Acceptance of Technology Digital Twin for learning in 21st Century

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***Abstract*— Due to the rapid information technology development, various organizations have used information technology as a tool to operate a plenty types of work. Digital Twin is perceived as the 21st century technology that is used to integrate process in many fields such as airline business and medical studies. Digital Twin acts as a tool that helps manager and organization's employee to work efficiently. However, it is important for manager to support employee to learn about Digital Twin, and how to use this technology in each part, because after the employee gets to learn about Digital Twin, he or she will be able to integrate this technology and utilize it in variety parts of jobs.**

Keywords; Digital Twin; Invention ; TAM; 21st Century

I. INTRODUCTION

In the past century, there were intense competitions to enhance information and communication technology (ICT) which caused the rapid changes and development of the relevant technologies. As a result, many organizations had to adjust and adapt themselves to the changes of information and communication technology. At the present time, information and communication technology is being used as a tool [17] to advance the development in other fields. Hence, many countries around the globe recognize how important this technology is, and use it as a tool to learn and work in various situations [18] such as designing and raising the potential of human resources.

According to the previous statement, Thailand has decided to implement ICT Policy Framework (B.E. 2011-2020, ICT 2020) [19] which has the objectives to improve Thai citizen's quality of life and Thailand's economy, and lead the country towards a knowledge-based society and economy. In this regard, information and communication technology is used to encourage learning and teaching in order to improve education system, and promote "wise learning".

As the result of the mentioned policy, executives and directors from a large number of Thai firms and organizations has recognized the advantages of this technology [18], and decided to apply information and communication technology to support errands and learning by operating Digital Twin, which is considered as the 21st century technology, in order to efficiently process works, make decisions, plan, and solve abundant issues. Moreover, Digital Twin is referred to an innovatively new technology for executives and employees. Therefore, it is necessary for them to understand its benefits, and accept to further or contribute this technology in their routines and works in order to generate huge benefits for firms and organizations that they belong to.

II. TECHNOLOGY ACCEPTANCE MODEL

Technology Acceptance Model (TAM) was created by Davis [3]. The theory of TAM was developed from 'A Theory of Reasoned Action' proposed by Ajzen and Fishbein .TAM theory is the most accepted, and utilized in academic and system development fields. The objective of this research is to explain acceptance factors that describes the behavior of different users, and TAM's relevant important variables that were related to each other [4] as follows:

1) Perceived Usefulness: PU is the main variable in the model of technology acceptance, especially innovative technology [2]. This variable explains the level of people's believe that technology helps to increase the potential and efficiency of works and routines [3] [5], [6].

2) Perceived Ease of Use: PEOU is another important variable. This variable measures the level of user's expectation towards technology's ease of use and convenience. In other words, users do not need to learn, and put their efforts to understand and use this technology. Additionally, 'Perceived Ease of Use' variable directly affected Perceived Usefulness [4], [5], [6].

These two variables are main variables that directly affected 'Behavior Intention to Use' [7] in order to show factors of technology usage [1]. Nowadays, a new technology is developed which lets academician or educational technology specialist study the theory of TAM to understand factors that impact the acceptance of innovative technology such as Digital Twin.

III. DIGITAL TWIN

The concept of digital twin was originally proposed by the concept of digital twin was originally proposed by Grieves [8]. The researcher stated that a virtual model of physical objects was commonly created in a digital form inside the virtual world in order to demonstrate behaviors of the mentioned model and physical objects in reality [9]. This involves data, system, product and object [11], [10], [13] that has at least one sensor that can display real-time information [12] and operate efficiently [13]. Hence, the three components of digital twin are the connected data that ties the two worlds, the physical entities in the physical world, and the virtual models in the virtual world. [29] physical objects was commonly created in a digital form inside the virtual world in order to demonstrate behaviors of the mentioned model and physical objects in reality. This involves data, system, product and object [11], [10], [13] that has at least one sensor that can display real-time information and operate efficiently [13]. Hence, the three components of digital twin are the connected data that ties the two worlds, the physical entities in the physical world, and the virtual models in the virtual world. [20]

Digital Twin Rationale and Potential Uses [14]

As a virtual representation, digital twin in a controlled test environment is perceived as easier to be studied and manipulated than its physical counterpart in the operational circumstance. This flexibility makes cost-effective exploration of system sensitivities and behaviors available to variety types of external disruptions and system malfunctions. Secondly, data created by the digital twin under different what-if conditions can be used to enhance maintenance cycles, develop system designs for future uses, prove preliminary design decisions, invent new system application ideas, and predict the response of system for various kinds of disruptions. Particularly, the digital twin can be used to:

1. Validate model of system with data of real world: the interactions of the system towards environment and data of operational environment can be integrated into the digital twin in order to make predictions and decisions, and verify its models.

2. Provide notification and decision making information for users: After integrating health data, operational data and maintenance, the digital twin can be used in a what-if analysis mode to create suitable decision supports and notification for operators of the physical system.

3. Forecast future changes in physical system: Simulation-based analysis of operational data, health data, and maintenance from the digital twin improves predicting system performance, and contingency planning, and supports the operation's optimization (including requirement's satisfaction and root causes identification). It is possible to embed the digital twin in control loop to forecast physical system's future changes, and modify parameters of physical system to handle unpredictable incidents.

4. Discover new revenue streams and opportunities of developing or improving application: with digital twin, various system versions can be used to determine features that provide the best performance. Machine learning and other scientific and technological data are able to support the analysis of enormous data generating volumes which helps to provide the informative insights of revenue streams and potential opportunities.

The components of Digital Twin [15]

Digital Twin's components consist of storage, events generation, method's execution, and access control to resources. Furthermore, it provides HMI to operators. These components support most functions of Digital Twin. The followings are a list of each component's brief explanation, and how it is used:

1. Storage: This component is used to keep modified and non-modified historical record in the generated events and device model. The historical log of the operating device is required for some applications, especially applications that are related to promising maintenance and analytics of big data. In other words, storage can be utilized as a record of local file, a connection to irrelevant database, or even a local database.

2. Events: It is possible for digital twin to generate events to show that a condition has met or something has happened. The examples of these mentioned events are changes in some functions of device's model such as the alarm that displays the sensor value when it is above a specific threshold.

3. Methods: Digital twin has a lot of features that can be retrieved by users or applications. The features' model is set as in 'methods', in other words, it is referred to objects that execute a set of instructions. Methods are able to run diagnostics, demonstrate simulations, control the device, and etc.

4. Access to Control Resources: Digital twin has measures of security that can limit the level of access to its information of device's model and features. To keep its flexibility, these measures were not required for building or using a model. However, they are crucial for security guarantee, especially when user can access to digital twin via internet. Access control measures include a list of access controls, user's authentication, or even a dedicated framework.

5. Human machine interface (HMI): Digital twin provides interfaces which help human to visualize the device virtual representation and interact with it. This can be implemented for example as a simple graphical user interface or with advanced augmented reality techniques.

6. Communication Interface: a Digital Twin may provide communication interface with the physical device. It is responsible to update properties of the Digital Twin. These interfaces make a bridge between the physical device and its virtual representation.

Features for Digital Twin:

There are 5 features for digital twin consist as follows [16]:

1. Identification: a global identification is required to link each physical product to its digital forms. The examples of technologies that can be applied for this method are 'Electronic Product Code (EPC)' and 'RFID tags'. These technologies provide lifetime unique identities for every physical object around the world.

2. Data management: product information and data has three stages of the product lifecycle: BOL, MOL and EOL. It is possible to achieve big proportions of the size of stored data during these three stages. With this feature, the issues of analytics for only storing the noticeable data or information, and Big Data management can be solved.

3. Digital Twin models: in each phase of product life cycle, different categories of product's models are innovated, for

example, functional models, 3D models, system models, models of multiphysics, usage models, and manufacturing models. These models are able to make use of information among each other. Thus, this can be considered as a problem.

4. Digital Twin information: there are an enormous amount of data (Big Data) generated during the real product's lifetime. This feature supports the information usage and maintenance that are relevant to product behavior's future prediction.

5. Human Computer Interface: since there are abundant information for different data repositories to handle, it is obvious that displaying appropriate information for the right user is an issue to be considered. Although digital twin provides information to all types of users and stakeholders, it is important to use Human Computer Interfaces (HCI) to instruct how the information is going to be displayed for the right users.

Utilizing Digital Twin for Learning

Digital Twin has been used in industrial, business and medical fields. The details are as follows [13]:

1. For airline business, digital twin system is practiced before building an aircraft in order to evaluate possible situations and the best method to deal with emergencies such as handling storm and fixing broken devices.

2. For the basic structure such as road, bridge and tunnel, digital twin is greatly beneficial for constructor since it helps the constructor to evaluate and analyze the future damages, for example, quake that causes building and construction project to collapse.

3. For machine production and repairing, by demonstrating the operation of different machines, users can understand and adjust the way machines work to be more effective. Thus, it helps to reduce operating issues significantly.

4. For business, digital twin is executed to demonstrate virtual business and markets that can be used to analyze for users to understand business and its system better. This helps the users' business to grow faster and more efficiently.

5. For medical field, digital twin has been widely used to demonstrate virtual human body that displays the functions of every part of the body. For example, when a person is doing exercises, the virtual body of that person is demonstrated and displayed for users to analyze the potential of this body, how it handles exercising, and solution to solve particular health issues.

IV. Summary

According to all the passages above, digital twin is clearly recognized as a new technology trend for 21st century. It is invented and studied to find the factors that are related to technology acceptance. This technology is a part of Technology Acceptance Model that posited 2 factors: Perceived Ease of Use and Perceived Usefulness. Digital Twin. Thus, digital twin is recognized as a technology with ease of use and various benefits that will be more essential for operations and projects in different fields such as automobile business, education and construction.

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