# Examining Factors That Influence the Use of 3D Gamification in E-Learning in Higher Education

[1,2]Sakirin bin Muhamed and [2]Nora'ayu Ahmad Uzir

[1]Faculty of Information Management
UiTM Selangor Branch, Puncak Perdana Campus, 40150 Shah Alam
Selangor Branch
Malaysia

[2]Legal Profession Qualifying Board Malaysia
Unit 22-01, Aras 22, Menara 2,
Menara Kembar Bank Rakyat,
No. 33, Jalan Rakyat
50470 Kuala Lumpur
Malaysia

Received Date: 11 January 2022
Accepted Date: 2 March 2022
Published Date: 2 April 2022

**Abstract.** The acceptance and use of the latest technology are an important due to various factors, especially when Covid-19 dynamics hit the world today. It is quite a difficulty for most people in Malaysia when this change occurs and have to go through it which is called "New Norms". They need to get used to doing work or study online because they are not allowed to attend any classes or events. Indirectly, they have to master almost all activities through online means. Therefore, this study aims to understand the underlying factors that influence user satisfaction on the implications of 3D Gamification in e-Learning. From the results of this study, we found that the results are as follows: (1) system quality, (2) service quality, (3) information quality, (4) perceived usability, (5) user satisfaction and (6) ease of use with the use of 3D gamification in e-Learning system. Data from 149 users have shown that satisfaction is influenced by the quality of service and the quality of information on the system. Surprisingly, service quality was found to be related to satisfaction. Lastly, the quality of information was found to influence user satisfaction rather than vice versa. Our findings support this implementation successfully make users easier to understand than the usual system used before.
**Keywords**: 3D gamification, information and knowledge system, e-learning

## 1 Introduction

Over past few decades, games have been incorporated into numerous sectors, such as commerce, health care, and education. Games are entertaining and encouraging user to participate and learn, purchase products, engage in social interactions, and

increase productivity. Gamification has been the subject of several studies, although there are still some debates over its efficacy, and some research has shown it to have less of an impact than the expectations of the players. Measurement issues may explain some of these results. The efficacy of gamification has been the subject of controversy in the past e.g., system broken and user acceptance of using 3D gamification in e-learning.

However, 3D gamification needs to be applied according to the current situation where we are a bit behind if we want to compare with other foreign countries.

Recent years have seen a growth in the application of gamification in the educational setting. This has drawn the interest of academic scholars. Gamification of learning systems has the ability to increase the learning performance of students by minimising boredom in some tasks and encouraging active participation in learning activities. These days, e-learning is getting more popular. However, it is often utilised to help users better grasp the material they are studying. Because of this, the present e-learning system is less responsive, (Dhawan S., 2020).

This e-learning system is not straightforward to use for users, who are used to reading books and writing to better grasp what they are learning, rather than using this system.

In this e-learning system, self-motivation of users is also crucial. Users who have taken distance learning courses are learning and quitting the notion of quitting, since the problems of managing the technological media also seem to be unsurmountable for these users. In addition to encouraging consumers, individual monitoring is also a challenge. It is quite difficult to see whether people are experiencing difficulties learning and implementing their new abilities because all or most of the work is done in groups. What about grading when some users have already done the presentations. Individual problems go unnoticed because they are too little. Helping people gain the required abilities, or ensuring that they obey the rules, is more challenging.

It is becoming increasingly difficult to supervise individual courses due to the growth in the number of users. A lack of manpower was a result of face-to-face encounters with each user. A quick and effective utilisation of the existing resources is therefore essential. With 3D gamification in e-learning systems, it may take use of tools, methods, and new advances in programming to improve the e-learning system that existed previously. Furthermore, it may leverage current ways to encourage users to learn new abilities that they will need in their professional jobs.

## 2 Background

Since the 1700s, school has presented opportunities for students to earn marks for handing in assignments and completing exams, which are a form of reward points. In early 1900s, with the advent of psychoanalytic theory, reward management programs were developed and can still be applied in schools. For example, many teachers set up reward programs in their classrooms which allow students to earn free time, school supplies or treats for finishing homework or following classroom rules. While some have criticized the term "gamification" then, as simply a new name for a practice that has been used in education for many years, gamification does not refer to a one-dimensional system where a reward is offered for performing a certain behaviour.

The gamification of learning is an approach which recently has evolved, in coordination with technological developments, to include much larger scales for gameplay, new tools, and new ways to connect people. The term gamification, coined in 2002, is not a one-dimensional reward system. Rather, it takes into consideration the variety of complex factors which make a person decide to do something; it is a multifaceted approach which takes into consideration psychology, design, strategy, and technology. One reason for the popularization of the term "gamification" is that current advancements in technology, in particular, mobile technology have allowed for the explosion of a variety of gamification initiatives in many contexts. Recently, 3D gamification of learning is an educational approach that seeks to motivate students by using video game design and game elements in learning environments. The goal is to maximize enjoyment and engagement by capturing the interest of learners and inspiring them to continue learning. 3D gamification, broadly defined, is the process of defining the elements which comprise games, make those games fun, and motivate players to continue playing, then using those same elements in a non-game context to influence behavior. In other words, gamification is the introduction of game elements into a traditionally non-game situation.

However, the study on the effectiveness of 3D gamification in learning are still scarce and the acceptance of 3D gamification in learning is still under-explored. Previous studies in gamification in learning revolve around. Gamification in e-learning offers the opportunity for learners to engage with content in an effective, informal learning environment. If learners get excited about learning, they are more likely to retain information.

## 3 Literature Review

In 3D gamification, game-design characteristics and gaming ideas are used to settings that are not games. Gamification works by leveraging our natural desires to improve activities or processes through the use of techniques. These enhancements can be attributed to increased user engagement, organisational productivity, and learning. These levers include socialisation, learning, mastery, and competitiveness. To successfully apply gamification, it is necessary to first understand its strengths and shortcomings, as well as to use a data-driven approach to its design and iterative development.

3D gamification is the practise of incorporating game principles into instructional curriculum, marketing campaigns, or corporate operations. These gaming mechanisms are used to either inspire or enhance the user's experience. 3D gamification extends game-design methods for player engagement to sectors other than video or mobile gaming. When these game principles are correctly implemented, 3D gamification transforms an area of personal or professional life into a game.

Two factors were discovered to be frequently assessed for 3D use gamification in e-learning systems: ease of use and perceived utility. These two elements have been shown to have significant consequences not just for the sake of adapting, but also for the desire to use the system in the future. The degree to which a person feels that using e-learning would increase or improve their academic achievement is referred to as perceived usefulness such as service quality, system quality, and information

quality. Particularly, information quality is the users' opinion of the system's ability to provide vital information to users. In e-learning systems for obtaining and sharing information, system quality refers to users' perceptions of 3D performance gamification, while user perception of service quality relates to the quality of services provided to satisfy individual users' information requirements and unique activities. In this case, researchers must quantify both the usage of IS and the extent to which it is employed.

In order to provide a useful guide for study and research, several theories and models have been developed to characterise technology acceptance and deployment. They were mostly based on prior research that revealed that an individual's views and beliefs about a specific problem impact his or her behaviour. Several theories and models have been created to describe technology adoption and deployment in order to give a useful guide for study and research. These theories and frameworks were mostly based on earlier studies that showed that an individual's attitudes and beliefs about a certain issue influence his or her behaviour.

Researchers are also curious about the function of 3D gamification in e-learning. The application of technology is said to predict individual performance. Accordingly, Fig. *1* depicts the development framework used in the production of the present study. Researchers can better understand 3D gamification in e-learning by creating a model that includes input, process, and output.

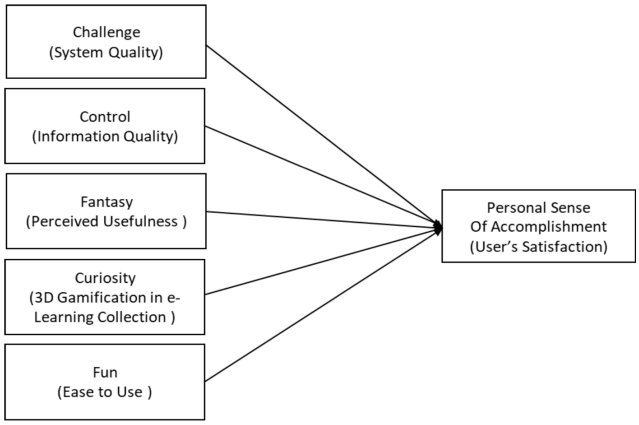


Fig. 1 Framework of 3D gamification in e-learning

*Task Innovation*

Task innovation indicates the degree of which this 3D gamification in e-learning systems can help users to come up with new ideologies during the learning process. The system gives a source of knowledge and information as a form of discovery and research output published research reports.

*3D Gamification Use*

Individuals who represent the next generation of 3D gamification in e-learning systems are those grown up with unlimited or limited access to the internet, thus can be comfortable when using the system. Among the individuals involved, they prefer to use the web resources that are easily accessible through search engines rather than through e-learning provided. However, resources that are easily accessible through websites are not promised to be trustworthy and reliable. Earlier research suggested that the resources supplied did not correspond to the current will and manner of life. While some feel that 3D gamification in this e-learning system is successful, others say that the traditional way is preferable. It is important that users understand why this 3D gamification system was established in order to persuade them to utilise it in e-learning systems.

*Systems Quality*

The user's impression of a system's capacity to gather and present information while also achieving a stated objective is considered system quality by most experts. Quality systems are found to be the key point in determining the usage of IS. Properties of system quality that affect the usage of IS our response time, output accuracy, system stability, system security and presentation format. Availability and reliability suggest that this system must allow access to remote areas and allow access to users regardless of time and locations. In other words, 3D gamification in e-learning systems must be reliable and technically prepared from time to time. The level of devotion and hard work spent by all users on attaining their learning goals is linked to the system's performance in terms of the correctness and completeness of the information obtained by the user while using the system.

*Service Quality*

Service providers who design and introduce this system should provide high quality services to meet consumer demand and expectations. Prior research has mostly focused on the influence of great service on user satisfaction and pleasure.

*Internet Efficacy*

When one believes in his or her own capacity to perform a specific activity, they are said to have self-efficacy (Bandura, 2000). Motivation and behaviour are significantly affected by perceived self-efficacy (Igbaria & Iivari, 1995). A person's computer self-efficacy "represents his or her thoughts on his or her competence to use a computer to execute a task," say Compeau and Higgins (1995). Researchers highlight that "few studies have explored self- efficacy as an additional explanatory variable for an individual's use of IT systems" (Compeau & Higgins, 1995; Igbaria &

Iivari, 1995). According to Igbaria and Iivari, computer self-efficacy had a substantial direct influence on perceived ease of use, but only a minor indirect effect on perceived utility via perceived ease of use (1995). As a result, researchers discovered that, while computer self-efficacy has minimal direct impact on Online usage, internet effectiveness is more significant and well-suited for e-learning purposes. Eastin and LaRose (2000), Robinson et al. (2002), and Hsu and Chiu (2003) showed that Internet self-efficacy was related with Internet usage (2004).

*Personal IT Innovativeness*

The authors of Agarwal and Prasad found that "IT personal innovativeness influenced both the causes and effects of individual attitudes toward new information technology" (1998). Determining its influence as a predictor or moderator has been welcomed by researchers in information systems because of this fact (Jackson et al., 2003) Examples are Jackson et al. (2013); Hwang (2014) and Pham & Ho (2015). Jackson et al. (2015) use Pham and Ho (2015), Lin (2015), and Jin (2015) as examples. Jin (2016) has been published in addition to Jackson et al. (2013) and Hwang (2014), Pham & Ho (2015) and Lin & Filieri (2015), See Lee (2007) and Fang et al. (2009). Studying the link between personal IT innovation and IT adoption and usage, however, makes this impact more obvious. IT innovators may have more favourable attitudes about technological developments than those with lower IT innovation levels. Tech-savvy individuals are more inclined to make advantage of it. IT experts have an influence on the innovativeness of 3D gaming systems used in online learning, according to recent research.

# 4 Methodology

*Data Collection*

An online survey will be used in this study to answer research questions and achieve research objectives. Research methods have a wide range of features, according to Pinsonneault and Kramemer (1993): (i) the objective of the researcher is to produce quantitative descriptions of various features of the examined population.; (ii) analyses may focus on the connections between variables or on projecting findings to a predetermined population in a descriptive manner.; and (iii) The objective of the researcher is to produce quantitative descriptions of various features of the examined population; and (iv) the researcher's objective is to create quantitative descriptions.

The research population consisted of persons who continue to learn in the traditional manner. These folks were chosen because they are in need of change but do not know how to learn more efficiently. They were more comfortable than those who had not wanted to modify their learning style before. To aid students with their studies, they will continue to rely on the present system at this period. Traditional methods are preferred over the previous system since people do not have to learn new things, which they deem ineffective. Because the information is constantly updated and the system is active 24/7, the system's upkeep is also impressive Information

quality, system quality, and service quality will be taken into account when comparing these qualities to the framework. People who have been elected will be asked to complete surveys by researchers. Only one month's worth of data will be collected due to the system's continual updating.

*Data Analysis*

An ordinal scale of measurement was used in this study, as well as a SEM analysis, which were both considered to be appropriate. In this study, the researcher utilised SmartPLS version 3.0, which was chosen for its user-friendliness and past experience with the programme. Statistic reports that SmartPLS is the most often used statistical software application among researchers. Amos Version 20 will be used in addition to SmartPLS to analyse the SEM data for the study. SEM analysis tools such as AMOS Version 20 and SmartPLS are commonly utilised. A software-based SEM, AMOS, was selected above other software-based SEMs.

In SmartPLS, all data will be coded after it is entered. During the data processing procedure, each questionnaire will be issued a unique code. Missing values were excluded from the study due to the huge number of responses, as SEM does not allow for them. "Explore" was used to check each variable for abnormalities, most notably typos. Following the discovery of any errors, the original questionnaire responses, which are identified by a unique code, are analysed and rectified.

These analyses will be performed: I descriptive statistics; II common method variance; and III structural equation modelling (SEM), further divided into measurement model and structural analysis model. Analyses that measure central tendency and dispersion are the most prevalent. Variance, range, and coefficient of variation are all measures of dispersion. " It will be utilised to quantify dispersion by calculating the mean and standard deviation of the research variables in this study.

Structural equation modelling was used to capture and understand complex social relationships (SEM). CFA (confirmatory factor analysis) is another name for a measurement model, which illustrates how measured variables are logically and consistently related to model components (Hair et al., 2006). It is also assessed whether or not the measurement model is valid and reliable. Second, the structural model is evaluated using SEM. There is a component interaction between endogenous and exogenous components in the model. Analyzing the link between exogenous components and endogenous components uses the unstandardized regression weight's probability value, much as in linear regression analysis.

# 5 Results

Here are the findings in relation to the study questions. Researchers evaluate and compare the findings to those of prior studies:

*Research Question 1: Is there any statically significant and explained relationship between System Quality and 3D Gamification in e-Learning?*

The system quality factors found as having a favourable effect on 3D gamification in e-learning system utilisation are not significant in this study. The resulting result (t = 1.2431.97, p = 0.214>0.05) is unsupported. However, the conclusions of this study differ from those of other studies in which system quality was regarded as the most significant and powerful component in terms of 3D gamification in e-learning system use. According to the target user survey that was collected for user satisfaction, the system is not well structured, it also lacks proper appropriate functionality to be used, users are unable to easily find any information in this system, and the response time of 3D gamification in e-learning system is unacceptable. However, Laumer et al. (2017) and Vijai, J. P. (2018) argue that when it comes to knowledge management systems, system quality has been shown to be strongly related to system use.

*Research Question 2: Is there any statically significant and explained relationship between Service Quality and 3D Gamification in e-Learning?*

The service quality factors found as having a favourable impact on 3D gamification in e-learning system utilisation are not significant in this study. The resulting result (t = 1.4521.97, p = 0.147>0.05) is unsupported. The conclusions of this study, however, contrast with those of other studies in which service quality was regarded as the most significant and powerful feature in terms of 3D gamification in e-learning system use. According to prior studies, this finding is accurate. It is believed that service quality is determined by the degree of aid system users receive from the IS department and its support employees, according to Yu, P. As Vijai, J. P. (2018) points out, service quality has a substantial and positive impact on the adoption of knowledge management systems. It is also backed by a number of prior researches that show the impact of service quality on usage and user satisfaction (Baptista & Oliveira, 2015).

*Research Question 3: Is there any statically significant and explained relationship between Information Quality and 3D Gamification in e-Learning?*

All information quality-related statements were organised and allocated to an information quality feature, such as relevance, usability, or presentation, based on prior research (Laumer et al., 2017). Indeed, information quality is a predictor of user happiness and the emergence of workarounds. In this study, the majority of information quality dimensions were shown to have a negative impact on user satisfaction. The resulting result (t = 1.6621.97, p = 0.097>0.05) is unsupported. According to the research findings of Akinola, J. O et al. (2013), the effect of information quality on user satisfaction was similarly substantial, with most respondents stating that most or all of their information demands were satisfactorily met. Nonetheless, the system's administration should not rest on their laurels and should strive to keep the system's information quality up to current and adequate at all times.

*Research Question 4: Is there any statically significant and explained relationship between Perceived Usefulness and 3D Gamification in e-Learning?*

According to the study's findings, the perceived usefulness dimension has a direct effect on 3D gamification in e-learning system use. The impact of 3D gamification on perceived usefulness in the e-learning system utilisation dimension is ($t = 8.028>1.97$, $p = 0.0000.005$). Previous study has backed up and verified these findings. The training effect on perceived usefulness results are very unsatisfactory, according to Costa, C. J. et al. (2016). The research highlights the crucial relevance of this specific construct's contribution to the adoption of information systems in general, and knowledge systems in particular (Rajan & Baral, 2015; Ruivo et al., 2014). In addition, the perceived usefulness of 3D gamification in e-learning system usage revealed that the majority of respondents believe the system is highly valuable in aiding them to perform their daily activities.

*Research Question 5: Is there any statically significant and explained relationship between 3D Gamification in e-Learning Collection and 3D Gamification in e-Learning?*

According to the findings of the study, 3D gamification in e-learning collecting aspects that have been recognised as having a favourable impact on EKMS use is not significant. The given result ($t = 0.2501.98$, $p = 0.803> 0.005$) renders it unsupported. This result is consistent with previous studies that investigated the direct relationship between user satisfaction and 3D gamification in e-learning system use, namely, if 3D gamification in e-learning system users believe that service meets their task needs, the user gains power and the collection lose power in explaining individual performance (Tam, C. et al., 2016). As a result, for the fifth research question, this study indicates that the degree of 3D gamification in e-learning system use has no beneficial impact on the target user's level of user happiness.

*Research Question 6: Is there any statically significant and explained relationship between Ease to Use and 3D Gamification in e-Learning?*

According to the study's findings, easy-to-use aspects that have been discovered to have a favourable impact on 3D gamification in e-learning system use are important. The obtained results ($t =5.292>1.97$, $p = 0.0000.005$) corroborate it. According to survey respondents, we can conclude that the system is extremely well accepted in terms of simplicity of use. However, prior study has shown that simplicity of use is the most significant element in determining intention to utilise 3D gamification in an e-learning system. Furthermore, such insights improve our knowledge and comprehension of user behaviour toward system utilisation and serve as a springboard for IS Department producers to develop the system. U. Bandara and T. Amarasena (2018). Aside from that, if the technology is simple to use, the obstacles will be overcome. No one is going to like it if it is difficult to use and has a complex UI. As a result, this study indicates, for the sixth research question, that respondent degree of acceptance of the system for ease of use is impacted by level of pleasure with 3D gamification in e-learning system usage.

## 6 Discussions and Recommendations

Some alternative has been suggested to overcome the rejected hypothesis which is included system quality, perceived usefulness, 3D gamification in e-learning collection and easy to use. This recommendation will be useful in the future to all parties that are participating in this study according to the result and conclusions from the data gathered and processed by SmartPLS version 3.0.

First, the current system has limited file storage capacity for knowledge and document records and currently has reached its storage capacity. The solution is, they should expand server storage capacity to overcome the system stability problem. These system stability problems faced by users regardless of time. Worse problems occur when it is time for all users to upload, retrieve and update the document, file and knowledge sharing into the system, this situation happens frequently. As this system involve license, budget is one of the constraints to upgrade the 3D gamification in e-learning system.

Second, to attract users to utilise 3D gamification in e-learning systems, the design components, user characteristics, execution process, policy effect, and organisational structure must be enhanced so that users may finish their learning more quickly and effectively, thereby enhancing their performance. It will also encourage users to do information retrieval more readily and think that 3D gamification in e-learning systems is beneficial in assisting them with their learning.

In addition, the 3D gamification in e-learning system need to be improve to satisfy the needs of user to use it in completing their daily task for learning. Most importantly need to be improve in term of information processing quality and also 3D gamification in e-learning system response time when user retrieve knowledge that their requested.

Moreover, there is a need to modify the system to be a more user-friendly system. The system must be ease to use. The definition and explanation must be short and compact. An interface must be user-friendly if it makes sense to the typical user and requires just a brief explanation of how to use it. An unstable system is not user-friendly since it causes the user unnecessary frustration. A user-friendly system is dependable and does not fail or crash.

## 7 Conclusions

The most popular definition of gamification is the application of game mechanics in non-game systems. However, it also incorporates dynamics, aesthetics, and game theory, in addition to mechanics. Gamification's major objective is to enhance user motivation, experience, and engagement. Gamification design characteristics are interesting for implementation in e-learning systems because learning requires a high level of incentive. It is essential to consider the different types of learners and their learning habits when integrating gamification in an e-learning system. We cannot focus just on socializers as the most common type of player; instead, we must support all types of players/learners. When we decide to incorporate game mechanics and dynamics into an e-learning system, we must go through all phases of e-learning system development, such as analysis, design creation, implementation, and

evaluation. The proper design components, as well as the participation of experts in education, technology, pedagogy, design, and finance, are essential for effective gamification implementation. This article featured points, badges, trophies, customization, leaderboards, levels, progress tracking, challenges, feedback, social interaction loops, and the ability to fail. For those elements, several design proposals were given, including the following (Enders, 2013; Glover, 2013; Zichermann and Cunningham, 2011).

Some of the above-mentioned design aspects may already be accessible in popular open-source e-learning systems, allowing us to use them for free. For our experimental study, we examined the influence of gamification in an informatics online course using our findings and gamified design components available in Moodle. According to the findings, students who participated in the gamified version of the online curriculum performed higher in terms of learning accomplishment. Based on our findings, we plan to investigate the gamification of online learning content for more subjects, as well as other ICT-related courses, in future study. We will also try to determine the effectiveness of each gamified design feature in e-learning systems and aim to validate the beneficial influence of gamification on learners in other courses, as we have observed in our experimental study and the studies of other authors (Domnguez et al., 2013; Ibanez et al., 2014).

## References

Al-Fraihat, D., Joy, M., Masa'deh, R., & Sinclair, J. (2020). Evaluating E-learning systems success: An empirical study. Computers in Human Behavior, 102, 67-86. doi: 10.1016/j.chb.2019.08.004

Akinola, J. O., Ogunmodede, T. A., Oyetola, S. O., & Apotiade, J. K. (2013). A Survey of the Services of Public Libraries in Meeting the Information Needs of Post-Secondary School Students in Some Three Selected Public Libraries in Nigeria. Greener Journal of Internet, Information and Communication Systems, 1(1), 001-012. doi:10.15580/gjiics.2013.1.110512229

Alalwan, J. A., Thomas, M. A., & Weistroffer, H. R. (2014). Decision support capabilities of enterprise content management systems: An empirical investigation. *Decision Support Systems*, *68*, 39–48. doi: 10.1016/j.dss.2014.09.002

Almarashdeh, I. (2016). Sharing instructors experience of learning management system: A technology perspective of user satisfaction in distance learning course. *Computers in Human Behavior*, *63*, 249–255. doi: 10.1016/j.chb.2016.05.013

Appelbaum, D., Kogan, A., Vasarhelyi, M., & Yan, Z. (2017). Impact of business analytics and enterprise systems on managerial accounting. *International Journal of Accounting Information Systems*, *25*, 29–44. doi: 10.1016/j.accinf.2017.03.003

Bandara, U., & Amarasena, T. (2018). Impact of Relative Advantage, Perceived Behavioural Control and Perceived Ease of Use on Intention to Adopt with Solar Energy Technology in Sri Lanka. 2018 International Conference and Utility Exhibition on Green Energy for Sustainable Development (ICUE). doi:10.23919/icue-gesd.2018.8635706

Baptista, G., & Oliveira, T. (2015). Understanding mobile banking: the unified theory of acceptance and use of technology combined with cultural moderators. Computers in Human Behavior, 50, 418e430.

Bolukbas, U., & Guneri, A. F. (2018). Knowledge-based decision making for the technology competency analysis of manufacturing enterprises. *Applied Soft Computing*, *67*, 781–799. doi: 10.1016/j.asoc.2017.11.023

Calisir, F., & Calisir, F. (2004). The relation of interface usability characteristics, perceived usefulness, and perceived ease of use to end-user satisfaction with enterprise resource planning (ERP) systems. *Computers in Human Behavior*, *20*(4), 505–515. doi: 10.1016/j.chb.2003.10.004

Centobelli, P., Cerchione, R., & Esposito, E. (2018). Aligning enterprise knowledge and knowledge management systems to improve efficiency and effectiveness performance: A three-dimensional Fuzzy-based decision support system. *Expert Systems with Applications*, *91*, 107–126. doi: 10.1016/j.eswa.2017.08.032

Chavarria-Barrientos, D., Chen, D., Funes, R., Molina, A., & Vernadat, F. (2017). An Enterprise Operating System for the Sensing, Smart, and Sustainable Enterprise. *IFAC-PapersOnLine*, *50*(1), 13052–13058. doi: 10.1016/j.ifacol.2017.08.2004

Chofreh, A. G., Goni, F. A., Klemeš, J. J., Malik, M. N., & Khan, H. H. (2020). Development of guidelines for the implementation of sustainable enterprise resource planning systems. *Journal of Cleaner Production*, *244*, 118655. doi: 10.1016/j.jclepro.2019.118655

Costa, C. J., Ferreira, E., Bento, F., & Aparicio, M. (2016). Enterprise resource planning adoption and satisfaction determinants. *Computers in Human Behavior*, *63*, 659–671. doi: 10.1016/j.chb.2016.05.090

Document management. Change management for successful electronic document management system (EDMS) implementation. (n.d.). doi: 10.3403/30181562u

Du, M., Qiu, F., & Xu, W. (2011). Construction of Enterprises' Financial Knowledge Management System (EFKMS). *Procedia Environmental Sciences*, *11*, 1240–1244. doi: 10.1016/j.proenv.2011.12.186

Fernandez, V., Giner, J. L. C., & Boladeras, M. D. (2009). Framework for the analysis of executive information systems based on the perceived usefulness and the perceived ease of use. *Intangible Capital*, *5*(4). doi: 10.3926/ic. 2009.v5n4.p370-386

Ho, C.-T., Chen, Y.-M., Chen, Y.-J., & Wang, C.-B. (2004). Developing a distributed knowledge model for knowledge management in collaborative development and implementation of an enterprise system. *Robotics and Computer-Integrated Manufacturing*, *20*(5), 439–456. doi: 10.1016/j.rcim.2004.03.006