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## End Users and ERP Systems' Success. Three Models

Gianina MIHAI<sup>1</sup>

### *Abstract*

*Information systems (IS) have an enormous impact on organizations, individual work, and performance in general. As a result, many research works in the field of IS are focused on the interrelationship between individual performance and IS performance. During the last 20 to 30 years many models have been developed and tested by researchers. Their main objective was to investigate IS success and user performance in different environments. Therefore, a number of models appeared, their goal being the studying of the success, usefulness, end user adoption and utilization of IS, and other user and IS-related aspects in different organizations. This research paper presents three of the most important models developed in specialized literature, which deal with measuring IS success and end user adoption of the IS: the TAM model, the D&M model, and the TTF model. The research also provides an overview of some studies that have applied these models in the field of ERP systems.*

**Keywords:** ERP systems, TAM model, D&M model, TTF model.

### 1. Introduction

Implementing an ERP system represents an important engagement of resources and has a huge impact on all operational aspects of a business for any organization [1,2]. Organizations often encounter great difficulties in using, maintaining, or enhancing ERP systems after implementing them. Often these challenges may turn the ERP implementation efforts into a post-implementation failure with major business consequences [3,4].

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Despite the enormous investments in ERP systems, the expected benefits after implementation are rarely achieved [5]. Two surveys, conducted by Panorama Consulting in 2008 and 2010, find that 57% of organizations experienced operation stoppages [6] and that 67.5% of organizations realized less than half of their expected benefits [5] after ERP implementation. Those percentages are almost similar in 2014. According to another survey from Panorama Consulting of 192 businesses, 66% of respondents reported that they received 50% or less measurable benefits from their ERP implementation, and less than 40% were satisfied with the rate of user adoption [7]. Even very recently, in a report published by Deloitte in 2017, it is estimated that the percentage of ERP projects which don't achieve their objectives varies from 55% to 75% [8].

Therefore, the ERP post-implementation phase is viewed as being critical [3,9,10]. After a successful ERP implementation, organizations would want to use the system in the most effective way. This is understandable, given the considerable efforts that an organization has to make in order to implement an ERP system. Moon (2007) states that the success of an ERP system will not come from the system itself but from its efficient and effective use [11]. The most often cited as the one main reason for ERP failure after implementation is the reluctance or unwillingness of end users to adopt or use the implemented ERP systems [11,12]. User acceptance can be defined as the demonstrable willingness within a user group to employ information technology for the tasks it is designed to support [13]. ERP systems could be implemented effectively from a technical perspective, but factors affecting success also depend on end-user's behaviour and the actual use of the system [14]. So, the post-implementation adoption of ERP systems by end users, is one of the most important factors that influence the success of ERP in an organization.

## 2. Theoretical background

The adoption of IS can be studied using several models, based on the contribution of psychology's Theory of Planned Behaviour (TRA) by Fishbein & Ajzen (1975) and applied in IS technologies research. Among these, the most referenced base model in this area of research, which explains the IS adoption by the end users, is Technology Acceptance Model (TAM) first elaborated by Davis [17]. The second model which researchers working on ERP system success apply often, is one elaborated by DeLone & McLean [30] [52]. In case of DeLone & McLean IS success model (D&M model), user satisfaction and use are considered the main success drivers, the success being understood as net benefits for the individual and the

organization [15]. The third base model used to measuring IS success is Task-Technology Fit (TTF) model belonging to the authors Goodhue and Thompson [16]. The TTF model measures the degree to which a technology supports individuals in performing their tasks and indicates that if technology provides features that fit the requirements of users' tasks, the individual and organizational performance will increase [16].

### **3. Argument of the paper**

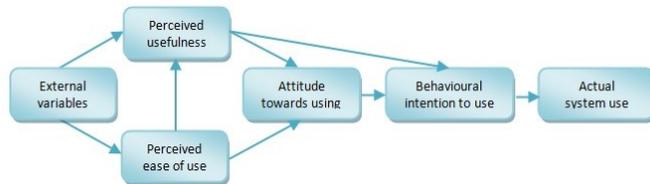
The three basic models (TAM, D&M, and TTF) most commonly used in specialized literature to measure IS success can be used for determining the factors that influence the users' acceptance and ERP systems' success in post-implementation phase. In order to demonstrate this assumption we will present all these models and we will synthesize some identified studies that applied these models in the field of ERP systems, during the post-implementation phase. Based on this synthesis we will draw some conclusions about the strengths and the limits of these models in context of their use to measure the ERP systems' success.

## **4. Arguments to support the thesis**

### **4.1 The Technology Acceptance Model (TAM)**

The first version of the Technology Acceptance Model TAM was elaborated by Davis in 1989 [17]. The TAM is an information systems theory which was developed in order to explain computer usage and the acceptance of information technology. With the help of his model, Davis [17] demonstrates that the use of technology is determined by two factors: individual perceived usefulness (PU) and individual perceived ease of use (PEOU). TAM is based on Fishbein and Ajzen's theory of reasoned action (TRA), which suggests that a person's behavioural intention depends on that person's attitude and subjective norms. If a person's attitude and subjective norms are known, the behavioural intention can be predicted [18]. TAM replaces the attitude measures of TRA theory with the PEOU (perceived ease of use) and PU (perceived usefulness) measures. Perceived ease of use (PEOU) refers to "the degree to which a person believes that the use of a system will be free of effort" [17]. Perceived usefulness (PU) is defined as "the degree to which a person believes that the use of a system will enhance his/ her job performance" [17]. The term "external variables" is used to describe all system design characteristics and features which have a direct influence on PU and PEOU. Similar to the TRA theory, the attitude towards

using an information system is determined by users' perceptions. In turn, this attitude leads to intention to use, which finally determines the actual usage of the system [19].



Source: Davis, Bagozzi, & Warshaw (1989)

**Fig. 1.** The Technology Acceptance Model

The original TAM model has suffered a whole series of additions and developments. Venkatesh and Davis (2000) proposed an extension called the TAM2, which incorporates some social influence processes of subjective norms and cognitive instrumental processes such as job relevance, output quality and result demonstrability, which influence usage intentions. In 2008, Venkatesh and Bala (2008) proposed another new, enhanced model, considered to be TAM3. This model has a broader approach, a new set of constructs were introduced and related to PEOU. Also, new hypotheses were considered, such as the moderating effect of experience on key relationships [15].

Based on TAM Model and other seven models and theories: theory of reasoned action (TRA), theory of planned behaviour (TPB), social cognitive theory (SCT), a Combined theory of planned behaviour/technology acceptance model (C-TAM-TPB), Model of PC utilization (MPCU), diffusion of innovations theory (IDT), and Motivation model (MM), Venkatesh, Morris, Davis, and Davis (2003) propose a Unified Theory of Acceptance and Use of Technology model (UTAUT). UTAUT postulates that adoption of technology by end users is based on four factors: performance expectancy, effort expectancy, social influence (behavioural intention), and facilitating conditions (usage behaviour) to determine the usage of information technology [15,20]. The acceptance of the new technologies is important for the organizations in the modern business era as they are helpful in improving the overall performance of the organization [21].

Many studies apply the TAM model in order to understand the behaviour and attitude of the users towards the ERP system and assess their satisfaction degree after using the system [22]. As several studies have revealed, one of the most common reasons for ERP failures is the resistance of users to adopt and use the implemented ERP system. For a better

understanding of the factors leading to the acceptance of ERP systems by the end users it is necessary to facilitate successful ERP usage [12,23]. A review of past ERP studies regarding TAM indicates that few studies have investigated ERP user acceptance and usage. Furthermore, all of them expose small numbers of external factors which could influence ERP acceptance and usage in different phases of an ERP system lifecycle [24]. In table 1 we present a number of studies that use the TAM model to measure the ERP users' acceptance and usage during the post-implementation phase.

**Table 1.** ERP studies that use TAM model

Study/Journal	Study objectives	Study findings
<b>Rajan &amp; Baral, 2015 [25]</b> <b>IIMB Management Review</b>	Proposal and testing of a conceptual framework in order to find the effect of some of the individual, organizational and technological factors on the usage of ERP and the impact of this usage on end users.	The results of the analysis suggest that computer self-efficiency, organizational support, training, and compatibility have a positive influence on ERP usage, which in turn has significant influence on panoptic empowerment and individual performance. The relationship between the external variables such as computer self-efficiency, organizational support, training, and compatibility and the TAM variables were found to be significantly and positively related.
<b>Hsieh &amp; Wang, 2007 [26]</b> <b>European Journal of Information Systems</b>	Providing a framework that explains Extended Use and addresses the issue of system underutilization by investigating Extended Use.	The synthesized model finds slightly higher variations in Extended Use, Perceived Usefulness (PU), and Satisfaction. Both Perceived Ease of Use (PEOU) and PU affected Extended Use. Satisfaction has no direct impact on Extended Use in the presence of PU and PEOU. PEOU has a stronger behavioural impact than the PU.
<b>Kwahk &amp; Lee, 2008 [14]</b> <b>Information and Management</b>	Examining the emergence of readiness for change and its effect on the perceived technological value of an ERP system leading to its use.	IT was developed a model of readiness for change which finds that readiness for change has an indirect effect on behavioural intention to use an ERP system and this readiness for change is enhanced by two factors: organizational commitment and perceived personal competence.
<b>Shih &amp; Huang, 2009 [27]</b> <b>Journal of Research and Practice in Information Technology</b>	Explaining the behavioural intention and actual usage of ERP implementation based on TAM using additional behavioural constructs like top management support, computer self-efficiency (CSE) and computer anxiety.	Analytical results prove that top management support strongly and positively affects CSE, PU and PEOU. CSE has an insignificant affect on PU, but was found to directly influence PEOU. PU influences behavioural intention, but does not significantly affect actual usage. PEOU has find to directly affect behavioural intention. Behavioural intention positively and directly affects actual usage.
<b>Youngberg, Olsen, &amp; Hauser, 2009 [28]</b> <b>International Journal of Information Management</b>	Research on the impact of PEOU, result demonstrability, and subjective norm on PU and its impact on usage behaviour.	This study empirically supports most of the constructs of the TAM2, focusing on PU. The study shows that information quality and job relevance of the information provided has a direct influence on the PU of the overall information system. The variables that significantly influence the perceptions of the involved personnel on the system usefulness are: job relevance, output quality, and PEOU.

Study/Journal	Study objectives	Study findings
<b>Lee, Lee, Olson, &amp; Chung, 2010 [29]</b> <b>Industrial Management &amp; Data Systems</b>	Proposing a model to examine the impact of organizational support (formal and informal) on behavioural intention (BI) regarding ERP implementation based on TAM	The results indicate that the organizational support is an important factor for perceived usefulness (PU) and perceived ease of use (PEOU) that leads to a higher level of interest in the ERP system and BI to use the system. Organizational support is positively associated with factors of TAM.
<b>Sternad &amp; Bobek, 2013 [24]</b> <b>Procedia Technology</b>	Examining three groups of external factors which influence ERP usage (organizational process characteristics - OPC, system and technological characteristics - STC, and personal characteristic and information literacy - PCIL)	All three conceptual group of factors: (1) PCIL: influence personal innovativeness, computer anxiety, self-efficiency, and computer experience; (2) STCs: data quality, system performance, user manuals, and ERP functionality; (3) OPCs: business processes fit, organizational culture, ERP support, ERP communication, and ERP training, influence PEOU and PU, which further influence the attitude towards using the ERP system in the phase of actual use of ERP.
<b>Bazhair &amp; Sandhu, 2015 [21]</b> <b>European Journal of Business and Innovation Research</b>	To investigate the effects of user training and education and PU on the ERP systems acceptance and the contribution of the ERP systems towards the improved organization financial performance.	ERP user training and education positively affects ERP PU and ERP Acceptance. ERP PU positively affects ERP Acceptance which, in turn, positively affects improved financial performance.

## 4.2. DeLone and McLean IS Success Model

Another branch of the research of information systems is represented by the examining of user satisfaction. The DeLone& McLean [30] model (D&M model) for IS success is the most cited model to measure on how the usage of these systems influences user satisfaction [15]. By examining 180 studies and over 100 measurements found in these studies for definitions of IS success, the D&M model presumes that system quality (SQ) and information quality (IQ), through the independent dimensions of use and user satisfaction, indirectly influence individual and organizational impact [15,30]. The strength of the D&M model resides in its theoretical foundation, which is based both on Shannon&Weaver's (1949) communication theory and on Mason's (1978) communication systems approach [22].

Based on the criticism of the public towards the first model, DeLone and McLean (2003) propose a new version of the IS success model which, beside SQ and IQ, includes IS service quality (ServQ). As the IS impacts not only users, but also workgroups, organizations, even industries, in their new model, the authors replaced the individual and organizational impact constructs with the "net benefits" construct [31]. DeLone and McLean

argue that their revised IS success model can be applied at multiple levels of analysis depending on the task at hand [31]. Despite this updated model, the first version is a success and remains the most cited in the literature [22].

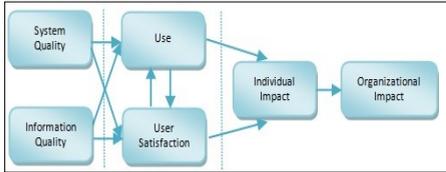


Fig. 2a *D&M IS Success Model*  
Source: DeLone and McLean (1992)

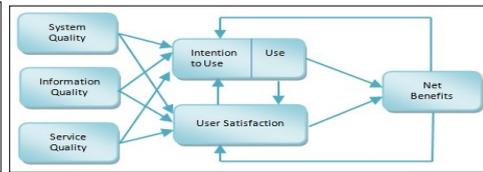


Fig. 2b *Updated D&M IS Success Model*  
Source: DeLone and McLean (2003)

The D&M (1992) and the D&M (2003) IS success models provide a useful framework by the means of which the ERP post-implementation success can be understood in a more integrative manner. With the help of the IS success model an IS system can be evaluated based on three quality dimensions: IQ, SQ, and ServQ. In an ERP context, the IQ and SQ indicate the resources, which are technically oriented, derived from the ERP system itself, whereas ServQ could indicate the resources that are human-oriented, controlled by the IS staff to affect users. These quality factors affect the user’s employment or intention to employ the systems and also the degree of satisfaction, by the means of which certain net benefits can be achieved [3].

Several researches have been conducted, in order to extend the D&M model to ERP systems. For example in Bradford (2003), Ifinedo (2011) and Sedera and Gable (2010) the quality of the ERP system is not only analyzed as a causal variable leading to success, but it can also be seen as a result of other external factors, such as organizational, innovative, and environmental factors [22]. In table 2 we synthesize some of these studies and their results.

**Table 2.** ERP studies that use D&M model

Study/Journal	Study objectives	Level	Study findings
Gable, Sedera, & Chan, 2003 [32] Proceedings of the 24th ICIS	Proposing a model that includes the following dimensions of success for an ERP system: System Quality (SQ), Information Quality (IQ), Individual Impact (II) and Organizational Impact (OI).	Organizational and individual	The analysis and validation of the model constructs (model testing) find that these four distinct and individual dimensions of success are applicable to any IS evaluation. The constructs are positively associated and when combined, they yield a single valid measure of overall success.
Zhang, Lee, Huang, Zhang, & Huang, 2005 [33]	Exploring the relationships among the ERP system environment, organizational environment, user	Organizational level	The study result is a guidance framework for a successful implementation of ERP systems and not a practical model to measure the

Study/Journal	Study objectives	Level	Study findings
<b>Int. Journal of Production Economics</b>	environment, ERP vendor environment, and ERP implementation success.		success of ERP implementation.
<b>Gable, Sedera, &amp; Chan, 2008 [34] Journal of the Association for Information Systems</b>	Validating the measures of D&M IS success model in the context of ERP systems.	Organizational and individual	After eliminating the Use and User satisfaction dimensions, the final model keeps four dimensions, grouped into two portions: the "impact" half that includes Organizational Impact(OI) and Individual Impact (II) and the "quality" half that includes System Quality (SQ) and Information Quality (IQ). Satisfaction is treated as a consequence of success not as a dimension.
<b>Hsu, Yen, &amp; Chung, 2015 [3] Information&amp;M anagement</b>	Explaining how ServQ, together with SQ and IQ, directly and interactively affect ERP post-implementation success from a user's perspective and to investigate the extended use of the ERP systems.	Individual level	The study results provide evidence that ServQ interaction effect can enhance SQ's and IQ's impact on extended use and is a much more valuable perspective for achieving the full potential benefits of ERP systems. Extended use is found as a meaningful measure of system use for an implemented ERP system.
<b>Gorla, Somers, &amp; Wong, 2010 [31] The Journal of Strategic Information Systems</b>	Understanding the impact of three quality dimensions (information, system, and service) on enterprise systems.	Organizational level	The results indicate that, overall, the IS quality dimensions have a significantly positive influence on organizational impact either directly or indirectly. A strong linkage between SQ and IQ is found.
<b>Chien &amp; Tsaur, 2007 [35] Computers in Industry</b>	Re-examining the updated DeLone and McLean model of ERP systems success and to empirically test the relationships between the model's variables using data collected from the users of ERP systems.	Organizational and individual level	This research discovers that SQ and ServQ are important dimensions for measuring post-implementation ERP success. ServQ and SQ dimensions play more important roles than their IQ counterpart in terms of influencing ERP benefits of use and user satisfaction.
<b>Ifinedo, 2011 [36] Journal of Systems and Software</b>	Empirically investigating the influence of external ERP expertise, in-house IT professionals' knowledge, and business employees' computer skills on ERP system success.	Organizational, workgroup, and individual	This study shows that if external ERP expertise exists and organization's IT employees and business employees (non-IT) possess high levels of computer/IT skills, the use of ERP systems can be effective.
<b>Ifinedo, 2006 [37] Journal of Inf. Technology Management</b>	Extending Gable, Sedera, & Chan (2003) model and to develop a more comprehensive model to measure ERP success.	Organizational, workgroup, and individual	Other important dimensions are included and validated Vendor/Consultant Quality (VQ) and Workgroup Impact (WI).

### 4.3. The Task – Technology Fit Model (TTF)

In order to proceed with their tasks, users employ technology. The Task-technology fit (TTF) theory states that individual performance is positively impacted by IT, and IT can be used if its capabilities match the tasks that the user must perform. TTF measures the degree to which a technology helps a user perform her/his tasks [38]. Moreover, the TTF model indicates that performance will be increased when a technology provides features and support that fit the requirements of the task [16]. In the same research paper, Goodhue and Thompson (1995) propose the technology-to-performance chain where features of IT, tasks, and individual users, explain the use of information systems and also individual performance. Empirical results suggested that TTF and usage together explain the impact of IT on individual task performance better than the usage alone [2].



Source: Goodhue and Thompson (1995)

**Fig. 3.** Task-Technology Fit model

Admitting that technologies must be used and modified to fit the task they support in order to have an impact on performance, this model gives a more accurate picture of the way in which technologies, user tasks, and utilization relate to changes in performance [16]. Goodhue and Thompson (1995) TTF model operates at the individual level of analysis. In 1998, Zigurs and Buckland (1998) elaborate an analogous model that operates at the group level.

Since the initial work, the TTF model has been applied in the context of a diverse range of information systems including enterprise information systems alone, but more often combined with other models or used as an extension of other IS success models such as TAM or D&M. In table 3 we present some studies about ERP success which use a TTF in combination with one or both two other presented models: TAM and D&M.

**Table 3.** ERP studies that use TTF model

Study/Journal	Study objectives	Base Models	Study findings
Glowska &	Facilitating the understanding of ERP	TTF model	Continuously increasing regulations are found as the most challenging factor for ERP systems.

Study/Journal	Study objectives	Base Models	Study findings
Sunyaev, 2014 [39]  Journal of Enterprise Information Management	systems and data quality interdependence by analysing the use of ERP systems in the context of data quality management.		Evolving task environments lead to the need to continuously adapt systems or organization and to the need for contextual understanding of data quality. TTF is an increasing challenge in the context of numerous not-routine tasks.
Abugabah, Sanzogni, & Alfarraj, 2010 [40]  International Journal of Advanced Computer Science and Applications	Proposing a synthesized model consolidating the three models used in IS research, a model which can help understand the relationship between IS and users in context of ERP systems.	TAM, D&M, and TTF models	The study shows that the most significant factors influencing user performance is PU and SQ. The findings demonstrate that most factors in the proposed model have direct and/or indirect significant influence on user perceived performance. The model is validated and can explain the main impacts of these factors on ERP users.
Costa, Ferreira, Bento, & Aparicio, 2016 [15]  Computers in Human Behavior	Finding the key determinants of user satisfaction and adoption and to elaborate a model of ERP adoption and satisfaction.	TAM and D&M models	The study outcomes are a valid model and the understanding that top management support, training, and SQ are important constructs to assess adoption and user satisfaction. Management support is a very relevant determinant to ERP usage. SQ has a significant influence on the behavioural intention to use and on user satisfaction.
Sun, Bhattacharjee, & Ma, 2009 [41]  Information & Management	Extending the IT usage models to include the role of IT's perceived work compatibility in shaping users' IT usage intention, usage, and performance in work settings.	TAM and TTF models	The study demonstrates the importance of incorporating perceived work compatibility (PWC), or the TTF construct, within new models of IT usage. PWC impacts intention to use IT, and thereby indirectly influences IT usage. PWC also has a strong indirect effect on intention through its effect on PU. Combining the direct and indirect effects, PWC has a stronger overall effect on IT usage intention than PU.
Abugabah & Sanzogni, 2010 [42]  International Journal for Infonomics	Integrating the three models into a more comprehensive and powerful one.	TAM, D&M, and TTF models	The study confirms the importance of TAM and TTF, and show that IQ and SQ powerfully determine PU and PEOU toward system use that strongly influence user performance when using a system. Results showed a strong and statistically significant relationship between TTF, PU and PEOU, leading to more system impact on user performance.
Smyth, 2001 [43]  The 9th European Conference on Information Systems	Proposing an ERP Success Model in which TTF, perceived usefulness and user satisfaction are analyzed like the most appropriate constructs to indicate ERP success in an organisation.	TTF and D&M models	A poor TTF contributes to a low level of user satisfaction, while the poor TTF and low user satisfaction each contribute to the lack of success of the ERP package. The usefulness of the TTF construct as an indicator of ERP success is demonstrated.

## 5. Conclusions

In accordance with other studies that indicate the paucity of research on ERP systems during the post-implementation stage [44], we also found a small number of studies that address this issue. In a study from Esteves&Bohorquez (2007), the authors found that, from the total number of ERP publications that they have included in their research, 47% were concerning the implementation phase only, and a mere 15% the post-implementation phase. All three models have proven to be applicable in ERP, but each of them has certain limits due to the narrowness of focus or inadequately developed methodologies [40]. That is why it often happens that, in many studies which aim at being exhaustive, these models are combined together, or used in combination with other models and theories which are not covered by this study.

The results of many studies using TAM, presented in Table 1, are unclear and/or inconsistent. This suggests that more significant factors must be included in the model [14,26,27,28]. The TAM model assumes that users have a choice about the extent to which they use the technology. In the context of ERP systems, the use of the system is mandatory and end users can only have an opinion and, at the very most, an attitude towards the system, but they don't really get to decide if it is going to be used or not. In this context, the "behavioural intention" construct may not be appropriate to represent the degree of acceptance by the end-users [16]. The frequency at which an end user may employ a system may not be a guarantee for user's higher performance. The users can favourable evaluate a not so good system due to various factors such as accessibility, ease of use, and personal characteristics [16,26]. Our conclusion regarding the TAM model is in accordance with that of other researchers [15,40,45,46], namely that the traditional TAM cannot fully explain adoption by users in the ERP context.

The D&M model is widely applied in the field of ERP systems research. D&M (1992) and D&M (2003) IS success models provide a useful framework through which the ERP post-implementation success can be understood in a more integrative manner. The D&M model presumes that system quality (SQ), information quality (IQ), and ServQ, through the independent dimensions of use and user satisfaction, indirectly influence the "net benefits" construct, which covers both individual and organizational impact constructs (DeLone & McLean, 1992, DeLone & McLean, 2003)[15]. Unlike TAM, the D&M model also provides the possibility to more clearly classify the different measures of IS success [40]. Many authors of ERP studies, presented in Table 2, have found that the D&M model is also incomplete, and that further factors should be taken into consideration

especially in the case of such a complex IS as an ERP system [3,34,35,36,40,42].

The Task-technology fit (TTF) model came with other important factors, which positively impact the individual performance and which are missing from the other two models, namely that the ERP capabilities must match the users performed tasks. The empirical results of the studies suggest that TTF and usage together can explain better the impact of ERP on individual task performance than the usage alone [43]. It is well known the fact that system usefulness must be evaluated before systems can deliver their performance [16]. More ERP studies conducted using TTF, presented in Table 3, [39,41] are not given the adequate attention to quality and usefulness of the system. It is hard to apply the TTF model in the context of an ERP system because of its frequent inadequacy with the characteristics and needs of an organization. Thus, this model is applied for more specific purposes [39].

Overall, all these models are suitable for ERP systems and provide a very useful theoretical framework for exploring interrelationship between ERP systems and their users from different perspectives. According to [15,40,41,42,43] each of them has limits and focuses on a limited set of factors and none can be considered comprehensive for various IS environments, including ERP systems.

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