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Investigating the uptake of educational systems by academics using the technology to performance chain model

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Abstract

Purpose – The purpose of this paper is to explore the relationship between the perceived performance, software usability, and attitude of academics to use online technology to perform their tasks in the academic context.
Design/methodology/approach – The paper assesses the acceptance and utilization of university lecturers for an online educational system using the technology-to-performance chain model. The evaluation process is conducted via an online survey which is administered to 180 university staff meanwhile objective measurements describing the actual utilization are considered during the analysis. Partial least squares path modeling is used in this study in tandem with other statistical methods to test the significance and influence of different constructs and factors related to the user.
Findings – The usability of information systems plays a crucial role compared to the attitude and social norms for lecturers to actually utilize technological products. Meanwhile, the TTF is observed to have more influence than the actual utilization for the perceived impact on performance. For the individual's characteristics, the study indicates that the age is an influential factor on the utilization and performance in contrast to the gender which has a marginal impact.
Originality/value – The study describes a model to assess the acceptance of technology by academics based on combining self-reported data and objective quantitative measures which describe the actual utilization of the user. Further, the usability estimated using the well-known System Usability Scale is integrated within the developed model to reflect the ease of use for technology. Further, covariate analysis is conducted to explore how different types of users interact and react to educational systems for different factors including age, gender, academic qualifications and experience.

Keywords Technology acceptance, Usability, eLearning, Human behaviour, TPC, User performance
Paper type Research paper

1. Introduction

Due to the unprecedented use of computers and smart devices combined with the availability of internet connectivity in most places, information systems are becoming ubiquitous and integral part of our daily life in such a contemporary era. The use of online technology at academic institutions has greatly reshaped and transformed the way we teach, work and conduct research. Software systems are designed to assist students and

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academic staff in performing their tasks more efficiently and effectively. Considerable amounts of funding are being spent to modernize and deploy information systems in order to improve individual and institutional performance. This is eased with the emergence of a new generation of undergraduate students being considered as the digital natives who have grown up for their whole lives surrounded by the use of computers, smart phones and online technologies (Joo and Choi, 2015). Although there are advocates within the university community who still prefer traditional teaching methods which include face-to-face communication, considerable efforts are being devoted to promoting the use of new technology and e-learning for course delivery, communication and research. Numerous recent studies (McGill *et al.*, 2014) have argued that educational innovations can wither and be subverted if technological initiatives are not embraced and maintained by university lecturers. In fact, academics play a pivotal role for the uptake and success of digital infrastructure via enriching the e-learning platforms with pedagogical materials to supplement their teaching activities in addition to publishing their e-textbooks and research contributions on the library repositories.

As more and more academic institutions have opted to use online technology for their course delivery and pedagogical activities, there has been an increasing interest in understanding the factors related to the acceptance and adoption of online information systems by higher education staff in order to devise strategies and to enhance and improve the teaching and research quality. Further, research on e-learning systems in addition to the linkage between information systems and staff performance have attracted unprecedented interest in order to better apprehend how effective and usable e-learning systems are in terms of principles related to human computer interaction (Navimipour and Zareie, 2015; Bringula, 2013; Escobar-Rodriguez and Monge-Lozano, 2012) and human behavior (Roca and Gagné, 2008; Liaw *et al.*, 2007). Numerous research studies concern the analytical quantification of the various factors that determine and shape software usability (Albert and Tullis, 2013; Hornbæk, 2006) and analyze the human behavior. Most examined covariate factors are related to the user, such as age, academic level, social status, gender or specific impairments (Pariente-Martinez *et al.*, 2016; Mentes and Turan, 2012). In spite of the fact that there are numerous research studies on child-computer interaction, performance rates of older people and accessibility for users with special needs, most web applications are designed and developed for younger people whilst ignoring other groups of users with specific requirements. Without doubt, studying these factors along with the involved constraints of these groups is crucial in order to enhance the software usability and user acceptance by adapting the graphical interface to suit different user requirements.

Positive user experience emerges as an important pillar for the adoption of educational learning systems. This is mainly because the availability of technological infrastructures and systems is not adequate to enforce the uptake of new educational approaches from the academic community (Persico *et al.*, 2014; Phillips *et al.*, 2012; Laurillard *et al.*, 2009). Considerable criticism regarding the quality of existing e-learning systems are being cited by a number of studies (Chua and Dyson, 2004) in addition to further issues including low performance and poor usability. The usability nature of educational software systems is defined as the extent to which a product can be easily used by specified users to achieve certain goals with effectiveness, efficiency and satisfaction (Mayhew, 1999), and it is a key characteristic to achieve the acceptance and adoption for academic staff regardless of their background, experience or orientation. The satisfaction part is related to how the users believe or feel positively that the system meets their requirements (Lee *et al.*, 1995; Capece and Campisi, 2013; Islam, 2014; Yeh and Lin, 2015). Meanwhile, other researchers have defined satisfaction as the gap between the expected gain and the actual gain when using the system (Tsai *et al.*, 2007). There is an emerging body of literature on relating the usability aspect of information systems as important factor to influence the human behavior to accept new technological products (Harrati *et al.*, 2016).

Due to the lack of research studies devoted to investigate the acceptance and adoption of information systems by university academics for using e-learning applications (Hrtoňová *et al.*, 2015; Šumak *et al.*, 2011), we conduct in this paper an empirical study to analyze the human behavior, infer the individual performance and assess the satisfaction level of how academic lecturers interact with the online university portal. As opposed to using only subjective data collected from questionnaires administered to a set of participants, this study is based on the use of subjective self-reported evaluation in tandem with objective measurements describing the actual usage of users. In order to infer the degree of fitness of how technology is relevant in assisting university lecturers to perform their activities in the academic context, the Technology to Performance Chain (TPC) model is applied to analyze the perceived impact on performance of users in relation to their expressed attitude and actual usage of e-learning systems. The well-known System Usability Scale (SUS) instrument developed by Brooke (1996) is integrated within the TPC in order to assess the facilitating factors related to the ease of use for the online platform. Furthermore, usability evaluation and covariate analysis are conducted to explore how different types of users interact and react to the online web portal for different human factors including age, gender, academic qualifications and career experience. This is motivated by the fact that the process for introducing e-learning systems is bound to have a slow and complex trend (Persico *et al.*, 2014) that needs to be understood and evaluated beyond the use of just summative and automated ways. Succinctly, this study addresses the following research questions:

RQ1. What factors influence university lecturers to adopt the use of online technologies for their academic activities?

RQ2. How does the TTF of online educational systems influence the utilization and impact on perceived performance by university academics?

RQ3. How does the usability of online information system relate to the perceived performance and actual utilization of academic users?

This paper is organized as follows. The next section outlines the existing approaches and studies related to evaluating the acceptance and adoption of e-learning systems. The theoretical description of the presented approach for modeling the use of technology and quantifying the perceived performance is described in Section 3. Section 4 is devoted to show the experimental results attained for the analysis of human behavior on the use of online technology. Finally, discussions and conclusions are drawn.

2. Literature review

Evaluation of e-learning applications in terms of user experience, satisfaction and acceptance has received recently considerable attention from the research community in order to assess and quantify the satisfaction and effectiveness level for academic users. This is due to the increasing concern that despite the wide use and deployment of e-learning technologies, the intended impact on education is not achieved (Phillips *et al.*, 2012; Asarbakhsh and Sandars, 2013). Although the majority of studies are purely based on subjective data analysis, Ivory and Hearst (2001) argued that automating the evaluation process for software systems in terms of acceptance and usability would help to increase the coverage of testing as well as reduce significantly the costs and time for the evaluation process. Interestingly, there is a recent trend of using medical machines for assessing the user satisfaction level for using information systems. Dimoka *et al.* (2010) pointed out to the potentials of employing brain imaging and psychophysiological tools, such as skin conductance response, eye tracking and facial Electromyography (Eckhardt *et al.*, 2012). Liapis *et al.* (2015) conducted research

experiments to recognize stress through analyzing skin conductance signals. This was carried out as part of an evaluation of user emotional experience in order to identify stressful tasks in human-computer interaction.

2.1 Evaluation models for acceptance and performance

There is a number of methods and theories in the literature for understanding, predicting, and assessing the interaction process with its involved parts including personal factors, behavior, and environment. In order to assess the user acceptance of technological products, one of the most well-established models is the Technology Acceptance Model (TAM), which was proposed by Davis *et al.* (1989). The TAM is tailored to include questions to explore two aspects of the user satisfaction which are as follows: perceived ease-of-use and perceived usefulness. The ease of use refers to how users believe that adopting a particular technological product would require no effort and hassle to use it (Davis *et al.*, 1989). The perceived usefulness concerns the degree to which a user believes that using a particular software system would improve their job performance. The TAM has been used in various studies to assess the factors affecting individual's to the use of technology (Venkatesh and Davis, 2000). For research studies related to assess the usability aspect of the Moodle e-learning platform, Persico *et al.* (2014) employed the TAM to investigate the willingness of university users for the adoption of e-learning systems. Evaluation is based on three dimensions including usefulness, ease of use and effectiveness. Escobar-Rodriguez and Monge-Lozano (2012) analyzed how university students use the Moodle platform in order to determine and understand the factors which might influence their intention to use the platform. The TAM is used to assess the usability of the system in terms of perceived usefulness and ease of use against actual usage behavior.

Due to the limitation of the TAM specifically for addressing the technology as a whole and its lack of task focus, Goodhue and Thompson (1995) introduced the TPC model to account for such drawback via combining both the utilization and Technology Task Fit (TTF). The TTF is defined by Goodhue and Thompson (1995) as the degree to which a technology is utilized to assist a user to perform their tasks. For the TTF, the primary objective is the fitness between the task requirements and the characteristics of the technology which both have a direct impact on the TTF. The performance and utilization are, in turn, influenced by the TTF for performing a specific task using a particular technology. In spite of the fact that individuals perceive technology as an innovative advanced solution for their well-being, users will not uptake technological products if they think they are unsuitable to perform their tasks or unable to improve their work performance. In other words, the TTF argues that technological systems need to be willingly accepted by individuals as well as fit well with the tasks and users to prove its effectiveness and improved performance. Previous empirical studies have reported that combining the TTF and utilization models gives better insight about the impact of technology on user performance better than the TAM alone (Dishaw and Strong, 1999). There are other studies which proposed other variations via combining the TAM with the TTF including the work of Dishaw and Strong (1999).

For the literature related to the use of TPC model in the academic arena, a few research studies have explored the interrelationship of technological products, academic needs, performance and TTF. McGill employed the TPC model for a number of educational case studies. In the study of McGill and Hobbs (2008), the fit for using virtual learning environment is investigated for both teachers and students. Further, learning management systems are evaluated in terms of the fit degree for tasks performed by students (McGill and Klobas, 2009) in addition to pedagogical tasks conducted by academic instructors (McGill *et al.*, 2011). In a different study, Raven *et al.* (2010) used the TTF model to explore the fit for using digital video tools for giving presentation inside the classroom. The authors

reported a significant fit between improving oral presentation skills and using video tools. Further, D'Ambra *et al.* (2013) applied the TTF model to assess the adoption of e-books by university students. Recently, Yi *et al.* (2016) considered a reduced model from the TPC to investigate the perceived performance for students to use their smart phones for accessing educational content within the academic context.

2.2 Usability evaluation for information systems

The process of usability evaluation consists of methodologies for measuring the ease-of-use aspects of the user interface for a given software system and identifying specific problems. In fact, Usability evaluation plays a vital role within the overall user interface design process which undergoes continuous and iterative cycles of design, prototyping and testing. Evaluating the usability of interactive systems is itself a process involving various activities depending on the method utilized (Ivory and Hearst, 2001). Empirical-based usability methods require the participation of end users who are instructed to interact with the software system. Meanwhile, their behavior and interaction with the system are recorded and observed by an expert. Results are obtained from the users through interviews and questionnaires where they are asked for their opinions and concerns in addition to possible suggestions of how to improve better the interface design and its usability. Meanwhile, other methods rely on examining the usage data i.e. logs of IT individuals. The user logs used for usability evaluation are captured at either the server-side or the client-side. Many studies advocate that logging techniques are proven to be more reliable and efficient in terms of providing useful usability insights for the evaluators (de Santana and Baranauskas, 2015; Harrati *et al.*, 2015). Analytical approaches involve usability practitioners to manually examine a graphical user interface in order to detect usability deficiencies via inspecting usage test cases or analyzing the results of questionnaires. Although such methods are known to be laborious and very expensive, they often yield results that are biased by the acquisition environment or experts' subjectivity. Alternatively, several automated evaluation methods are conceived for auto discovery of usability faults at the same time alleviating the drawbacks in terms of reducing costs and time through liberating usability experts from conducting repetitive tasks manually. Further, the coverage of tested features can be remarkably increased through the use of automated procedures (Quade *et al.*, 2013).

In the same way to the behavior theory models, there are usability-related models and theories, such as the SUS which was proposed mainly for the evaluation of web application for two aspects, i.e. the learnability and usability. The SUS is a well researched and widely used questionnaire for assessing the usability of web applications mostly. Surprisingly, only a limited number of studies in the literature have used SUS to evaluate the perceived usability of e-learning management systems (Orfanou *et al.*, 2015). The first study of using the SUS for e-learning system was conducted by Renaut *et al.* (2006) to inspect usability problems for the SPIRAL platform. The researchers employed the SUS scale as a post-assessment of the usability reporting a score of 72 percent of the participating university lecturers who described the platform as positively easy to use. In Simões and de Moraes (2012), the authors examined the usability of the Moodle e-learning platform using three different evaluation methods including the SUS questionnaire to assess user's satisfaction for a sample size of 59 students. The authors concluded that the SUS is an effective tool for exploring the usability aspect without reporting the obtained SUS score. Marco *et al.* (2013) proposed a way of remote collaboration in real time within the platform Moodle through the use of Drag and Share. The collaborative tool enables sharing and synchronization of files. The efficiency of users was quantified using the time taken for task completion, meanwhile user satisfaction was assessed using the SUS questionnaire with a reported score of 89.5 percent. In a study conducted recently by Orfanou *et al.* (2015) involving 769 university students to assess their

satisfaction for using the platform Moodle, an average SUS score of 76.27 percent is reported. Various factors related to the user were investigated in the context of evaluating the e-learning platform including gender, age, prior experience, Internet self-efficacy, and attitude toward the internet in addition to usage frequency.

2.3 The Adoption of e-Learning by academics

There is only a limited number of research studies on the acceptance and adoption of academics for the uptake of e-learning systems compared to the considerable body of research publications focusing on students (Hrtoňová *et al.*, 2015; Šumak *et al.*, 2011). Liaw *et al.* (2007) surveyed 30 college teachers using their proposed three-tier Technology Use Model which was derived from the TAM. The obtained results had shown that positive perception for the use of e-learning systems was demonstrated by lecturers as a valuable teaching tool. Moreover, the perceived usefulness and self-efficacy are found to play a vital role to shape the behavioral intention to adopt e-learning. In the same way, Yuen and Ma (2008) described a composite behavioral model derived from the TAM consisting of five main constructs which are the perceived usefulness, intention to use, subjective norm, perceived ease of use and computer self-efficacy. Based on an empirical experiment which involved 152 teachers, the authors argued that the perceived ease of use can be considered as the sole factor which determines the intention to use e-learning systems. Meanwhile the usefulness of e-learning systems is found to have no major significance. Mahdizadeh *et al.* (2008) conducted an experiment involving 178 teachers who were subjected to questionnaires on the use of e-learning systems in order to identify the user's factors that can determine and influence their adoption of e-learning technology. The authors argued that the adoption can be related to the teacher perception of the added value from e-learning systems which, in turn, affect their perception on web-based activities. Recently, Hrtoňová *et al.* (2015) surveyed 228 teachers from primary and secondary schools from the Czech Republic. The authors reported that the voluntary participation and positive expectations held by teachers before the experiment are the two major elements to impact the e-learning acceptance. Surprisingly, it was found that the factors related to the users as teacher's gender, age, type of school play no significant role in terms of performing voluntary tasks on the e-learning platform. Harrati *et al.* (2016) conducted an empirical study to assess the satisfaction level of how university lecturers interact with the e-learning environment Moodle based on a predefined task model describing low-level interactivity details in tandem with using the SUS instrument for the users to express their perceived satisfaction level using the Moodle platform reporting an average score of 69.3 percent for a total population of 50 university lecturers.

3. Research methodology

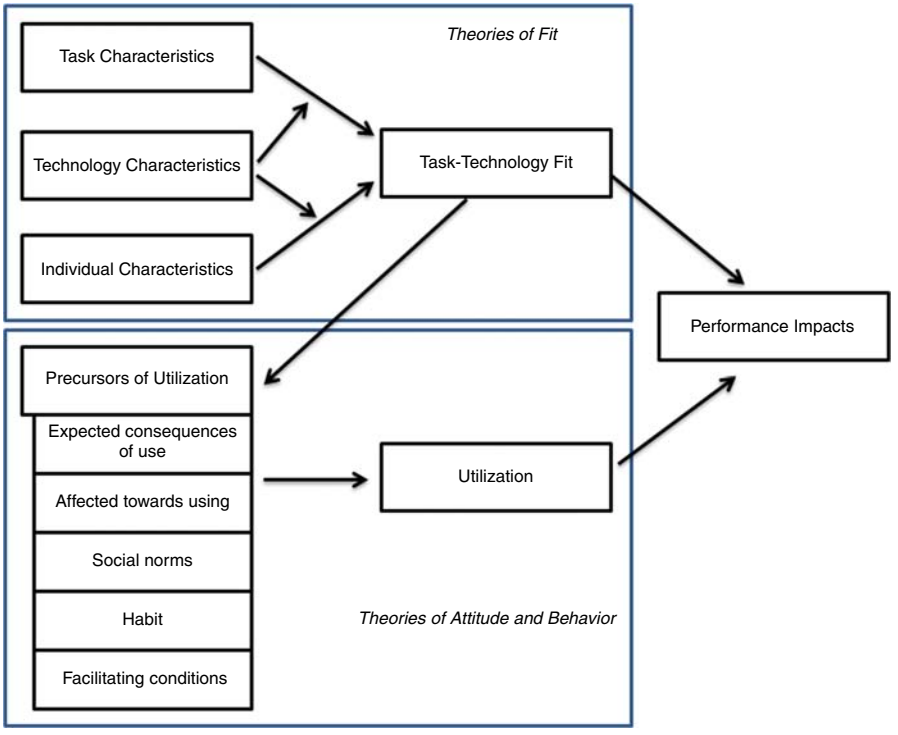
3.1 Context of the study

The work described in this paper is carried out to analyze the various factors that influence the university lecturers for the uptake of online technology within the academic context. From a theoretical point of view, the main objective is to determine the interrelationship between the perceived performance impact, software usability, and attitude of academics to use online technology to perform their job-related tasks. From the experimental side, the evaluation process is conducted on the university intranet portal which is an online information management system being developed by the Information and Communications Technology (ICT) center at the University of Souk Ahras where the study is conducted. The portal is deployed in 2014 as an alternative solution to the Moodle e-learning management system which was never used by the university staff. The online portal is integrated within the university main website for academic staff and university students to login using their private credentials to access different resources on the portal. Three main modules of the

information system are being evaluated during this study including e-learning, library repository and administration modules. Upon testing the application, participants are not required to install any software apart from using their preferred browser to use the online portal regardless of their hardware platform or operating system. As part of the usability project, the data set related to the utilization and performance collected during this experiment is made publicly available for the research community at the address: www.usability.ws

3.2 TPC model

In this research paper, we explore the perceived performance impact by university lecturers in relation to their actual utilization and the degree of fit for the technology available to conduct their academic tasks. The TPC model proposed by Goodhue and Thompson (1995) is considered in this research study as the most suitable approach for this context because it is a comprehensive model to explain the relationship between information systems and individual perceived performance based on behavior theory, attitude and TTF. Goodhue *et al.* argued that focusing on the individual's perceptions for technology cannot be sufficient to analyze their utilization and acceptance. The TPC asserts the importance of TTF to address the drawback of the TAM by focusing on the task. Figure 1 shows the diagram for the TPC model. The TTF, which is drawn from the TPC model, is concerned with measuring the degree of fit for a technology to assist an individual to perform their desired task. The TTF is influenced directly by the task, technological product and individual characteristics which constitute the main constructs for the TTF model. These elements for the TTF are explained as follows within the context of this study. The main elements for the



Source: Goodhue and Thompson (1995)

Figure 1.
Technology to performance chain model (Goodhue and Thompson, 1995)

TTF model are elaborated with their relevant definitions as follows within the scope of this empirical study.

Task which is defined as "the actions carried out by individuals in turning inputs into outputs" (Goodhue and Thompson, 1995). For the university context, academic can perform various tasks on the online information systems which includes, for instance, looking up their teaching timetables, downloading administrative forms and uploading their research articles into the library repository. In this study, we specify three main meta tasks related to the use of three modules: e-learning for uploading teaching materials and interacting with students; library repository for uploading their research contribution including PhD thesis; administration for accessing online forms and teaching timetables.

Technology is defined as the tool which users utilize to perform their required tasks. The university online portal is considered as the technological tool for university academics to perform their tasks within their workplace. Numerous research studies have stressed on the roles of web portals as an effective tool to improve the teaching and research qualities. Because users can alternate on using smart phones, tablets or desktops, we did not consider analyzing separately these characteristics.

Individual is the person who uses the technological tool in order to perform their tasks. The user's attitude to use particular technology or their experience with a related technology can influence their competence or confidence in using the technologies. We considered in this study university academics with teaching and research roles. The characteristics of lecturers include different academic rank, gender age and research discipline.

This study was inspired by mainstream research on the use of TPC for assessing the acceptance of technological products including the work of Yi *et al.* (2016) for assessing the adoption of smart phones for academic use and the research study conducted by McGill *et al.* (2011) for evaluating the use of learning management systems by university staff. This is in addition to the work of D'Ambra *et al.* (2013) for evaluating the adoption of e-books by academics. We described a variant reduced model from the TPC model (Goodhue and Thompson, 1995) which considers the use of usability evaluation assessed using the SUS instrument (Brooke, 1996) to quantify the facilitating factors. Further, instead of using surrogate measures for the users' utilization, we preferred to gather the actual usage of individuals to online technology using formative objective indicators. The proposed model is shown in Figure 2. From the TPC standpoint, the TTF directly impacts the performance and affects indirectly the utilization through the precursors of use which, in turn, influences the utilization of technology. Based on the deployed model, the following hypothesis on the impact of the TTF on the attitude can be made:

H1. The TTF has a positive impact on the attitude of university academics.

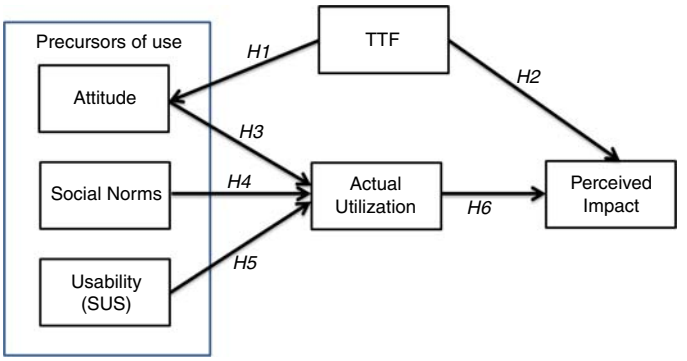


Figure 2.
TPC Reduced Model combined with Usability and Actual Utilization

Meanwhile the technology has a positive impact on the user performance when it is used provided there is a good fit between the technology and task requirement. The user perceived performance is affected directly by the TTF which is expressed in the following hypothesis:

H2. The TTF impacts positively the performance perceived by academics.

Goodhue and Thompson (1995) defined the precursor of utilization as the user's attitude and beliefs for using a technological system. Based on the TPC model, the TTF affects the user's beliefs about the usefulness and benefits gained from utilizing technology. Further, theories about behavior and attitude from the social psychology literature argued that a change in social norms, individual's attitude or facilitating conditions impacts the user decision to use or not to use the technology (Bagozzi, 1982; Goodhue and Thompson, 1995). For this research study, the precursors of utilization are made of three major constructs including attitude, social norms and usability conditions.

Attitude: it is explained as the person's favorable or unfavorable evaluation toward an object or its use (Ajzen and Fishbein, 1977). Based on a study published by Staples and Seddon (2004), the TTF has a considerable influence on the individual's attitude for utilization when the user is obliged to use the system meanwhile this influence lessens when it is optional. For the context of this research, academics within the university where the study is conducted, have no obligation to use technological products to support their teaching or research activities. Although lecturers will be more likely to have a favorable attitude for the convenience to access administrative files from their home at anytime from anywhere besides the benefits for them to promote their research contributions via using the library repository. This attitude might lead to the acceptance and use of online technology.

Social Norms: they refer to the beliefs for an individual of whether other users want them to perform the desired task using the technological tool (McGill and Klobas, 2009). Previous studies affirmed the existence of a direct influence of social factors on the successful uptake of technological systems (Hsu and Lin, 2008). In the academic context of this study, the adoption of academics to use online technology can be influenced by administrative staff (head of the department, dean of the faculty), work colleagues and even students who prefer to access pedagogical materials from home.

Usability/Facilitating Conditions: in order to quantify the ease of use for university participants to use the e-learning platform via self-reported subjective measures, the SUS (Brooke, 1996) is considered for this experiment. The SUS is one of the most popular methods in the literature which is devised mainly to evaluate the usability for web applications. Its popularity is gained among the HCI community mainly due to its desirable psychometric metrics including high reliability and validity (Lewis and Sauro, 2009; Bangor *et al.*, 2008; Brooke, 1996). The SUS questionnaire is composed of ten questions with a mix of positive and negative items. For each question, the respondent rates the magnitude of their agreement using a five-point Likert scale with statements going from strongly disagree (1) to strongly agree (5). In order to compute the overall SUS score, the score contribution for each odd question which is positively worded is estimated as the scale minus 1. For the even items, the score contribution is 5 minus the scale position. Therefore, each contribution ranges from 0 to 4. The SUS is the sum of all score contributions for the 10 items multiplied by 2.5, as shown in the following equation, where U_i refers to the rating of the ith item. The SUS scores range between 0 and 100 in 2.5-point increments where higher values reflect higher satisfaction from the user:

$$\mathrm{SUS} = 2.5 \times \left[\sum_{n=1}^{5} (U_{2n-1} - 1) + (5 - U_{2n}) \right] \tag{1}$$

The actual utilization by university academics is defined as the choice to use or not to use the online technology in order to perform their desired tasks. In the present study, the

utilization is measured via providing quantitative estimates directly from the backend database of the online system. The retrieved measures concern the number of uploaded teaching materials into the e-learning system, the number of uploaded research items into the library digital repository, number of questions or answers posted by the lecturer in addition to the number of downloaded administrative files. The perceived impact on performance is defined as what the individual has expressed on their accomplishment of a given task. Goodhue (1997) suggested that a user will not always use technological tools with the highest TTF degree but when used, tools with better TTF will yield greater performance. The following hypotheses are formulated:

H3. The lecturer attitude have a positive influence on their actual utilization.

H4. The social norms within the academic context have an impact on the actual utilization.

H5. The usability aspect has a positive effect on the actual usage of online technology.

Previous research studies argued that TTF and utilization influence positively the perceived impact on the performance of an individual. The main concern for dealing with the performance impacts for information systems is the difficulty to quantify directly. Many researchers opted to use surrogate measures of information system success including subjective user evaluations. The evaluation is based on an assessment made by a participant containing a series of questions in which the user is asked to respond or rate on a positive to negative scale. However, such measures are criticized for the absence of a strong empirical or theoretical evidence (Goodhue, 1997):

H6. The actual utilization of academics to online technology affects their performance.

3.3 Data collection

In order to collect the data, academics are presented with an online questionnaire when they log into their online accounts at the university portal. The questionnaire is implemented using PHP and JavaScript to consist of three pages such that each page contains a set of related question to one aspect of the evaluation process. The answers for questions are set on a Likert scale of five dimensions from Strongly agree to Strongly disagree. Upon answering all questions on a given page, the user would be taken to the next page, meanwhile the answers provided by the users are stored into a relational database along with an identifier for the user. For gathering data related to the actual utilization of the university on the website, a database query is performed internally when a user completes the online questionnaire to fetch data on the actual usage including the number of uploaded pedagogical materials, number of uploaded research items to the library repository, number of questions and answers on the question board platform.

3.4 Participants

For the experiment, the survey is implemented as an online application which is integrated within the university portal for academics to answer all the questions. The study is conducted within the ICT center, the University of Souk Ahras, Algeria in order to assess how lecturers perceive the use of online technology for their academic activities. There are 180 academic staff who choose to respond to all questions on the survey from a total population of 670 full-time lecturers employed by the university. All users are being asked to answer the survey remotely from their workplace through logging to the intranet portal of the university main website. The age distribution of the university academics is ranging between 26 and 65 years with an average of 36.7 years old, as illustrated in Table I. There are 120 male participants and 60 female staff. For the academic rank or position of the participants, 15 percent are university professors meanwhile 43 percent are lecturers who have obtained successfully a doctorate degree. The rest of users are assistant lecturers

Variables	Categories	Number of lecturers (%)
Gender	Male	120 (66.7)
	Female	60 (33.3)
Age	25-29	17 (9.4)
	30-39	123 (68.3)
	40-49	33 (18.3)
	50-65	7 (3.9)
Faculty	Science and Technology	40 (22.2)
	Biology	13 (7.2)
	Law and Political Sciences	12 (6.7)
	Economics and Management	28 (15.6)
	Arts and Languages	24 (13.3)
	Social Sciences and Humanities	17 (9.4)
	Agriculture and Veterinary	8 (8.4)
	Sport Sciences	4 (2.2)
Academic rank	Professor	15 (8.3)
	Lecturer	43 (23.9)
	Assistant Lecturer	122 (67.8)
Length of academic experience	Over 15 years	11 (6.1)
	10 to 15 years	30 (16.7)
	5 to 10 years	69 (38.3)
	Less than 5 years	70 (38.9)

Table I.
List of participants

who are still working toward the completion of their PhDs whilst they hold a teaching position within the university. The study spans across the eight faculties of the university where most of the respondents are from the Science and Technology and Economics faculties. We considered also grouping the list of staff by their academic experience as the total number of years employed in the academic sector. The majority of participants are those who have an experience of less than ten years.

4. Analysis and results

In order to analyze the obtained experimental results, the *R* programming language is used during this study. Initially, the proposed TTF constructs for using online technology by university lecturers are validated in the academic context. Exploratory Factor Analysis is applied with Principal Component Analysis (PCA) and varimax rotation. The results obtained for the proposed 13 TTF items are presented in Table II. The Kaiser-Meyer-Olkin (KMO) is

Items	Question : I want to use the online university portal to	Communality	Item-total correlation
TTF1	Upload my lecture handout and teaching materials	0.818	0.671
TTF2	Upload exercise and laboratory sheets	0.754	0.301
TTF3	Post questions/answers and interact with students	0.513	0.773
TTF4	View the syllabus and course information	0.605	0.748
TTF5	Publish my research papers into the library repository	0.653	0.699
TTF6	Upload my thesis and reports into the library repository	0.394	0.531
TTF7	Read articles from local journals from library repository	0.528	0.619
TTF8	Read announcements and news	0.778	0.659
TTF9	Access administrative and scientific reports	0.891	0.653
TTF10	Download application forms related to my activities	0.732	0.781
TTF11	Access my teaching schedule	0.932	0.624
TTF12	Access all the university timetables	0.971	0.659
TTF13	Use the university e-mail service	0.654	0.669

Table II.
Results for the exploratory factor analysis of the TTF constructs

estimated in order to examine the sampling adequacy of participants and the validity of the proposed instrument. Based on the attained results, the sampling was appropriate because the KMO value is 0.91 which is greater than 0.50. For the initial factor analysis, we have extracted three factors with eigenvalues which are greater than 1. The three main factors which are regrouped from the TTF items are regrouped based on applying the PCA to project the data into a reduced 3-dimentional space. The main dimensions are eLearning (TTF1-4), library repository (TTF5-7) and administrative tasks (TTF8-13). The items TTF2 and TTF6 are removed from the TTF construct because of the criteria of item-total correlation and communality for choosing the appropriate underlying factors. TTF2 has a low item-total correlation value of 0.301 (cutoff is 0.60), meanwhile TTF6 has a low communality value of 0.394 (cutoff is 0.50).

To assess the overall measurement model as well as to analyze its reliability and validity, we have performed Confirmatory Factor Analysis using Partial Least Squares (PLS) which is a structural equation modeling (SEM) technique used for analyzing the influential relationship between variables for a given research model. The main merit of PLS is its benefit to relax the assumption about the distribution of variables and therefore more robust than parametric modeling techniques. The study uses PLS with path modeling and bootstrapping technique to test the significance of the impact for the various constructs. The attained results for the factor analysis are shown in Table III reporting the internal consistency for each of the model constructs using both the Cronbach's α and the measures proposed by Fornell and Larcker (1981). To ensure the reliability of all measurements, the composite reliability and Cronbach's α are considered in this study. All constructs exceed the minimum value of 0.70 for composite reliability and 0.6 value for the Cronbach's α (D'Ambra *et al.*, 2013). This is an indicative for the strong reliability of the questionnaire instrument used in the evaluation process. The average variance extracted is estimated to affirm the convergent validity such that all constructs are above the minimum cutoff value of 0.5 (D'Ambra *et al.*, 2013; Yi *et al.*, 2016). The discriminant validity is assessed for the obtained results, as shown in Table IV which presents the inter-correlations between the various constructs. The values on the diagonal line shown in italic are the square roots of the average variance extracted for each construct. To ensure discriminant validity, the values on the diagonal line must be larger than any of the inter-construct correlations between the variables which are indeed greater. The other test of the discriminant validity

Constructs	Number of items	Composite reliability	Cronbach's α	Average variance extracted
Technology task fit	13	0.926	0.912	0.512
Attitude	4	0.932	0.902	0.774
Social norms	4	0.906	0.861	0.707
Usability	10	0.918	0.878	0.737
Impact on performance	7	0.960	0.951	0.744

Table III.
Internal consistency of the constructs

	TTF	Attitude	Social norms	Usability	Utilization	Performance
TTF	*0.843*					
Attitude	0.752	*0.880*				
Social Norms	0.539	0.641	*0.841*			
Usability	0.690	0.693	0.571	*0.859*		
Utilization	0.176	0.194	0.085	0.186	*0.646*	
Performance	0.680	0.763	0.657	0.667	0.113	*0.880*

Table IV.
Discriminant validity analysis

as reported by Staples and Seddon (2004) is to examine the loadings of each item and ensure that items load highest on their own construct. Overall, the statistical data shown in the previous tables confirm that the measurement model is satisfactory to conduct the analysis in terms of reliability besides discriminant and convergent validity.

In order to test the introduced hypotheses and analyze the TTF and utilization of technology for university academics, PLS path modeling is employed to compute the SEM, as shown in Figure 3. All constructs are modeled with reflective items with the exception to the actual utilization construct which uses formative indicators. To examine the structural model quality, two criteria are used including the significance of path coefficients (β) and coefficients of determination R^2 as indicative measures to analyze the variance of variables. The model predicts 48 percent of attitude, 43 percent of perceived performance impact and 8.5 percent of the actual utilization construct. The obtained value of R^2 for the actual utilization reflects the weak effect achieved under the current settings and proposed model. Interesting, similar results were reported in previous studies for the utilization construct including the following empirical studies (D'Ambra *et al.*, 2013; McGill *et al.*, 2011). For the structural model, it is observed that all paths are significant ($p < 0.005$) which suggests that the influential impacts described in the model are supported. The results confirm that the TTF has a positive impact on the attitude of lecturers to adopt online technology for academic purposes (*H1*). For the precursors of utilization, weak effect on the actual utilization of technology is reported from the attitude (*H3*) and social norms (*H4*) constructs, whilst the usability factor is confirmed to have considerable impact compared to the other two constructs on the utilization for convincing lecturers to actually use the technology (*H5*). Consistently, the hypothesis (*H2*) is supported claiming that the TTF has greater influence on the perceived impact on performance, meanwhile weak impact is observed for the actual utilization on the performance (*H6*).

Further analysis using the Kruskal Wallis test for the covariate factors related to the users themselves, such as age, gender, academic experience and ranks, as shown in Table V. For the test between the age group versus the other constructs including TTF and SUS scores, it reveals clearly that the *p*-values are much smaller for the case of TTF e-Learning, TTF administrative tasks and the actual utilization compared to other variables indicating the stronger difference between the various age groups for the two TTF constructs in addition to their actual utilization of technology. The reported results are consistent with the research findings confirmed by Bringula (2013) and Wagner *et al.* (2014). The computed

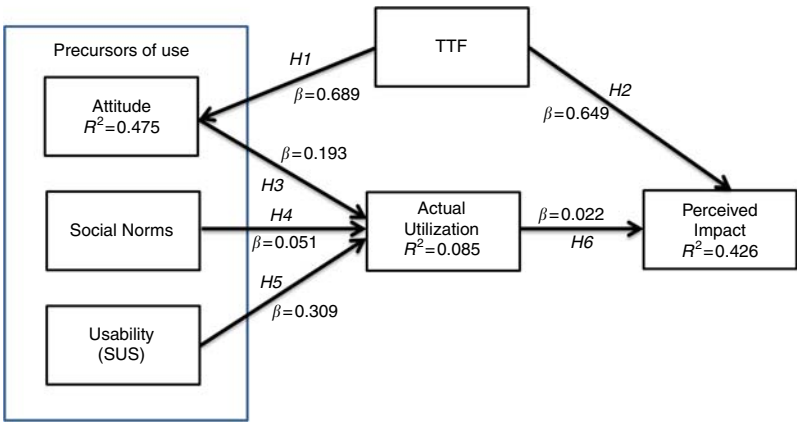


Figure 3.
Results for the structural research model

Notes: β is the path coefficient; R^2 the coefficient of determination

p values are slightly larger for most usage metrics and SUS based on the ordinal data of gender. This shows that there is not enough evidence to reject the null hypothesis to strongly conclude that gender can greatly influence the performance and utilization. In terms of the academic qualification, the results show that there is a moderate influence only for the case of the actual utilization and perceived performance. Surprisingly, the academic experience is observed to have no strong influence on most of the constructs with the exception to the actual usage of online technology for the academic context.

The SUS scores are computed for all lecturers who completed the ten-item questionnaires whilst answering the survey. Table VI shows the SUS scores placed against the estimated usage metrics for all users grouped by gender, different age groups, academic qualifications and experience duration. The average usability score based on the subjective evaluation is reported to reach the value of 72.83 percent with a standard deviation of 16.04 percent. The utilization construct is composed of four items that measured based on the actual usage of the user retrieved directly from the backend database. UTS1 refers to the number of e-learning materials uploaded to the portal for students, meanwhile UTS2 is the number of

	p-values			
	Age group	Gender	Aca. rank	Aca. experience
TTF : eLearning	0.0585	0.0930	0.8994	0.9526
TTF : library repository	0.5363	0.4533	0.9922	0.5427
TTF : administrative tasks	0.0910	0.7808	0.5583	0.7914
Precu. of use: attitude	0.2602	0.2704	0.4159	0.8465
Precu. of use: social norma	0.7532	0.2016	0.6423	0.6286
Precu. of use: Usability	0.1980	0.4770	0.6614	0.7882
Actual Utilization	0.0090	0.0049	0.0007	0.0002
Perceived performance impact	0.0842	0.3576	0.0502	0.2816

Table V.
Analysis of the variance using Kruskal Wallis test

	SUS	Actual utilization (mean)			
	Mean	UTS1	UTS2	UTS3	UTS4
All participants	72.83	3.99	1.59	0.76	7.89
Gender					
Male	71.94	4.90	2.17	1.03	8.02
Female	74.61	2.17	0.25	0.22	7.63
Age					
25-29	76.80	0.18	2.18	0.18	7.93
30-39	72.75	3.82	1.04	0.95	7.82
40-49	71.85	5.55	2.64	0.52	8.35
50-65	69.22	4	10	0.00	6.85
Aca. Rank					
Professor	70.68	8.27	10.13	2.60	7.05
Lecturer	72.14	5.63	1.90	0.744	7.86
Assistant Lecturer	73.34	2.89	0.43	0.54	8.00
Aca. Exp.					
Over 15 years	69.20	2.63	6.81	0.00	6.74
10 to 15 years	70.11	7.7	3.5	0.26	7.70
5 to 10 years	73.35	4.65	1.39	1.18	7.81
Less than 5 years	74.05	1.96	0.16	0.67	8.23

Table VI.
SUS and actual utilization for participants

research contributions placed within the library digital repository. UTS3 is computed as the number of questions or answers posted by the lecturer on the platform. The last utilization item quantifies the number of accessed administrative files within the last 90 days. Most users have reported higher SUS scores expressing their satisfaction for the exception of older users and users with more than 15 years of experience who have expressed lesser SUS scores. Inversely for the utilization, professors and academics with more experience have better usage metrics in terms of number of teaching and research materials. For gender-based analysis, female lecturers showed greater self-content using the e-learning system with an average SUS score of 74.61 percent against the male counterparts having scored 71.94 percent.

5. Discussions

In this research study, a number of unique contributions are made related to the evaluation of educational systems and exploring the factors that can affect the acceptance, the satisfaction level and perceived performance for university academics when using technological tools. Primarily, it is not surprising that a number of empirical studies have compared both self-reported subjective and objective measures for using an information system concluding that self-reported data are observed to be less accurate than objective measurements (Szajna, 1996; Pentland, 1989). This would help to cluster different users and even conduct deep analysis of the reported measures based on the actual performance or utilization of participants. Consequently, the scores reported by means of questionnaires administered to a set of users can potentially have different interpretation by the user in expressing their acceptance level. In other words, are the academics satisfied because of the ease of use for the e-learning platform or because of experiencing a new technological product that they felt happy about it regardless of the expected results. The same argument has been confirmed in a recent study about the relationship between user ratings vs their expectations (Michalco *et al.*, 2015). Based on the attained measures in comparison to the usage data, the recommendation for assessing the satisfaction level, TTF and performance should go beyond surrogate measures to include other metrics. In fact, combining the estimated usage metrics with the self-reported measures can be an indicative gauge to get an insight about the user intentional behavior, performance and system usability.

Albeit the rich amount of studies on analyzing interaction process and user acceptance for information systems, there is still an ongoing research on how to understand the user behavior in a more insightful and comprehensive way. The TTF model is suggested to have a considerable positive impact on the attitude of university lecturers to accept using online technological systems for their academic activities meanwhile there is a moderate influence for attitude of academic staff on the actual utilization of technology. In fact, the usability factor is observed to have more influential role in contrast to the attitude and social norms for lecturers to actually adopt the technology. This is considered in numerous recent research cases studies on the importance of usability for e-learning management systems (Navimipour and Zareie, 2015; Bringula, 2013; Escobar-Rodriguez and Monge-Lozano, 2012). Consistently, Yuen and Ma (2008) argued that ease of use is the sole determinant for teachers to adopt e-learning whilst the usefulness plays no significant role. Meanwhile, the TTF seems to have more influence than the actual utilization for the perceived impact on performance.

For other factors related to the participants themselves, younger academics have shown greater motivation and skills to use new technological products, meanwhile older users have expressed lesser satisfaction levels with the e-learning platform. This was based on the computed usage metrics regardless of the reported ratings. This is in alignment with a number of recent studies which arrived to the same conclusions (Wagner *et al.*, 2014; Bringula, 2013) arguing that the age factor has a pronounced impact on the performance of users.

Though there are studies which argue that factors related to the users have marginal role on the acceptance of e-learning technology (Hrtoňová *et al.*, 2015). For the user academic status, lecturers with the highest academic qualifications have reported better trend for utilization of technology to publish their research contributions and upload their pedagogical materials in contrast to other types of users who have expressed better usability with poor utilization due to the lesser academic experience and limited amount of research publications to be placed within the library repository. This is intuitively due to the proportional relationship between the age and the academic qualification. In alignment to previous studies on gender (Page *et al.*, 2012; Mentes and Turan, 2012) which argued that gender is a factor that can impact the performance and acceptance users for utilizing technology, the results obtained in this study show male staff uses technology more than their female colleagues but marginal difference for the other constructs including TTF, attitude and social norms. However, female academics have expressed greater self-content with the online educational system.

6. Conclusions

In this research study, we have investigated the acceptance and utilization of university lecturers for an online educational system using the technology-to-performance chain model. The study is based on a derivative of the TPC model to assess the acceptance of technology by academics based on combining self-reported data collected from 180 university lecturers and objective quantitative measures which describe the actual utilization of the academics. PLS path modeling is employed during this study in tandem with other statistical methods to test the significance and influence of different model constructs. Further, the usability is estimated by using the well-known SUS that is integrated as a construct within the model to reflect the ease of use for technology. The usability of information systems plays a crucial role compared to the attitude and social norms for lecturers to actually utilize technological products for the academic context. Meanwhile, the TTF is observed to have more influence than the actual utilization for the perceived impact on performance. Further, covariate analysis is conducted to explore how different types of users interact and react to educational systems for different factors, such as age, gender, academic qualifications and experience. For the individual's characteristics, the study indicates that the age is an influential factor on the utilization and performance in contrast to the gender which has a marginal impact. In alignment to previous studies on gender, the results obtained in this study show that male staff uses technology more than their female colleagues but there exists marginal differences for the other constructs including TTF, attitude and social norms. For future work, more studies should be done to explore other ways to quantify the impact on performance within the academic context.

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Appendix

Variables	Item	Question
TTF : (*I want to use the online university portal to*)		
e-Learning	TTF1	Upload my lecture handout and teaching materials
	TTF2	Upload exercise and laboratory sheets
	TTF3	Post questions/answers and interact with students
	TTF4	View the syllabus & course information
Lib. Repos.	TTF5	Publish my research papers into the library repository
	TTF6	Upload my thesis and reports into the library repository
	TTF7	Read articles from local journals from library repository
Administ.	TTF8	Read announcements and news
	TTF9	Access administrative and scientific reports
	TTF10	Download application forms related to my activities
	TTF11	Access my teaching schedule
	TTF12	Access all the university timetables
	TTF13	Use the university e-mail service
Precursors of use		
Attitude	ATT1	I feel happy and satisfied when using the website for my activities
	ATT2	I find my frequent use for the website great
	ATT3	My use for the online portal is good for me and to the university
	ATT4	Using the university website is pleasant
Soc. Norms	SNO1	Most academics use the website to interact with students
	SNO2	The administration thinks that my use of the website is good
	SNO3	The students feel that my use of the website is beneficial
	SNO4	The university community would respect me when using the website
Usability	SUS1	I think that I would like to use this system frequently
	SUS2	I found the system unnecessarily complex
	SUS3	I thought the system was easy to use
	SUS4	I think that I would need the support of a technical person to be able to use this system
	SUS5	I found the various functions in this system were well integrated
	SUS6	I thought there was too much inconsistency in this system
	SUS7	I would imagine that most people would learn to use this system very quickly
	SUS8	I found the system very cumbersome to use
	SUS9	I felt very confident using the system
	SUS10	I needed to learn a lot of things before I could get going with this system
Actual Utilization		
	UTS1	The number of elearning materials uploaded
	UTS2	The number of items placed within the library digital repository
	UTS3	The number of questions or answers posted by the lecturer
	UTS4	The number of accessed administrative files within the last 90 days
Perceived Impact on Performance (*The online university portal […]*)		
	PIM1	Helps me with my teaching and progress
	PIM2	Helps to improve my academic and work performance
	PIM3	Helps to increase my productivity
	PIM4	Makes it easier for me to perform my activities with effectiveness
	PIM5	Helps me to control my academic career
	PIM6	Increases the visibility of my research contributions
	PIM7	Saves me time and efforts to access administrative files

Table AI.
Questionnaire items and utilization measures

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