



# Financial information management for university departments, using open-source software



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## ABSTRACT

This paper presents a model to analyse the different outcomes generated by the application of Task-Technology Fit (TTF) theory to economic and financial information management in university departments. This model extends that proposed by Goodhue (1995), in two ways: (i) a key role is played by the manager in designing the technology and in performing the task in question. Both of these aspects can be modified, depending on the evaluation made of a series of characteristics (or dimensions) inherent to the model. (ii) The free dissemination of the source code of the application not only allows the transfer of knowledge, but also creates virtual communities which, through collaborative work and the exchange of experiences, can achieve a better fit of the technology to the task at hand. This model has been introduced in several departments at the University of Granada (Spain), and evaluated in terms of the results obtained at both individual and group levels. This evaluation was conducted by means of in-depth interviews with departmental managers.

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## 1. Introduction

Few sectors, organisations or groups have escaped the consequences of the current economic crisis, which is exceptional in both intensity and duration. Public administrations have been particularly affected, having been the object, first, of stimulus packages and then of stabilisation programmes. In addition, they have undergone a marked contraction in tax revenues, which has resulted in severe fiscal deficits in most countries in the euro zone, including Spain. Consequently, measures have been taken to increase revenue (by raising tax rates or creating new taxable areas) and reduce expenditure (by rationalisation).

Spanish universities have sought to rationalise their expenditure and thus improve efficiency in the use of the public resources provided. In this respect, a series of documents have been issued (Carrasco Díaz, 2011; Consejo de Universidades, 2010; Intervención

General de la Administración del Estado (IGAE), 2011; Ministerio de Educación, 2010) addressing both the public and the private sector, aimed at achieving a more efficient use of resources, and connecting this goal with the question of funding.

All of these documents reflect the necessity to determine the real cost of the activities carried out by each area of the university so that these can be analysed and the institution's resources used more rationally (Aartsen, 2011; Denneen & Dretler, 2012; EUA, 2008). In many cases, moreover, the documents highlight the absence of systems for obtaining the requisite information for corrective measures to be taken to improve efficiency.<sup>2</sup> It would be desirable for a set of best practices developed in various universities to be used as a universal reference and generally adopted.

In view of these considerations, this paper presents a model based on Task-Technology Fit theory (TTF) to enable university departments to benefit from the better dissemination and management of economic and financial information. This model (based on a website designed by the authors in accordance with these principles) was applied in a UGR department and produced valuable outcomes both for the individuals concerned and at department level. In addition, a third "global" level could benefit from the introduction of this open-source philosophy.

*Abbreviations:* EU, European Union; IS, information system; IT, information technology; OSS, open source software; TTF, Task-Technology Fit; TAM, Technology Acceptance Model; UGR, University of Granada.

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<sup>2</sup> In fact, Tribunal de Cuentas (2008) has stated that the lack of analytical accounting in public universities has been a limiting factor in the analysis of efficiency and economy.

The rest of this paper is structured as follows: Section 2 presents various problems associated with information system management in academic departments, and the relevant theoretical background. Section 3 shows how we have adapted TTF theory to the present case study, and introduces two new aspects: (i) the manager's role in designing the software and modifying task characteristics; (ii) the positive externalities provided to the community. In such cases, a feedback flow can be generated, and the technology improved. In Section 4, we discuss the results achieved by this innovation, and finally, the main conclusions are drawn in Section 5.

## 2. The management of information in academic departments

The term 'information management system' refers to the introduction, design, development, use and maintenance of the information technology required by an organisation to carry out its activities. Its introduction is not an end in itself, but provides an additional instrument to enhance the efficiency of the organisation, from the standpoint of the management and of the users (including the managers themselves). Managers require tools enabling them to handle information effectively and efficiently, in the same way as if this were a service provided to customers (Van Bon, 2002). Information and communications technologies offer a wide variety of possibilities for achieving this goal, but it must be made clear what is to be modified and how, and any difficulties arising in this process must be overcome (Heeks & Davies, 1999).

In the university context, "management information is data converted to information which allows managers at all levels in all functions to make timely and effective decisions for planning, directing, and controlling the activities for which they are responsible" (Lucey, 1995 as cited in Marcela & Knox, 2004). In recent years, this task has been facilitated by the development of information technologies, which increase and improve an organisation's capacity to manage and exploit available data. However, the relevant question is how people interact with information, not the complexity of information technologies. For this reason, authors such as Galliers and Wilson (as cited in Allen & Wilson, 1997) have identified nine characteristics that determine an institution's capacity to implement information strategies successfully: (i) there is a need to align strategies across all organisational areas; (ii) key stakeholders are involved in the process of formulating strategies; (iii) the process allows opportunities for debate and consultation; (iv) the process is reviewed on a regular basis; (v) the approach taken fits the organisational structure and culture; (vi) motivational issues are important, and are implemented for internal reasons, not simply to satisfy an outside body; (vii) those who implement the strategy feel that they have ownership of the policies; (viii) the process has a powerful champion; (ix) the strategy is adequately resourced.

Marcela and Knox (2004) identified several problems associated with existing information systems in universities: a lack of cohesion, consistency and reliability across data sets; no single institutional responsibility for the data and information management function, with resultant uncertainty about lines of responsibility; confusion and frustration arising from the multiple sources presently existing; concerns about the location of data and its appropriateness to user needs; and a lack of flexibility within the system. Huntley-Moore and Panter (2003) highlighted another reason for the difficulty encountered in implementing information strategies, namely the impact of each academic discipline culture on department heads' perceptions of their management roles and associated development needs. In consequence, these authors recommended that training programmes should be implemented for the heads of department, taking into account perceptual differences

between academic disciplines. Thus, information systems can be designed in various ways, but the first priority is for the heads of department to be committed to the issue, to ensure it is addressed in a meaningful way.

To make management information in academic departments easier, efficient, consistent and effective, Greene, Loughridge, and Wilson (1996) made various recommendations: universities should identify the perceived or anticipated management information needs of heads of departments, and address the question of how those needs may be satisfied more effectively; steps should be taken to clarify and simplify the structure of information provision pathways; more effectively structured training should be provided to refresh or update managerial skills; university finance officers should re-examine the relevance of the economic and financial information they supply to departments, as well as the form, manner and frequency of information communication; finally, universities should consider the balance between the administrative or managerial role of heads of department and their teaching and research duties.

The fundamental question underlying all these problems, and which must be addressed to achieve a valid solution, is that of how all the members of a university department – management, teachers and administrative staff – can improve their productivity and efficiency through the appropriate use of information technologies (IT). Although the latter are becoming increasingly user friendly, the real problem is often that of an inadequate adaptation of the technologies to the task at hand. Many previous studies of IT utilisation have suffered from the absence of a strong theoretical foundation. Although the concept of IT originated in the 1960s, and it is rooted in organisational literature (Perrow, 1967; Thompson, 1967), organisational research has emphasised the fact of a 'cumulative tradition' in information systems, to which considerable attention has been paid. Landmark theories in this field include the information systems success model (DeLone & McLean, 1992), the unified theory of acceptance and use of technology (Venkatesh, Morris, Davis, & Davis, 2003) and the technology acceptance model (TAM) (Davis, 1989).

The TAM, which has extensively influenced management information systems, is a specific adaptation of the theory of reasoned action model to the study of information systems. According to the TAM, behaviour is determined by intention to perform the behaviour. As Dishaw and Strong (1999) say, "Davis' research, in essence, examines the external variables which determine or influence attitude towards IT use. The TAM identifies perceived ease of use, and perceived usefulness as key independent variables. Perceived usefulness is also influenced by perceived ease of use. The TAM includes the very important assumption that the behaviour is volitional, which is to say voluntary or at the discretion of the user". However, a weakness of TAM is its lack of task focus, because its application to the evaluation of acceptance, use and performance has obtained mixed results. For example, while it is useful for predicting system usage, TAM is less valuable for explaining the relationship between system usage and task performance. In addition to this limitation is the fact that user perceptions may not match objective assessments. As a result, the TAM may fail to understand (or evaluate) whether IT is truly useful for investigating tasks related to IT usage (Nance & Straub, 1996). For this reason, a more explicit inclusion of task characteristics may provide a better model for IT utilisation.

This problem has been apparent since the mid-1990s, when IT were coming into extensive use. A few years after Davis' seminal paper, another model was proposed to address this problem. Various authors (including Goodhue, 1995; Goodhue & Thompson, 1995; Zigurs & Buckland, 1998) had paid special attention to these interrelationships, and their articles constituted the starting point of a theory that has been used to identify the key factors

determining the appropriate use of technologies so that users may achieve their goals. As Goodhue (1995) says, “What is needed is the identification of some theoretical perspective that usefully links underlying systems to their relevant impacts, and the definition of a specific user evaluation construct within that perspective”. This theory has been termed Task-Technology Fit (TTF) and it is one of the most important developments in information system theory.

TTF theory<sup>3</sup> argues that information systems can increase the outcomes of users when IT match the task they must perform, depending upon its configuration and purpose (Goodhue & Thompson, 1995). Under TTF theory, “fit” is a key concept, because organisational effectiveness is considered to depend on the extent to which organisational variables fit the context in which the organisation operates. Goodhue and Thompson (1995) argue that fit can be assessed by evaluating the extent to which a technology deviates from a theoretical profile of ideal characteristics, and developed a measure of TTF consisting of eight IS capability dimensions: (1) data quality, (2) data locatability, (3) authorisation to access data, (4) data compatibility, (5) ease of use/training, (6) production timeliness, (7) systems reliability, and (8) IS relationship with users.

These measures have undergone numerous modifications to suit the purpose of particular studies, but their flexibility provides relatively comprehensive instruments for measuring user perceptions of TTF and can explain why in recent years there has been a notable increase in the use of TTF, whether individually or extended to other points of view. As a result of its flexibility and capacity to incorporate different elements, TTF has been adapted to many fields of knowledge. Cane and McCarthy (2009) present a meta-analysis of the differences in the definition of the theory itself, the various research methodologies utilised to explain the theory and the contexts in which the theory has been applied. Survey-based TTF research has been conducted in a wide range of organisational contexts, but as Furneaux (2012) says, “This work has, however, tended to be based on different research model specifications and inconsistent construct measures”. In comparison to more quantitatively oriented survey and experimental studies, relatively little attention has been given to examining TTF using qualitative techniques such as interviews and case studies.

### 3. Application of TTF theory to managing economic information in university departments

University departments have traditionally lacked expenditure control systems, even though their teaching and research specialisation would readily enable such systems to be developed. In the best of cases, the only control consisted of a spreadsheet in which each teacher was assigned a column, but for which either there were no clear, explicit criteria for distributing the budget available (such as item limits, spending ceilings per teacher, the use made of budget surpluses), or if there were, they were unknown to many staff members. Consequently, all expenditure requests were directed to the head of the department, who was ultimately responsible for the payments made. This situation overloaded the head of department or even, in the worst cases, provoked the risk of inappropriate payments (by amount or concept) being made, given the high level of discretionality and the absence of transparency in this system. Other undesirable effects included, on the one hand, a manifest inequality between some teachers and others, with a small number of persons accounting for a substantial proportion of the spending, and on the other, the lack of any incentive for responsible use of financial resources, in the absence of any reward (individual or collective) for efficient management.

Moreover, it is normal for part of each department’s budget to be subject to meeting the targets (both common and specific) set out in contracts<sup>4</sup> signed with the universities, foundations or companies, thus directly linking budget allocation and specific objectives, which highlights the importance of these issues. This circumstance, together with the above-described situation, justifies the implementation of measures for expenditure planning, information and control. This accounts for the widespread interest in achieving better management of economic and financial information, not only because of the financial consequences, but also to achieve broader goals. In some cases, innovations in departments’ economic and financial management have enabled them to achieve the following goals in the field of university international excellence: (i) enhanced cooperation between teachers and administrative personnel, involving both groups in the development of applications aimed at improving economic and financial management; (ii) participation in the model of sustainable economics, primarily through resource savings.

Clearly, this question presents multiple dimensions: (i) individual decisions on spending; (ii) the workload imposed on administrative bodies and personnel; (iii) the linking of funding to the fulfilment of objectives; (iv) creating synergies among the various parties involved; (v) commitment by all concerned to environmental sustainability; (vi) generating positive externalities through knowledge dissemination based on open-source culture. It is not sufficient just to create a mechanism for transmitting economic and financial information to and from university departments; it is necessary to go further and design a global economic and financial system to successfully address these challenges. Fundamentally, what we are proposing is an enhanced information system based on the technology resources that are most appropriate for the different tasks to be performed, both by the parties directly involved (the university department) and by the university community as a whole, and even by the business world.

As stated in the previous section, Goodhue proposed the analysis of eight dimensions to evaluate the fit of the technology application to the task presented. However, different situations of information systems management require the TTF model to be adapted to the circumstances in question, which in the present case concern the economic and financial management of university departments. To this end, we apply Goodhue’s model, but from another standpoint: instead of evaluating the fit of the technology to the task, in terms of the different dimensions it presents (*ex post*), these are viewed as intermediate objectives, which will contribute to achieving the ultimate goals. Under this approach, we design a technological application that meets these requirements (*ex ante*). Once the application is in operation, the TTF model could well be applied to evaluate the degree of success obtained – and this would almost certainly be much greater than if these dimensions had not previously been taken into account. Furthermore, the results obtained could be used to improve the application, in a feedback process that would be facilitated by the direct involvement of the managers in the design, implementation, management and evaluation of the software application.

The starting point for the proposed extension of the TTF model (see Fig. 1) is the organisation manager, in a broad sense, who may be an individual with comprehensive knowledge of the task to be

<sup>3</sup> Furneaux (2012) presents a survey and synopsis of the literature on TTF theory.

<sup>4</sup> In Andalusia (Spain) this contract is called “Programme Contract” and involves applying to the entire university community the targets set out in the Andalusian Public University Funding Model 2007–2011. These targets are defined in the Programme Agreement signed between the UGR and the Ministry of Economy, Innovation and Science of the Junta de Andalucía. For all the UGR departments, the provision in this respect for 2012 was 574.58 million euros, representing 12.75% of the budget credits allocated to them.

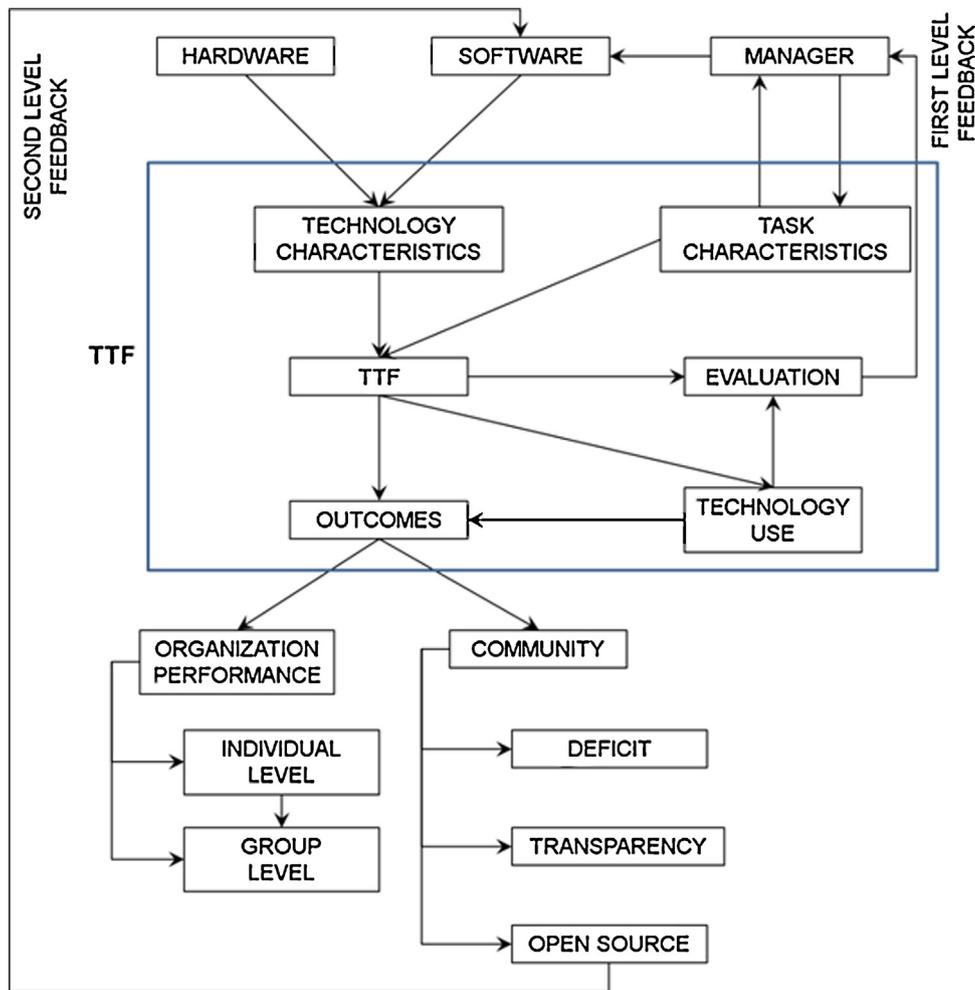


Fig. 1. Research model for TTF in university departments.

Source: The authors, based on Goodhue (1995).

performed or, preferably, a committee composed of administrative staff, users and the departmental management, thus incorporating all points of view. This ‘manager’ will be well acquainted with the characteristics of the task at hand and will be able to adapt them in accordance with the needs of the department. In this respect, a close working relationship should be maintained with the computer programmer to ensure that the software features are well matched to the characteristics, interests and goals of the users of the application, as these questions will largely determine the characteristics of the technology applied.<sup>5</sup> Once the technology has been adapted to the characteristics of the task, its degree of fit must be determined. To do so, we first analyse the degree of compliance with the minimum requirements of any management information system, which correspond to Goodhue’s “dimensions”:

1. Data quality is ensured by the use of the official data from the departmental accounting system, which are periodically checked against those entered into the TTF application.
2. Production timeliness. The administrative personnel enter data into the system in real time, as expenses are paid and revenues received.

3. Transparency, to reveal the fair distribution and allocation of budget resources and thus enable customised listings.
4. Accessibility, i.e. ready availability to department members, such that all necessary information can be consulted, categorised by appropriate criteria. Moreover, the application can be directly accessed on the department’s website.
5. Flexibility. The application must be valid for any department, regardless of the criteria applied for budget allocation, requiring only the details for personal data and regulations applicable; for this purpose, a help link is provided on the website.
6. Ease of use. At all times, users’ queries and system administration are handled in the most intuitive way possible.

Although a high degree of compliance with these requirements is to be expected, as they were defined by the manager and taken into account in designing the application itself, the true value of the system will be revealed with the practical use of its technology and its contribution to achieving the department’s ultimate goals. A detailed analysis will complement the initial evaluation, highlighting possible weaknesses or issues not taken into account in designing the application or in evaluating the TTF model. All this information will be considered by the manager, to propose improvements in the application and, when appropriate, better definition of the tasks to be performed. This stage will represent a first level of feedback in evaluating the model.

<sup>5</sup> As many applications make use of an on-line database support on dynamic web pages, the hardware requirements are of secondary importance, except perhaps as regards access to them via different devices.

Depending on the fit between the technology and the task and the use to be made of this technology, two types of results will be obtained: those benefiting the organisation and those benefiting the whole community. With respect to the organisation, both individual and collective benefits can be obtained. Obviously, success at the individual level will contribute to the better functioning of the department, not only due to the greater transparency of the system, but also because the greater or lesser availability of financial resources for the department as a whole is the result of the sum of individual decisions. Community-wide benefits will include the contribution of the department to compliance with government targets such as budget stability and transparency.

Moreover, we have introduced into the model a second level of feedback in which the application was open source and freely distributable under the GNU licence (version 3). Thus, not only the departments of the institution (in this case, the UGR) benefit, but also any other public or private organisation. Improvements in other areas and the sharing of experiences will enhance the application and give rise to collaborative dynamics with a positive impact on the task-technology fit. This approach is focused on public administration (but it can also be extended to private firms) and allows us to introduce new, relevant aspects (both individual and at the organisational level) in TTF theory, which are developed in the next section.

#### 4. Open source software as a detailed instance of TTF theory

The term “open source” is applied to software development projects based on the contribution of collaborators who may be geographically dispersed but who remain in online contact with the project. The basic requirement for the feasibility of an Open Source project or OSS is that its source code must be made available; however, this does not merely mean access to the source code – the distribution terms of open-source software provided by Open Source Initiative ([www.opensource.org](http://www.opensource.org), last accessed 12/3/2013) must also comply with other criteria. Furthermore, according to [Madedy, Freeh, and Tynan \(2002\)](#), this option must be distinguished from the increasingly common practice among commercial software publishers of only releasing the binary executable versions of the software. Most open source software is also distributed at no cost with limited restrictions on how it can be used<sup>6</sup>; the term “free” when used to describe open source carries two meanings: (i) freedom to the user to modify and innovate on top of the existing source code, which may be redistributed and reused in other projects ([Fitzgerald, 2006](#)), and (ii) the software is available for download without charge. Although OSS only mentions the first meaning, in fact, both are included, and there are no significant differences between the terms OSS, FOSS (Free and Open Source Software) and FLOSS (Free/Libre Open Source Software).

Although an increasing number of organisations are incorporating OSS in their IT portfolio ([Ghosh, Ramakrishnan, & Khuntia, 2013](#)), the public sector has specific requirements that need to be addressed in developing a community-focused model. Its applications are usually (although not exclusively) associated with an open-source licence and are intended to benefit a specific community of users on a particular application domain ([Driver et al., 2009](#)). As [Okoli and Carillo \(2012\)](#) say, “most information systems managers think of open source only in terms of being an interesting type of freeware (which in fact it often is not, especially for enterprise-grade applications). Few have even considered that it might possibly be a feasible systems development methodology

that is flexible enough to meet the challenges they face in their software development projects”.

Public access to information is essential both for proper democratic functioning and for the productivity of the economy; being able to access, use, investigate and innovate from the data provided by the public sector adds value to society as a whole. But for this to be so, the culture of open resources must become more widespread, and this requires not only a different mentality among stakeholders, but also the implementation of appropriate strategies by the governing bodies. Although such strategies are based on various principles, [McMillan \(2012\)](#) highlighted the following: (i) the information must be visible and readily accessible; (ii) there must be open access to information, unless otherwise required by the situation; and (iii) an information-recording system must be created and maintained.

The advantages for public administrations in using web-based information management systems are not limited to the greater budget control and efficiency obtained regarding the organisation or cost centre, but extend over multiple dimensions when such systems are based on OSS. By this means, the public administration can reduce costs (and therefore reduce its deficit), add value to the private sector,<sup>7</sup> promote competitiveness and contribute to the sustainable development of economies on the basis of knowledge and open innovation.

In many areas of government, open source software is being used to develop applications for the performance of routine management tasks. In some cases, there are even employees whose task is to contribute to the creation of an open source code base, working in projects (also known as communities), led by or involving public agencies, whose goal is the development of OSS in the public administration ([Bryant & Ramsamy, 2011](#)). Although the use of these applications remains limited and its market penetration low, the need to replace legacy applications, combined with the reluctance to be locked into application vendors can explain the ambition to accelerate their development. The business impact is limited because the applications include those for which no mature market solutions are available or, if available, they lack the necessary flexibility

The development and application of this type of software is a key element in improving government computing systems, as has been recognised in Spain<sup>8</sup> and throughout Europe through initiatives such as e-Europe and EU recommendations in this respect. However, the successful outcome of these projects requires the continuing involvement of stakeholders in the adoption of OSS, because otherwise the frustration generated could lead to the project being abandoned ([Fitzgerald, Kesan, Russo, Shaikh, & Succi, 2011](#)). Before undertaking a community source project, it is necessary to confirm the existence of a well-identified, sustainable community of users and developers, who all have a clear business case for participation and support. Moreover, it should be taken into account that if frequent problems arise during integration with existing systems, this could lead to outright rejection of OSS ([Fitzgerald, 2009](#)). Therefore, governments should take an active

<sup>6</sup> Although many OSS advocates have proclaimed these advantages, several authors have also questioned them or expressed doubts ([Feller & Fitzgerald, 2002](#); [Ven, Verelst, & Mannaert, 2008](#)).

<sup>7</sup> However, some authors believe the development of OSS may delay innovation and technological advances, and have highlighted disadvantages such as insufficient documentation and/or technical and training support, overwhelmingly frequent releases of patches and software version upgrades, and constraints imposed by the various OSS licence terms ([Gwebu & Wang, 2011](#)). On the other hand, according to [Samoladas, Stamelos, Angelis, and Oikonomou \(2004\)](#) “there is strong evidence that projects with clear and widely accepted specifications, such as operating systems and system applications, are well suited for the OSS development model.”

<sup>8</sup> The National Centre for the Application of Open-Source ICT aims to promote the awareness and use of free and/or open source software in all areas of society, with special attention to public administrations, businesses, the technology sector for suppliers and/or users of free technologies, and development communities.

role in promoting standards for the OSS process (Madey, Freech, and Tynan, 2002), even if technological and organisational mismatches may occasionally be encountered.

Public administrations need to motivate their workers to share organisational knowledge (information, technology, know-how and skills), which constitutes a valuable resource and potential source of capabilities and competencies for innovations. Endres, Endres, Chowdhury, and Alam (2007) outlined four steps in the knowledge process: socialisation (spending time and actively working together on solving problems), externalisation (expressing knowledge in a comprehensible form), combination (converting explicit knowledge into a complex set of knowledge) and internalisation (converting explicit knowledge into the organization's tacit knowledge). Appropriate development of the knowledge-sharing process is dependent on individual cognition and is related to individual and organisational goals. When those involved believe in their ability to perform a specific task, the task will probably be achieved and the organization's goals met. For this reason, it is impossible to separate individual and organisational performance in any organisation, including, of course, those in the public sector. Chen, Li, Clark, and Dietrich (2013) examined team cognitive mechanisms that can facilitate knowledge sharing in OSS teams, taking into account that while knowledge sharing is a cognitive task, an OSS team is a complex cognitive system. These authors adopted the perspective of a transactive memory system to explore its relationships with knowledge sharing, communication quality and technical achievements by OSS teams.

The versatility of TTF allows us to consider specific instances that enhance the contribution of OSS to this theory. Thus, we have identified both organisational and social factors; in fact, these are just different aspects of a single global phenomenon of knowledge creation and sharing. These factors, incorporated in our TTF model, are corroborated by organisational success and by theoretical research. Some studies also include technical features, such as compatibility and trialability, which are taken into serious consideration by managers when deciding whether or not to adopt OSS.

Organisational factors are the characteristics and resources that characterise an organisation. These factors have received considerable research attention and present both constraints and opportunities for successful OSS adoption. Qu, Yang, and Wang (2011) identified the following key factors in this respect: firms are more likely to adopt OSS when they have the necessary technical skills; prior experience with proprietary software, which may reduce the propensity to adopt OSS due to switching costs; managers' stance towards IT innovation; decision-makers' ideology; and the presence of boundary spanners. Gebauer and Ginsburg (2009) argued that a good match between the organization's information systems and its tasks and context is very important to system success. As the choice of individuals can significantly affect performance, Liu, Lee, and Chen (2011) added 'individual' as a further dimension in their TTF framework. In this respect, Basaglia, Caporarello, Magni, and Pennarola (2009) proposed a theoretical model in order to understand the factors which influence individuals' attitude towards convergent mobile phones and intentions regarding their use. This approach can be extended to other fields of IT, including OSS.

On the other hand, environmental factors can influence an organization's decision on whether or not to adopt OSS; for example, political pressures can exert a two-fold influence: on the use of commercial software for organisations (businesses, agencies, schools, universities, etc.) that are dependent on the government; and government policies to support OSS development (when the government informs potential users about the existence and the characteristics of OSS, or makes a payment to those who adopt OSS). The successful adoption of these new technologies by governments will depend on how well the strengths of proprietary software and

OSS are understood and applied – especially with respect to the use of open standards to speed up the deployment of integrated capabilities in response to emerging challenges (Simon, 2005).

An additional factor considered in our model is related to the success of OSS from a community point of view. Many open source projects have no clear community structure or involve just one person (Gacek & Arief, 2004), and so achieve little social impact. The benefits of attaining a higher project profile are reflected in the creation of a larger base of users and programmers (Subramaniam, Sen, & Nelson, 2009); a successful OSS project will benefit from the input of skilled professionals and build up its own reputation on the basis of their individual capabilities and reputations (Mendez-Duron, 2013). It has recently been argued that the adoption of social networking tools is the most preferred system of knowledge management due to their ease of use and characteristics as a social phenomenon (Lee & Lim, 2011). Among these tools, particular attention should be paid to the use of online resources dedicated to open source projects. These websites are a form of collaborative software used by people worldwide and their dynamics can be analysed by addressing TTF to the question of the social technical gap, i.e., the gulf between what should be socially supported and what can be technically achieved – this can be conceived of as a specific instance of TTF. As Dwyer (2007) says, "social requirements are a sub-set of requirements that make up social tasks, such as communication, coordination, and cooperation. Therefore the Social Technical Gap describes the lack of fit between social requirements and technical solutions".

This extension of the TTF model discussed in Section Three will explore two additional dimensions: OSS characteristics of the tasks carried out by employees in their day-to-day activities, and the consequences of OSS for community knowledge creation and sharing. In the next section we will focus on analyzing the varying degree of integration in our model of this set of issues related to OSS and TTF.

## 5. Results

On the basis of these considerations and the authors' experience in economic and financial management, we have created and implemented a dynamic web application. In implementing the system, we chose to apply a Model View Controller architecture, which divides an interactive application into three components: (i) the model, which contains the core functionality and the data; (ii) the view (or external schema), which provides information to the user by generating events and access to the model; and (iii) the drivers, which update the view and act upon the model. The proper functioning of a system such as this requires a well-designed database, which in turn must be derived from the reality that is of interest to the system and respond to the demands corresponding to it. The direct involvement of departmental financial managers in the design of the application, from the outset, has (for the first time) achieved a high degree of fit between the tool created and the task at hand.

However, the objectives and usefulness of the system for the departmental management team are not the same as those for other users, and hence two websites have been designed: one for all staff, and one for the managers. In the first case, the application allows university department staff, subject to authentication, to monitor the expenses incurred and the funds remaining, in real time, and to access all kinds of economic and financial information. Thus, over 30 different inquiries can be made, meeting the information needs of even the most demanding user. Furthermore, users can generate automatically annual reports, and consult all the issues addressed by the Department Council in the area of financial management.

To make this possible, it was necessary to create another web-site (with higher levels of access security) to provide input to the system, managed by the administrative head of each department. This higher-level application is used to introduce the expenditure information for each staff member as the general data available, or even the configuration of the database, including the possibility of making consultations over and above those available to all users. All of this is achieved straightforwardly, accessible so that any departmental manager can handle the system, without requiring previous knowledge of computer programming.

The design and implementation of the application requires the participation of all involved (end users, administrative staff and department managers); any lack of motivation in the initial phases of the project could hamper its development, and non-awareness in the test phase could lead to some users not clearly perceiving the advantages of this technology and therefore being more reluctant to accept it. This would be the case, especially, of persons less familiar with such technology, and of the older population. For this reason it is very important to ensure the proper functioning of the application and that it meets the needs of all users. In turn, this requires an ongoing evaluation of the application (particularly during the implementation stage) concerning the degree to which it is suitable for the task at hand, and the use made of it.

In order to determine whether the project succeeded in its aims, we interviewed the main users of the system, using a qualitative methodology of in-depth interviews. It was observed that the administrator found it useful to include a reference number for each invoice (to facilitate its localisation), while the management team wished to have the reports automatically generated and to be provided with a breakdown of some types of spending. In relation to the use of this technology, on occasion users did not access the system (for example, to consult the regulations or to ascertain their budget balance) but preferred to address their queries to the administrator, thus increasing his/her workload. We also identified the following dysfunctions: (i) the maximum annual expenditure per teacher was found to be insufficient, and (ii) the provision of a maximum annual expenditure led some to believe that these resources were freely available. These issues did not affect the application itself, but rather the parameters applied to it and the administrative procedure, respectively. Ultimately, the information obtained from these interviews allowed the managers to assess the suitability of the application for the task for which it was designed, and the use made of it. The conclusions drawn led to certain aspects being modified, as necessary. We termed this process “first level feedback” in our research model for TTF in academic departments (Fig. 1).

The implementation of the model produced these positive findings:

1. Department members. Reported increased accountability in the use of department resources, through: (i) a heightened perception of the expenditure incurred; (ii) full knowledge of the funds available; (iii) awareness of the cost of the products used; and (iv) access to all regulations affecting the department’s economic affairs.
2. Management team. Improved control was observed with respect to: (i) individual expenses, advising staff members approaching their spending limit; (ii) invoices presented by suppliers, highlighting the possibility of seeking alternatives, and/or detecting errors; and (iii) the overall evolution of the budget (by concepts, items, etc.) in both absolute and relative terms.

As can be seen, the application of this system was considered positively by all departmental members (users and managers), and the individual improvements observed had a direct impact on the overall functioning of the organisation, both as regards information

(accessibility, transparency and flexibility) and budgeting (cost control and compliance with objectives). Moreover, to the extent that the department forms part of the public administrative system, its proper functioning contributes to achieving public goals.

At a broader level, the implementation of this software can benefit the whole community, in two ways: by its provision to all who wish to use it, and through the free availability of its source code. In coherence with our belief in the philosophy of open resources, this application has been released by the UGR, through its Office of Research Results Transfer and the Free Software Office, making it available to the entire university community. Thus, the application (with its installation instructions) can be freely downloaded from <https://github.com/emelchor/gestorgastos> and can be redistributed and/or adapted in accordance with version 3 of the GNU Affero License (<http://www.gnu.org/licenses/>).

This action is aimed at extending the use – and thus the benefits – of the application to other departments of the University, and at creating a community of teachers, managers and software developers to support the project, enabling it to expand and improve. This we term “second level feedback.” However, the presence of an application in a forge does not in itself guarantee awareness and dissemination, especially if it has been designed and implemented by a relatively small group of persons. In the case in question, a significant proportion of the people who have expressed interest in the application became aware of its existence by verbal references (direct or indirect), although the UGR Free Software Office had issued a press release informing the entire educational community of the project. Therefore, and as observed in Section Four, the involvement of the public sector is essential to foster the introduction and use of such applications, either in the form described in this paper, or by offering it as an integrated part of the institutional databases in computerised administration services.

## 6. Conclusions

The management teams of university departments have teaching and research responsibilities and, in addition, their administrative work, in which a great deal of information must be processed. By carefully selecting the most relevant data and making it available to all department members, management transparency will be increased, the control of revenue and expenditure facilitated, and users of the system made more aware of the economic impact of their decisions. In short, a system like this leads to a more efficient use of public resources. Information and communications technology is an important aspect of this task, and the web application described contributes to achieving the above goals.

The system is currently operational in a UGR department, and has been awarded the Campus of International Excellence prize of the UGR, reflecting this institution’s interest and recognition. The most tangible result of the system is the subsequent generation of a year-on-year budget surplus, increasing the balance available to the department. The new system has also greatly facilitated the economic and financial management tasks carried out by the administrative staff. Our experience in the introduction of this system has revealed that it is first necessary to define clear, agreed and transparent cost allocation criteria, taking into account the real situation of each department (composition, history, area of expertise, etc.) in order to minimise the need for subsequent adjustments.

Building tailor-made applications for economic and financial management is of increasing importance for all types of organisations. The complexity and variety of IS and software make it necessary to create interdisciplinary teams to share knowledge and to apply methodological developments to management issues. For this reason, the tool described in this paper is available (in Spanish) in open access and has an open source licence, so that users can

adapt it to their own specific needs. Building a network of managers making use of this instrument could be a very good strategy to improve the tool, our knowledge of the subject and our way of addressing it. The creation of a network of managers in university departments could be enhanced by connecting the software to the university's corporate databases in a web hosting service that teachers, staff and heads of department can access and where online inquiries can be achieved as and when needed, thus obtaining synergies and collaborative experiences.

We hope the technological characteristics and features provided by our platform will encourage other departments and researchers to study the fit between the tasks performed by academic staff and the technological features offered by this networking tool. Moreover, we would be pleased if this software thus inspired managers in other fields of study who share our organisational aims.

Some issues for future research emerge from this study. In particular, future research should:

1. Examine the compatibility of the software with other information systems within the organisation, in order to analyse the context for its integration.
2. After confirming its compatibility with the other systems, analyse the possibility of extending its use to other centres within the organisation. In this respect, future research could adopt a longitudinal perspective in order to compare attitudes and intentions at different stages of the adoption process (Basaglia, Caporarello, Magni, & Pennarola, 2009).
3. Measure the degree of acceptance of the system and its real value for decision making. To do so, an analysis taking into account sex, age and educational background should be carried out in order to characterise the users and the cultural dimensions that may be involved.
4. Finally, it would be interesting to associate with the application a scoreboard indicating the action to be performed. Another area of interest, in this context, is the possibility of applying question-answering technology (Robles-Flores & Roussinov, 2012).

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