as a solution, especially when the current agreement for discounted prices ends in 2017.

Nevertheless, the IT manager at school B disagreed with the cost saving aspect. According to her quick analysis, the cost break-even point would be in 10 years on the condition that all schools migrate simultaneously. Otherwise, the cost of running two parallel platforms exceeds the gained benefit. Moreover, she suggested that the needed training expenses after migrating from Microsoft Windows and Office would diminish the gains from saving money on licensing.

The interviews revealed that besides total or partial migration of the schools' computers, there is also a possibility that computers with Linux are delivered to schools through special projects. An example was at school A where pupils were given laptops running on Linux in order to use Wolfram Mathematica. These computers also needed maintenance by the school's IT manager. It could be considered a good possibility to test the user experience on Linux on a small scale and with low cost.

In the interviews, issues with outdated infrastructure were also mentioned as relevant. For example, in school D Linux has proven to be a better choice on older hardware, as it needs less resources and thus runs more smoothly. On the other hand, interviewees from schools A and C said that since the computers at their schools are rather new or will be replaced in the near future; there are no significant benefits from this aspect which would increase the need for OSS.

There was no consent on whether it is beneficial to run two systems in parallel. On the positive side, this gives the possibility for only the more competent users to migrate and the switch can gradually take place over a longer period of time. Moreover, although IT as a teaching object was not at the core of the thesis, pupils should have access to both platforms in order to prepare them better for their future jobs. Yet, administration and maintenance of unstandardised IT infrastructure, including software, is considerably more costly to the schools.

During the interviews, lack of users' interest toward OSS was pointed out as a barrier. It is difficult to motivate users to learn new programs if there is disinclination and users cannot see a positive outcome. In contrast, interviewees said that they have come across users who enquiry about possibilities to have Windows 8 installed on their computer. It could be seen as surprising on one hand, since Windows 8 has received strong criticism for difficult-to-use interface, especially for office work (e.g. Reed, 2014; Crothers, 2013). The cause for this preference is difficult to analyse, but it may be due to Microsoft's marketing or the tendency to favour Windows because of expected familiarity.

Moreover, most IT managers did not see an issue with the availability of competent OSS vendors in Estonia. In other words, the general consensus was that either the companies that could install and support OSS already are on the market or that they would appear soon after an increased demand for them. Still, the interviewee from school B did see the limited number of vendors as a barrier and also suggested that

the price might be higher for services which are less common on the market.

The IT manager at school E argued that the support has recently become more costly. School C, on the other hand, was confident that most issues could be solved internally within the school and thus vendor availability is not important for them.

Weaker security of OSS was mentioned as a barrier in some academic papers analysed above, but not confirmed in any. The same results were obtained in the interviews. None of the interviewees saw issues with vulnerability, security or delayed patching in OSS applications. The matter of security threat was only brought up in connection of Windows XP end of support date, although it was not relevant to any of the schools as they had migrated to either Windows 7 or Lubuntu before the deadline.

Lastly, the interviews showed that lobbying is ineffective on schools, as most of the interviewed IT managers said that they have not been targeted for any direct persuasion. Only the interviewee at school E said that he had received offers, but those had been sent out to large mailing lists of which he happened to be a member of. The most likely reason for this is that these offers are sent only to the education department or the ministry of education and research. Since these institutions agree on licencing rates for all local schools, it is probably not worthwhile for the software vendors to spend any resources on persuading individual schools.

Cloud services for replacing office suits have been discarded in the discussion. They cannot be categorised to neither open-source nor proprietary software categories, although the source code is not open. The interviewees' attitude toward online solutions, such as Google Drive, Microsoft's OneDrive or Dropbox, was somewhat negative. Mainly, security concerns were emphasised. Nevertheless, the decision is up to the teachers and it is not possible, nor is it to goal, to hinder them from using these services in their work.

To sum up, school representatives were generally positive toward OSS, although some were more sceptic in certain aspects. Still, the opinions were all realistic and the argumentation well-reasoned from their perspective.

Schools that had not migrated to Linux need reasoning for the migration. Cost savings and help from the department of education are enough, but schools are not willing to switch without compensation for the difficulties of adjusting to the new system. Furthermore, there is a threat

that users would decrease the use of computers when they feel that new systems are different and difficult to learn.

In Estonia, the effort expectancy factors are the most important, as the schools cannot carry out their daily tasks if there are compatibility issues or if they lack competence for using the software. Nevertheless, policy from the facilitation conditions set was also mentioned on most occasions as relevant, since schools find it difficult to carry out major software changes without support from the city, although there are no strict regulations. The schools are free to select the software, but it is costly to discard offers from the city.

More specifically, the three most emphasised barriers to OSS adoption were interface user friendliness, functionality and compatibility. However, the other barriers and drivers received also variable mentioning by the interviewed IT managers.

4 Discussion

The research on academic papers regarding the barriers and drivers to OSS utilisation allowed to create a framework which could be applied to selected schools in Tallinn. The interviews showed that although certain influencers match, divergences exist for various reasons. Four categories from the UTAUT model were used to categorise the drivers and barriers in order to facilitate the analysis.

Performance expectancy in the created framework consisted of three factors and two of them were found to be almost unanimously relevant. Namely both functionality with interoperability and compatibility were emphasised by the interviewees. These results cannot be considered surprising as they determine the user experience and also the outcome of users' work on the computer. Neither can any of these be seen as significantly different in the Estonian or education context.

On the contrary, the possibility of weaker security was not named as a barrier for OSS migration. There are two likely reason for this outcome. Firstly, the vulnerability of OSS compared to proprietary software was not confirmed by any academic papers, and secondly, the tasks that schools' employees carry out on their computers do not require the highest security standards.

Only one of the three effort expectancy set of influencers was deemed relevant by the IT managers. Based on the academic research and assumption, limited vendors were expected to be the most important factor, but interface user friendliness was highlighted in the empirical analysis. Although it is not a distinct characteristic of the Estonian or educational context, the possible reason for this focus is that schools' employees have a competence below the European average and IT managers have concerns about users rejecting use of computers after the switch.

Vendor availability and cost received contradicting opinions. The former was named as a significant barrier in the analysed research papers and was also assumed to be important in Estonia. The interviews however suggested that most IT managers did not expect a significant problem with finding suppliers for OSS. However, the department of education showed concern for finding a vendor for central administration, if all schools were to migrate. This might be a peculiarity of Tallinn or Estonia in general as a large number of small open source oriented

vendors may be on the market.

Cost saving after the migration also received opposing evaluations. It is clear that on one hand money is saved by avoiding to pay for the licenses, but on the other hand administrating and maintenance might be more expensive, especially during the migration period and shortly after. Moreover, new costs could arise from the need to train users on the new software.

Yet, as probably a characteristic for Estonia, the schools do not intend to spend money on trainings, which increases the overall cost saving. The employees are in most cases supposed to learn the new software themselves or with the help of local IT managers, if the migration is decided.

Facilitating conditions too had three identified factors. Policies by the government were assumed to be the most influential ones. The empirical research, however, revealed that the matter is slightly more complex — the schools are affected by policies created on the national level, but even more by the policies made by the city's education department. Yet the choices that schools can make regardless of the policies may not be understated either.

It is a clear peculiarity of the educational sector that common agreements are made by a representative — either the town or ministry. The contracts influence the schools directly, as they determine the prices schools need to pay for software licenses or support. Therefore, the policies play a significant role in shaping the barriers and facilitators for OSS migration.

For the same reason, the interviews showed that schools are not a target for lobbying and marketing by vendors of either type of software. It is not cost-efficient for the profit seeking companies to contact schools and create demand for their software, since it is more profitable to persuade on the higher level, where the contracts are signed.

Social influencers in the created framework included one barrier and one facilitator for OSS use. It was expected that the need for legal software and the end of support for Windows XP are drivers for migration to open-source alternatives, but this assumption was not confirmed in the empirical research. The schools in the analysis had already switched to either Windows 7 or Linux. It is important to note, however, that according to an analysis commissioned by the city council, 38% of computers still had Windows XP in the beginning of 2014 (Ernst & Young, 2014).

The general perception of OSS among the users was seen to be more influential by the interviewees. Some had encountered users who have a bias toward OSS and would rather see their school continuing with Microsoft's software, thus creating a barrier towards the change. Yet again, there are no relevant traits to Estonia or the educational sector.

The hypothesis set in the beginning assumed an equal influence ratio between functional, emotional perception and cost aspects. As suggested by the analysis, emotional barriers were

mentioned, but not as influential on the final decision. Functionality and ease of use were brought up in all interviews, but since OSS was seen as similar or at least comparable to proprietary solutions, it proposed neither a driver or a barrier. Cost received opposing opinions in the interviews and also in the analysed academic papers. Yet in any case, cost is a very important factor, probably the most significant for the schools of Tallinn.

From these results, three policy recommendations can be made. Firstly, in order to guarantee communication with organisations that have switched to open-source office software, open file standards should be used in the schools. As a positive side effect, the early use of open formats helps to facilitate the migration later, because issues with opening archived files will be avoided. Although recommendations to use open standards have been made before, more strict policies should be applied.

The most know open standard is ODF (open document formant) which was also recommended by the State information systems department (Põldmaa, 2009). The idea is to ensure consistency over all platforms and editors, but as pointed out by the IT manager at school D, this has not succeeded to the expected extent. In any case, the users need to be made aware of the formats and their properties, since they are not selected by default in any text editor. Alternatively, if the document does not require later editing, it should be exported as a .pdf file, which has the least compatibility complications.

Secondly, it is necessary to plan trainings to avoid rejection of the software on users' side. The local IT managers play a key role, as due to cost saving they should attend trainings, perhaps with some of the more competent teachers, and later distribute the knowledge within their schools.

Finally, there is time and money to be saved from standardisation of software on computers. Although it was argued that it is beneficiary for the schools to run both proprietary and open-source software in parallel, it is also a costly solution. A remedy to tackle the issue can be found in keeping the software on the computers centrally managed. Both the city and the state should contribute with resources in developing the standards and providing administrative assistance by investing financial resources and assigning teams with the needed know-how on the task.

The framework based on the UTAUT model served its purpose in the context of OSS in gymnasiums rather well. Yet, an improvement for the model could be made by analysing the policy environment as a separate matter. In other words, since policies can be seen influential on different levels, it could be added as the fifth category to the model when investigating OSS in public organisations.

It needs to be acknowledged that there are limitations to the research undertaken and slightly different results would possibly have been gathered, if the methodology had been changed. The

goal of using qualitative method was to analyse certain areas in depth, but it might not reflect the overall situation. Furthermore, the samples were picked only from Tallinn, which is not likely to represent the attitudes of schools in the rest of Estonia.

5   Conclusion

This paper focused on analysing the drivers and barriers to open-source software adoption in gymnasiums in Tallinn, Estonia. The analysis was done by applying the unified theory of acceptance and use of technology (UTAUT). Each of the four categories in the model received 2 or 3 factors which were expected to have an impact on the migration decision according to published research. The deciding factors were applied to the situation in Estonia by carrying out interviews with five gymnasiums and with representatives of the Tallinn City Educational Department.

The research concludes, similar to academic papers published, that functionality, user friendliness and compatibility aspects are important in the decision making process. Yet some findings contradict the general findings. For example, security aspects received less attention by the IT managers than expected and lobbying was argued to be ineffective.

Policies were considered important as the schools were influenced by the decisions made by the educational department. Based on the analysis, three policy recommendations were given to improve the decision making process and ease the software administration in the future: software standardisation, software training planning and a stricter orientation to open file formats.

The UTAUT model was generally suitable for the analysis. However, the framework could be developed further by creating a separate category for policy environment. The schools are influenced by strategies created on different levels — from schools' management to national or even international. OSS adoption research would benefit from a closer look at relevant policies.

Additionally, it is suggested that the paper is followed by more quantitative analyses and also a comprehensive financial budgeting of the effects of curbing further Microsoft software licences procurements. This is needed for the decision on how to continue after the year 2017, when the current agreement with Microsoft on reduced licensing prices ends.

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