JISTEM - Journal of Information Systems and Technology Management
Revista de Gestão da Tecnologia e Sistemas de Informação
Vol. 13, No. 3, Set/Dez., 2016 pp. 515-532
ISSN online: 1807-1775
DOI: 10.4301/S1807-17752016000300009

FACTORS INFLUENCIG SOFTWARE MIGRATION DECISION: CASE STUDIES OF ACERLORMITTAL TUBARÃO AND THE CITY GOVERNMENT OF SERRA, ESPIRITO SANTO

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ABSTRACT

The objective of this research is to identify the factors that influence the migration of free software to proprietary software, or vice-versa. The theoretical framework was developed in light of the Diffusion of Innovations Theory (DIT) proposed by Rogers (1976, 1995), and the Unified Theory of Acceptance and Use of Technology (UTAUT) proposed by Venkatesh, Morris, Davis and Davis (2003). The research was structured in two phases: the first phase was exploratory, characterized by adjustments of the revised theory to fit Brazilian reality and the identification of companies that could be the subject of investigation; and the second phase was qualitative, in which case studies were conducted at ArcelorMittal Tubarão (AMT), a private company that migrated from proprietary software (Unix) to free software (Linux), and the city government of Serra, in Espírito Santo state, a public organization that migrated from free software (OpenOffice) to proprietary (MS Office). The results show that software migration decision takes into account factors that go beyond issues involving technical or cost aspects, such as cultural barriers, user rejection and resistance to change. These results underscore the importance of social aspects, which can play a decisive role in the decision regarding software migration and its successful implementation.

Keywords: migration; free software; proprietary software; adoption; innovation.

Manuscript first received/Recebido em: 17/03/2013 Manuscript accepted/Aprovado em: 20/12/2016
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1. INTRODUCTION

Although information systems have become a vital part of the workplace, there is still little understanding of the factors that contribute to their adoption and acceptance (Jamielson, 2007). Most authors have their focus limited to system attributes and user requirements (Ven, Verelst, and Mannaert, 2008), although there is a growing number of authors–such as Rogers (1995), Mintzberg and Westley (2001), and Huysmans, Ven and Verelst (2008) –who consider the organizational and contextual aspects of adopting these systems.

Specifically in the software market, the focus of this research, there are two paradigms: free software vs. proprietary software. It is believed that the technology of free software is economically attractive due to its low cost, as well as its technological viability (Subramanyam and Xia, 2008). However, free software still faces institutional barriers that prevent its full adoption, including the arguments that there is no associated technical support and that the higher consulting service costs do not compensate for its being free (Kologlugil, 2012; Sacks, 2015). On the other hand, despite the high prices of user licenses, proprietary software is perceived as more technologically and institutionally reliable because of its broader compatibility, adherence to a standard, and available technical support (Hemphill, 2006; Benlian and Hess, 2011).

Thus, both options offer pros and cons, and some companies that used proprietary software have migrated to free software, while others, which used free software, have taken the opposite approach and opted for proprietary software. However, the real factors influencing migration decisions are not yet clear (Benlian and Hess, 2011; Sacks, 2015). Thus, the objective of this research is to identify the factors that influence the decision to migrate from one particular technology standard to another, whether from free to proprietary software, or vice-versa, in the Brazilian context.

The theoretical framework was developed in light of the works of Rogers (1976, 1995), Mintzberg, Raisinghani and Theoret (1976), and Mintzberg and Westley (2001), as well as the Unified Theory of Acceptance and Use of Technology (UTAUT) developed by Venkatesh, Morris, Davis and Davis (2003). Since 2003, UTAUT has been a useful tool for managers seeking to assess the likelihood of acceptance of technological innovation in an organization. This model was validated by means of six studies conducted in six large-sized companies, and showed a higher success rate than other models adopted for the study of technology acceptance (Gupta, Dasgupta and Gupta, 2008). For this reason, this was chosen as the theoretical framework for this research.

To achieve its goal, the research was structured in an exploratory phase and a qualitative phase, in which case studies were conducted at ArcelorMittal Tubarão (AMT), a private company that migrated from proprietary software (Unix) to free software (Linux), and at the Serra City Government (SCG), a state organization that migrated from free software (OpenOffice) to proprietary software (MS Office).

This research contributes to the understanding of a complex phenomenon, which has been widely studied but little explored in Brazil, and mainly addressed from the

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technical and cost perspectives. This research is intended to broaden the scope of analyses – investigating social, contextual and organizational issues –in decision-making and software migration in the context of Brazilian companies, surveying a state organization and a private company.

2. FREE SOFTWARE VERSUS PROPRIETARY SOFTWARE

In the beginning, all software was free. When a computer was sold, the sale included both hardware and software in one package. This technique, known as bundling, encompassed programs for any kind of applications, free of charge, which manufacturers supplied with a view to stimulating and supporting the sale of their computers. This scenario began to change in the 1970s in response to anti-trust actions of the US government against IBM, thus leading most manufacturers to price hardware separately from software, i.e., unbundling. (Kologlugil, 2012). Unbundling promoted the birth of two sides to the software industry, namely free software and proprietary software. The basic difference between them is the ownership of the source code. With free software, the source code is open and the term "free" refers to the users' freedom to run, copy, distribute, study, change and improve the software (Kologlugil, 2012; Sacks, 2015). On the other hand, with proprietary software, the source code belongs to the authors – it is closed and they are the only ones who have access to it (Hemphill, 2006; Benlian and Hess, 2011).

The free software model has proven to be economically advantageous –as it yields cost savings from the non-payment of royalties to manufacturers and does not create technological dependence on updates –and, technologically viable, as some solutions have proven to be more efficient and easier to customize than proprietary alternatives (Bonaccorsi, Giannangeli, and Rossi, 2006; Panetto and Molina, 2008; Benlian and Hess, 2011; Kologlugil, 2012). However, the market still strongly criticizes the quality of free software development and the support provided by its developers (Lee, Kim and Gupta, 2009; Sacks, 2015).

Therefore, managers still face a trade-off in their decision to adopt free or proprietary software (Economides and Katsamakas, 2006; Benlian and Hess, 2011; Sacks, 2015). According to Sacks (2015), the decision about which software to adopt does not necessarily involve quality or price, but the fact that it is the standard application for the market and/or it is the software with which the team is familiar. The essence of this argument is that one gets tied to a previously adopted or known standard and that adapting to new software requires time and knowledge costs.

3. THE MIGRATION DECISION

The reasons for the adoption of information technology (IT) have been studied since the late 1970s (Costa and Freitas, 2006). However, most authors have limited their

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focus to system attributes and user requirements (Ven et al, 2008; Benlian and Hess, 2011), although a growing number of authors– such as Rogers (1995), Mintzberg and Westley (2001) and Huysmans et al. (2008) – have considered the organizational and contextual aspects of system adoption.

According to Rogers (1976, 1995), *diffusion* is defined as the process by which a new idea or new product is accepted by the market. Similarly, the concept of *adoption* is also related to acceptance on the part of an individual. Thus, the adoption of a technology goes hand in hand with its diffusion process, whereby an individual moves from initial knowledge of an innovation to a decision to approve or reject it, then to the application and use of the new idea and, finally, to the confirmation of this decision.

Mintzberg et al. (1976) add the aspect of dynamism to the decision-making process, considering factors such as process interruption, lack of feedback, deadline problems, integration and rework. For the decision-making process, the authors propose a model that consists of three stages – identification, development and selection – seeking to identify other aspects in addition to the technical or economic ones.

Venkatesh et al. (2003), in an attempt to unify the most used theories regarding the acceptance and use of IT, gathered eight theories and models that were considered the most influential, and introduced the Unified Theory of Acceptance and Use of Technology (UTAUT). UTAUT was structured from the Theory of Reasoned Action (TRA), the Technology Acceptance Model (TAM), the Motivational Model (MM), the Theory of Planned Behavior (TPB), the combined TAM/TPB model (C -TAM/TBP), the Model of Personal Computer Use (MPCU), the Diffusion of Innovations Theory (DIT) and the Social Cognitive Theory (SCT).

Since 2003, UTAUT has been a useful tool for managers seeking to assess the likelihood of new technology acceptance in an organization (Attuquayefio and Addo, 2014; Oh and Yoon, 2014; Sijde, Reekum, Jeurissen and Rosendaal, 2015). UTAUT stands out in that it seeks to integrate and summarize in a single model the most common dimensions that influence the use of technology. This model was validated by means of six studies conducted in six large-sized companies, and showed a higher success rate than other models adopted for the study of technology acceptance. For this reason, it was chosen as a reference for application in this research, which aims to study the migration of technological paradigms, with adaptations (Gupta et al., 2008).

According to UTAUT, there are three dimensions that directly and significantly determine *Behavioral Intention*, which is the intention to use a particular system in the future: *Performance Expectancy*, *Effort Expectancy* and *Social Influence*. This relationship is mediated by factors such as *Gender, Age, Experience* and *Voluntariness of Use*. *Usage Behavior*, in turn, which is the actual use of a system, is directly influenced by *Behavioral Intention* and by *Facilitating Conditions*, which are the existing technical and organizational infrastructures to support the system (Venkatesh, Morris, Davis and Davis, 2003).

Although some of the mentioned theories apply to the adoption and not to the migration of technology, which is the focus of this research, migration can be understood

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as an adoption, but it involves other factors such as giving up an already adopted standard (Sacks, 2015). Thus, this research has not fully adopted any of the theories individually, but has adopted some of their constructs: four dimensions were selected from the UTAUT model and two from the Diffusion of Innovations Theory (DIT), proposed by Rogers (1976, 1995). DIT aims to explain the decision-making process regarding innovation and to determine the factors that influence the rate of adoption and the categories adopted (Rogers, 1995).

The dimensions selected for this research, as well as their source models and theories are described in Table 1.

Table 1 – Theoretical Framework of Dimensions Used in this Research

DIMENSION: PERFORMANCE EXPECTANCY (Theory: UTAUT) – the degree to which an individual believes that using a certain system will increase his/her productivity and improve his/her performance. Source Models or Theories: *Perceived Usefulness (TAM):* the belief that one puts in technology as something that will improve his/her performance. *Extrinsic Motivation (MM):* users want to perform an activity because it is perceived as a means to improve professional performance, compensation or promotions. *Adjustment to Work (MPCU):* the degree to which an individual believes that he/she will increase the performance of work using a particular technology *Relative Advantage (DIT):* the degree to which an innovation is perceived as better than its predecessor. *Expected Results (SCT):* Behavioral consequences of outcomes related to work.
DIMENSION: EFFORT EXPECTANCY (Theory: UTAUT) – user-perceived degree of system ease of use. Source Models or Theories: *Perceived Ease of Use (TAM):* an individual believes that using a particular system will be effortless. *Complexity (MPCU):* degree to which an innovation is perceived as relatively difficult to understand and use. *Ease of Use (DIT):* degree to which an innovation is perceived as being easy to use.
DIMENSION: SOCIAL INFLUENCE (Theory: UTAUT) – the degree to which an individual perceives that important others believe he/she should use the new system. Source Models or Theories: Subjective Norm (TRA and TAM): the behavior and opinion of professional groups taken as a reference by an individual; personal perception of the social pressures toward an individual to adopt a particular behavior or not. Social Factors (MPCU): the internalization of group culture and interpersonal relationships. Image (DIT): the degree to which the use of an innovation promotes an improved image or the social status of those who use it.

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DIMENSION: FACILITATING CONDITIONS (Theory: UTAUT) – the degree to which the individual believes there is an organizational and technical infrastructure to support the system. Source Models or Theories: Perceived Behavioral Control (DWT): an individual's perceived ease or difficulty of performing a certain behavior. Facilitating Conditions (MPCU): objective factors in the environment that may allow a certain act to be performed. Compatibility (DIT): degree to which an innovation is perceived as being consistent with existing values, needs, and past experiences of potential users.
DIMENSION: VOLUNTARINESS OF USE (Theory: DIT) – the degree to which the use of an innovation is perceived as voluntary.
DIMENSION: VISIBILITY (Theory: DIT) – the degree to which a user can see or perceive that others are using an innovation in the organization.

Source: Adapted from Venkatesh et al, 2003, p. 442.

4. METHOD

This research is qualitative and based on multiple case studies. Case studies were chosen as they allow for the empirical investigation of contemporary aspects in their real-life context, and for being appropriate for the in-depth investigation of a decision or set of decisions: why they were taken, how they were implemented, and their outcome (Yin, 2010).

The research was structured in two phases: the first phase was exploratory, characterized by adjustments of the revised theory to fit Brazilian reality and the identification of companies that could be the subject of the investigation; and the second phase was qualitative, in which case studies of the selected companies were conducted.

The exploratory phase contributed to understanding the theme, to mapping the categories to be studied, and to identifying the cases to be analyzed in depth. The authors joined the discussion list for Linux, a free software, and the forum for Microsoft, a proprietary software. Additionally, they visited various discussion sites about free and proprietary software in order to interact with people who deal with both types of software, and to understand the issue in question more deeply. These interactions have enabled the authors to contact editors of magazines about the subject, such as the *Linux* and *SoftwareLivre* magazines, consultants who act as coordinators of free software user groups, and managers of two companies that sell information technology solutions for free and proprietary platforms: Polaris Informática and Acrópolis Informática.

From these contacts, 23 organizations that used free and/or proprietary software were identified in Espírito Santo (ES). Of these, only two organizations experienced software migration and were receptive to the survey: ArcelorMittal Tubarão (AMT), a private company that migrated from proprietary to free software; and the Serra City Government (SCG), which migrated from free to proprietary software. AMT performed

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the migration on computer servers that provide services to a computer network, with less of a direct impact on the end user, while SCG's migration was completed on workstations, directly impacting the daily lives of end users. The researchers considered the differences between the two cases to be useful, for enabling, as highlighted by Seawright and Gerring (2008) and Yin (2010), a richer analysis of the phenomenon, which occurred in different environments. The authors sought to identify the similarities rather than the differences between the cases.

The material collected from in-depth interviews, from participation in discussion lists, and from the reading of blogs was analyzed in the light of the theoretical framework presented in Table 1, using Microsoft Excel software. This process resulted in the identification of nine dimensions in cases of technological standard migration. The relationship between these nine dimensions and those found in the literature (Table 1) is shown in Table 2.

Table 2 – Relationship between the dimensions that emerged in the exploratory phase of the research and those found in the literature

Research Exploratory Phase	**Theoretical Foundation**		
Dimension	**Dimension**	**Theory**	**Source**
1) Performance expectancy	Performance Expectancy	UTAUT	Perceived Usefulness – TAM Extrinsic Motivation – MM Adjustment to Work – MPCU Relative Advantage – RTD Expected Results – SCT
2) Efficiency improvement 3) Effort expectancy	Effort Expectancy	UTAUT	Perceived Ease of Use – TAM Complexity – MPCU Ease of Use – DIT
4) Influence from others 5) Influence from management 6) Influence from suppliers	Social Influence	UTAUT	Subjective Norm – TRA, TAM Social factors – MPCU Image – DIT
7) Ease of use	Facilitating Conditions	UTAUT	Perceived Behavioral Control – TPB Facilitating conditions – MPCU Compatibility – DIT

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Research Exploratory Phase	**Theoretical Foundation**		
Dimension	**Dimension**	**Theory**	**Source**
8) Confidence in new technology 9) Team anxiety (change management)	Voluntariness of Use	DIT	Voluntariness of Use – DIT
	Visibility	DIT	Visibility – DIT

Source: The authors

The nine dimensions shown in Table 2 composed the interview script used in the qualitative phase of the research. In that phase, there were in-depth interviews with professionals involved directly in the migration process of both companies and who played different roles in the process. The interviews were conducted in person by the first author; they were recorded and later transcribed. The authors sought to obtain different views on the subject– from technical staff, managers, users and consultants –in order to build a comprehensive picture of the studied phenomenon. The profile of the respondents is shown in Table 3.

Table 3 – Profile of the respondents interviewed in the qualitative phase of the research

ArcelorMittal Tubarão	Serra City Government
Infrastructure Analyst– conceived the project, worked to convince senior management, and participated in the implementation.	*CIO (Director of Information Technology)*
Systems Development and Support Analyst– participated in the migration team.	*Network Administrator*– professional in the Information Technology team reporting directly to the CIO (IT Director).
Systems Analyst– end user.	*Head of Network*– professional in the Information Technology team reporting directly to the CIO (IT Director).
Chief Technical Officer of Polaris Informática– participated in the sale and project planning process.	*End user* of migrated software.
Polaris Informática Consultant– participated in the planning and implementation of the solution.	

Source: The authors

The interviews were analyzed in the light of the nine dimensions shown in Table 2 and the works of Rogers (1976, 1995) and Mintzberg et al. (1976) and Mintzberg and

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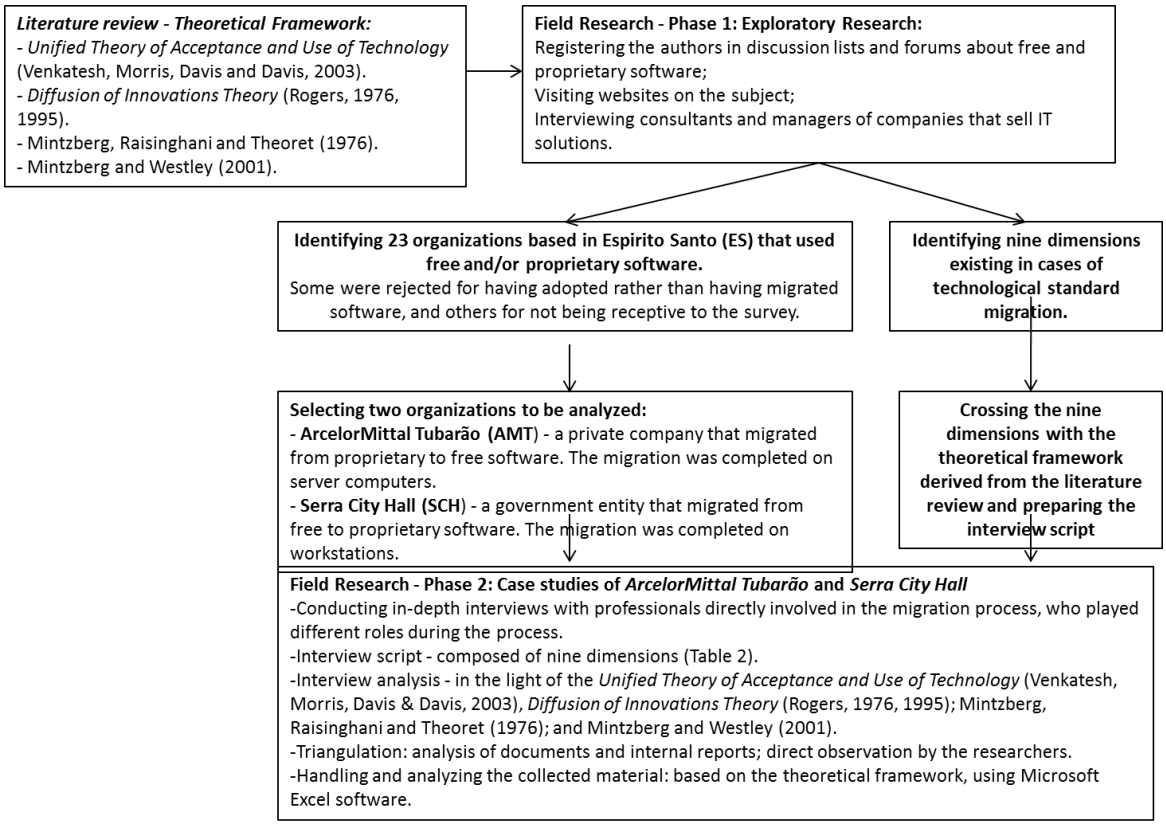
Westley (2001), using Microsoft Excel software. For the purpose of the triangulations proposed in the literature (Yin, 2010; Woodside, 2010), the authors analyzed documents and internal reports that describe the arguments for and against the alternatives considered at the time of the migration decision. The researchers also directly observed the use of the system following migration. The research method is shown in Figure 1.

Figure 1: Phases of the research



Source: The authors

5. CASE 1: MIGRATION FROM PROPRIETARY TO FREE SOFTWARE

ArcelorMittal Tubarão (AMT), a private steel company located in Espírito Santo state, was still called Companhia Siderúrgica de Tubarão (CST) in 2003, when the migration from Unix (proprietary software) to Linux (free software) was implemented. In 2006, the company was acquired by Mittal and was renamed ArcelorMittal Tubarão. At the time of migration, AMT had been in operation for twenty years and was the largest producer of steel plates in the world, with annual output of five million tons and annual net income of R$910 million (Brazilian reais) (Companhia Siderúrgica de Tubarão, 2003).

The migration analyzed at AMT was performed on servers that had IBM's Unix AIX operating system installed. The cost required by a computer that used this operating

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system was considered very high. Unix AIX required the company to invest in computers from a single manufacturer, with spacious hard drive and memory from specific vendors. These computers were based on the RISC technology provided primarily by a single company: IBM. Thus, maintenance was costly and the acquisition of new hardware required large investments, in addition to creating a large dependence on a single supplier, which was not located near the customer. Unix was used only on servers, since the workstations used the Windows operating system.

The Infrastructure Analyst reported that he prepared a spreadsheet for his director, comparing the investment necessary to acquire new RISC-based computers or to migrate to another, cheaper hardware standard, namely the Intel standard, which operated with Linux and Windows. This analysis was sufficient to obtain the support from senior management to migrate from the Unix standard. Thus, the cost of hardware was the indicator that guided AMT's decision to replace Unix.

In principle, the most "natural" path for this migration would be to adopt Windows, since the installed computer base in the company consisted of Unix and Windows. However, another analysis began, this time comparing the technical features of the two operating systems. The conclusion was that for the server environment Windows would be slow, since it runs with a number of graphical features that would not be useful for the services provided by those computers, requiring more powerful hardware, even if it was Intel. Linux, on the other hand, did not overload the machines and, for being simpler, would have a better performance. Another item considered in the analysis was the price of the software license. Windows is proprietary software and its price could not compete with that of Linux, which is free software and, in some forms, also license-free.

The proposal was then to migrate the databases that were running on Unix to Linux. However, this was not so well accepted. The Infrastructure Analyst recalls that employees and management questioned whether Linux was a reliable platform, considering the low adoption rate of Linux in the country. The scenario at that time contributed to this question: a survey published by the Goldman Sachs Group in 2002 revealed that only 39% of American companies were using Linux for any application, especially on servers; moreover, a survey conducted by the Getúlio Vargas Foundation in 2002 indicated that Windows was second to none in the workstation market in Brazil, being used by 97% of surveyed companies.

A second point criticized by management involved support services: who to call in case of problems? Who is accountable for Linux, as it is free software? A strong feature of AMT's IT department is to establish strategic partnerships with leading vendors: IBM, Oracle, Novell, and Microsoft, and to utilize services for these platforms. So, the issue of support was crucial. In addition, Polaris Informática's Consultant, a Unix, Linux and Windows specialist who was already being consulted by AMT in the decision-making process, recalled that *"Windows was well-known. People were reluctant to work on an unfamiliar platform and were afraid of losing control."*

The Consultant also pointed out that opting for Linux as opposed to Unix was not only for the sake of performance: *"Unix is wonderful, stable [...], but it runs on expensive computers. It is proprietary, uses only one supplier and the maintenance contract is*

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expensive. The computer with the Intel standard is more fragile, but now less so, and is cheaper. The license for the software that runs on Intel is cheaper than the RISC-based software". The cost played an important part in the decision: due to the price of the licenses, it was feasible to have more than one computer running the same service so that, in case one of them failed, the other could replace it, even if this required higher expenses on Linux support services, as compared to Windows.

The Infrastructure Analyst reported that there was a long process of negotiation and persuasion before migrating from Unix to Linux and not to Windows. Users, including the decision-makers in this case, had already undergone an unsatisfactory experience of using software that was not developed for the Windows standard. In the early 1990s, they used a Lotus office software package in place of MS Office, the most popular software for editing text and spreadsheets. Senior management complained greatly about the lack of compatibility between these applications. Thus, according to this Analyst, *"There was already a cultural barrier, an aversion to anything other than Windows."* The Analyst stated that the support of the consulting firm that participated in the migration was critical, as they were experts in the three platforms: Unix, Linux and Windows.

The company's Chief Technical Officer recalled that this resistance began to weaken when he learned that Red Hat – the distributor of Linux licenses – had started to invest in paid and official support services. This was a milestone in the decision-making process, because it signaled that if they adopted Linux, they could have support from a vendor. The Infrastructure Analyst's team, together with the team of Polaris Informática, could then carry out a pilot project using a company's system: they changed it from a less powerful computer, which had Linux, to a more powerful computer, which had Windows. The Infrastructure, Support and Development Analysts commented that users began to complain about slowness and poor performance. Thus, the need to replace Unix to reduce equipment and labor costs, coupled with the poor performance of Windows, led AMT to consider Linux as a new option for its technological paradigm.

The company migrated to Linux on 50 servers, which accounted for 25% of the company's servers. In total, the company's installed computer base included more than 3,000 computers, and some 4,000 users accessed the system daily. The migration was carried out gradually in specific sectors of the organization, according to the Consultant, who highlighted the Infrastructure Analyst's able guiding of the process. Respondents reported that it was much easier to find Linux specialists in the market at a much more affordable cost than Unix experts. The old team that operated the system showed great skepticism at first, and fear of losing data, but realized that the processes worked differently in this environment: some features were lost and others gained. What prevailed was the long-term cost advantage.

In 2009, the migration process had stabilized. The Mittal Group, to which AMT belongs, follows the guideline of adopting the Microsoft technology and has little expertise in Linux, with AMT being an exception. The respondents' answers indicated that it is difficult for the company to change this tendency, because the cost aspect is no longer so relevant, since it is a large company that can negotiate packages with

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manufacturers and, even giving up the benefits, the cost is still advantageous. Respondents also highlighted the idea of having one single platform to make the training of staff more financially viable in a large group.

6. CASE 2: MIGRATION FROM FREE TO PROPRIETARY SOFTWARE

The city of Serra is part of the metropolitan area of Greater Vitória and is the largest city in Espírito Santo state, accounting for nearly 20% of the state's gross domestic product.

The CIO began his report noting that in 2005 the Serra City Government (SCG) underwent a technology migration that would later lead to another in 2008 – the subject of this study. However, the migration implemented in 2005 is critical to the understanding of the analysis. At that time, Microsoft Office was the application used to perform everyday office tasks, but the user licenses of this application suite became costly for the SCG, which had expanded the number of its computers. According to the CIO, *"Our migration [in 2005] was based on the cost. Proprietary software [MS Office] was expensive ...The IT staff searched for alternatives and we had an idea: to opt for free software. So we started migrating office applications to OpenOffice, which was very similar to MS Office. "*

With the use of free software, the SCG obtained savings of R$ 640 thousand (Brazilian reais) in the purchase of office applications (Serra City Government, 2008). In addition, the IT department did not have to comply with Law No. 8666/93 (Procurement Act), since they could download the software for free. The CIO added: *"We installed the software and trained the users. Everything seemed fine and the users liked OpenOffice."* At the end of 2005, when the IT staff had already migrated all the computers to OpenOffice, the Head of Network identified a computer that had MS Office installed. Moreover, it was a version installed illegally without paying the license agreement. When the computer user was asked about the reason why he had installed this illegal version, he replied: *"It was the only way to be able to read the files attached to email messages […]. Even a supplier, who had brought his file to some presentation, had trouble opening it here. The solution was to install the other [referring to MS Office] and it wasn't only me [...]; it is common practice in the city government"*. The Network Administrator said, *"That's why we didn't have any complaints about OpenOffice. They weren't using it..."*

When the Mayor complained about the difficulty of exchanging e-mails with attachments due to the lack of compatibility with MS Office applications, the IT team decided to return to proprietary software. It was this migration that this research analyzed. At that time, the number of computers in the SCG had increased from 500 to 2,400 and the city did not have licenses for all the computers. They decided that the new computers should be initially purchased with MS Office and, at a later time, official licenses would be acquired from MS Office to migrate existing computers. Thus, the migration was gradually completed throughout 2008.

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The Head of the City Government Network said that in 2009, the computers still had Office 2003 and OpenOffice, and that *"some users preferred to use OpenOffice but acknowledged the difficulty of adopting a non-dominant paradigm."* MS Office does not recognize the file standard generated by OpenOffice, creating communication constraints. It was the lack of user collaboration that led managers to choose to migrate to MS Office. The CIO concluded, *"Our idea of free software should have been successful, but unfortunately we didn't know how to address the issue of change. Some users are adaptable but there are users who don't use the tool and don't want to help."*

7. CASE ANALYSES

The results of both cases corroborate the idea of Mintzberg (1990) and other authors such as Li, Tan, Teo and Siow (2005), Spirov (2007), and Huysmans et al. (2008), that decision making in the migration from a particular technology standard to another, and the results achieved, are influenced by numerous organizational and informational factors, which go beyond system attributes and user requirements, and that organizational and contextual aspects of systems adoption should be taken into account. Thus, in both cases, the authors identified categories that aligned with the models and theories that study technology acceptance (Venkatesh et al., 2003), along with the dynamism and trade-off of the decision-making process highlighted by Mintzberg et al. (1976), Economides and Katsamakas (2006), Benlian and Hess (2011) and Sacks (2015).

Interviews conducted in the case study of AMT identified the three dimensions that, in accordance with UTAUT, directly and significantly determine the intention to use a given system –*Performance Expectancy*, *Effort Expectancy and Social Influence*– as well as *Facilitating Conditions*, which influence system usage behavior (Venkatesh et al., 2003).

Performance Expectancy

- *Performance*: found in the interview with the Infrastructure Analyst, whose demonstration of improved performance was crucial to convince senior management, in line with the Benlian and Hess (2011) and Kologlugil (2012) studies, among others.
- *Cost*: found at the beginning of the problem, becoming a barrier to the expansion of the computer network on IBM's Unix AIX platform.

Effort Expectancy

- *Unfamiliarity with the paradigm*: a concern expressed by management given the low adoption rate of Linux and the lack of the team's mastery of this technology. Sacks (2015) emphasized this aspect, in stating that the decision about adopting a given software does not involve only quality or price, but also the adaptability of users, who have to expend time and effort to adapt to unfamiliar software.
- *Support:* found in the interview with the Chief Technical Officer, when he

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commented that the company had already suggested Linux because of its performance, but the client was not sure due to uncertainties about technical support services; management asked, "If Linux is free, whose responsibility is it?" This concern was in line with previous research results, such as those obtained by Lee, Kim and Gupta (2009) and Sacks (2015).

- *Limited manpower:* Linux professionals are scarcer and therefore more expensive; this issue has been resolved by training AMT's own personnel.

Social Influence

- *Dependence on a single supplier*: this was found since the beginning of the problem, as having only one supplier represented an AMT weakness; this was recalled by the Support and Development Analyst, who said that the system was stable, but was tied to one type of hardware. As shown in the literature, free software is still a concern (Lee et al., 2009).
- *Fear of change:* illustrated by the interview with the Consultant, who noted that Windows was known at AMT, and that the change to an unknown platform caused a sense of loss of control, as Sacks (2015) noted.
- *Previous experiences:* found in the interview with the Infrastructure Analyst, who recalled a negative experience that users had when using a non-Windows-based software, creating an aversion that would protect themselves from similar situations that caused similar disturbances.
- *Cultural barriers:* the Consultant mentioned that Linux was considered "something for amateurs," expressing a distrust of free software, as pointed out by Lee et al. (2009) and Sacks (2015).
- *Influence from senior management*: AMT had already had an unpleasant experience with non-Windows software and senior management did not look favorably at the low Linux usage rate.

Facilitating/InhibitingConditions

- Change management: heard in the words of the Consultant, when he highlighted the Infrastructure Analyst's ability to lead the migration process as a professional who had calmly and confidently gone through migration in a previous downsizing experience.

Similarly, the in-depth interviews at the SCG demonstrated an alignment with the theory, since the dimensions involving *Performance Expectancy*, *Expected Effort* and *Facilitating Conditions* were identified in the responses of those interviewed.

Performance Expectancy

- *Costs:* drove the migration completed before this survey, but were not considered in this case study, since the migration was from free to paid software versions.

Effort Expectancy

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- *Compatibility of paradigms:* found in the interview with the user who opted for the illegal copy in order to be able to read files attached to e-mails. Again, there is resistance to change, as indicated by Sacks (2015).
- *Usability:* noted in the same interview with the user, who worked at home with one type of software and in the office with another; it is also reflected in the use of illegal versions of software more familiar to the users. The issue of usability is shown in the results of Belian and Hess (2011).

Facilitating/Inhibiting Conditions

- *Change management* : mentioned in the interview with the CIO, when he said that free software should have been a success, but they did not know how to manage the change.
- *User collaboration*: a record of the lack of collaboration is noted when one of the respondents said that in the public sector users are unable to dictate the rules; it is also found in the response of one of the users, saying that the IT team is commissioned and will soon be gone from city hall, while he (the user) will stay.
- *Visibility:* found in the Network Administrator's statement, commenting that he did not have complaints about the use of OpenOffice because users did not use it, and instead used a pirated copy of Microsoft Office.

8. DISCUSSION OF RESULTS

Performance expectancy can be seen in both cases. At AMT, the performance of the Linux server was compared to that of the Windows server, which defined the choice for the latter, considering the option of migrating to the Intel-based server; at the SCG, the expectation of productivity gains with MS Office, a standard for the exchange of files inside and outside the organization, also strongly influenced the decision.

The *effort expectancy* factor was observed in the case of the SCG, where users experienced a great effort to convert MS Office standard files to the OpenOffice standard, but did not when converting from MS Office 2003 to 2007 and vice versa. Although the efforts were similar, the former was more negatively perceived than the latter, affecting the acceptance of the free-standard technology. And the *social influence* factor can be seen in AMT management's concerns regarding the low usage rate of the Linux operating system in companies similar to AMT.

The results allow the authors to state that *cost*, despite influencing the decision to change the technological paradigm, was not the foremost reason in the decision, from the perspective of the respondents. In the case of AMT, some technical factors (performance, technical support, training, previous experience and adoption rate of the new paradigm) and social factors (cultural barriers and change management) were identified. The same applies to the SCG: the factors that motivated the process were technical (paradigm

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compatibility and usability) and social (user collaboration and familiarity with the paradigm).

These results are in line with the ideas of Lee et al. (2009), Benlian and Hess (2011) and Sacks (2015), according to which the effective adoption of free software still faces strong institutional barriers at the social, economic and political levels. Thus, the migrations share the fact that they were not primarily motivated by cost but also by performance and usability. Moreover, in both cases the fact that the solution was either free or proprietary was not the predominant influence on the migration decision, and the statements of the respondents show the importance of usage habits, saving time and effort, as noted by Sacks (2015).

9. CONCLUSION

Although in both organizations studied migration decisions were heavily influenced by technical issues such as performance and compatibility with installed equipment, one cannot forget the importance of the social aspects that may underlie the decision about and the success of software migration. In this study, we chose to research two distinct organizations – a private company and a state entity – to explore the diverse facets that can emerge and make up the complexity of software migration decisions. Thus, the results of this research contribute to the academic discussion about the factors that affect the migration of a technological standard that, as per the case studies, go beyond technical issues, and include organizational, social and contextual aspects of system adoption. For managers, these results indicate the importance of considering non-technical aspects for the success of a system migration process, requiring great managerial ability on the part of those responsible for the process.

It should be noted that this study does not intend to generalize the results obtained, nor to consider that all the factors that influence a technology migration decision were addressed. The UTAUT model, used as a basis for the analysis, can be a limiting factor, since it is a model developed for the analysis of technology adoption and acceptance, in addition to not being adapted to the reality of governmental organizations or of companies operating in Brazil. However, based on some insights from the two case studies, some hypotheses or assumptions are proposed to be tested in future studies in a larger number of organizations, or explored in depth in other cases of technological paradigm migration. Some hypotheses are listed below:

1. Performance is more important than cost in decisions to migrate operating systems.

2. The security of technical support is an inhibiting factor in the decision to migrate from proprietary to free software.

3. Dependence on a supplier is an inhibiting factor in the decision to migrate from free to proprietary software.

4. The influence from senior management is a key factor in any migration decision.

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