Contents lists available at Science-Gate

International Journal of Advanced and Applied Sciences

Journal homepage: http://www.science-gate.com/IJAAS.html

The system architecture of digital activity portfolio via internet of things for digital university

Rukthin Laoha [1, *], Panita Wannapiroon [1, 2], Prachyanun Nilsook [1, 3]

[1]*Department of Information and Communication Technology for Education, Faculty of Technical Education, King Mongkut's University of Technology North Bangkok, Bangkok, Thailand*
[2]*Innovation and Technology Management Research Center, Science and Technology Research Institute, King Mongkut's University of Technology North Bangkok, Bangkok, Thailand*
[3]*Vocational Educational Technology Research Center, King Mongkut's University of Technology North Bangkok, Bangkok, Thailand*

ARTICLE INFO

Article history:
Received 17 September 2018
Received in revised form
25 December 2018
Accepted 27 December 2018

Keywords:
System architecture
Digital activity portfolio
Internet of things
Digital university

ABSTRACT

Progress in technology nowadays makes serious competition among universities. Many of them adjust themselves by applying technology and innovation to improve their efficiency in both learning-teaching and management. The goal of using technology and innovation is for students' satisfaction and being a digital university. Digital activity portfolio system is the tool that helps enhance students' more effective learning through IOT. It is accepted that system architecture is the important part of effective system development. System architecture makes developers realize the factor concept and environment. In this research, the researcher presented System architecture of digital activity portfolio. The knowledge from studying articles, approaches and theory related was used to synthesize system architecture of digital activity portfolio. The purposes of the research were (1) to design system architecture of digital activity portfolio via the internet of things for digital university and (2) to evaluate the system architecture of digital activity portfolio via the internet of things for digital university. The research procedure was divided into two phases. The first phase is system architecture of digital activity portfolio via the internet of things for digital university design, and the second phase is the architecture evaluation by experts. The samples were 10 experts in the field of a digital portfolio, Internet of things and higher education chosen by purposive sampling. Data collection tools were the system and the assessment of an appropriate model with a 5-level rating scale. The statistics used in data analysis were means and standard deviation. The results showed that 1) the system architecture of digital activity portfolio via the internet of things for digital university consists of 3 tiers; the application tier, the network tier, and the context aware and sensing tier and 2) expert opinions on the system developed were at the good level ($\overline{X}$ = 4.60, S.D. = 0.51).

1. Introduction

Nowadays competition in higher education is intense and serious. Therefore universities, both state and private university, have to accelerate development in academic quality (Gholami et al., 2015) student satisfaction, skill supplementary activity design and management. Higher education administer realize the significance of the application of management theory: Student relationship management, student satisfaction management, parent relationship management and emphasized information and communication technology. The aim of the application is to change and develop academic capabilities (Mukwasi and Seymour, 2016; Rigo et al., 2016; Hrnjic, 2016), finally to a leading organization. Some of the examples of IT in education includes Mobile learning wireless connectivity, using online learning Management systems (Lee and Lee, 2015), internet technologies, high speed communication infrastructures, emerging technologies for visual presentation, accessing course materials through internet resources and

* Corresponding Author.
Email Address: Rukthin094@gmail.com (R. Laoha)
https://doi.org/10.21833/ijaas.2019.02.012
Corresponding author's ORCID profile:
https://orcid.org/0000-0003-3876-1625

artificial intelligence (John, 2015). Information Technology in education is defined as a combination of the processes and tools involved in addressing the educational needs and problems by using computers and other related electronic resources and technologies.

Currently information and communication technology (ICT) is a force that has changed many aspects of the way we live. Just as technology is influencing and supporting what is being learned in schools and universities, so too is it supporting changes to the way students are teaching (Bala et al., 2012). Moves from content centered curricula to competency-based curricula are associated with moves away from teacher- centered forms of delivery to student- centered forms. Through technology-facilitated approaches, contemporary learning settings now encourage students to take responsibility for their own learning.

Higher education considers information and communication technology as powerful aspect. They use ICT in such area as course material development, content delivery and content share, learner communication with other learners, teacher and outside society, lectures and presentation creation and delivery, academic studies student enrollment and administration support (Rahatgaonkar and Parmanand, 2017). Learning is no longer limited within timetables and schedules when ICT is used for Digital University.

Internet of Things (IoT) refers to the stringent connectedness between digital and physical world (Atzori et al., 2010; Madakam, 2015; ITU, 2005). Various researchers have described IoT in multitude forms:

- "a dynamic global network infrastructure with self-configuring capabilities based on standard and interoperable communication protocols where physical and virtual 'Things'
- have identities, physical attributes, and virtual personalities and use intelligent interfaces, and are seamlessly integrated into the information network" (Kranenburg, 2008).
- "3A concept: anytime, anywhere and any media, resulting into sustained ratio between radio and man around 1:1" (Srivastava, 2006).
- The International Telecommunication Union (ITU) defines IoT as "a global infrastructure for the information society, enabling advanced services by interconnecting physical and virtual things based on existing and evolving interoperable information and communication technologies". Despite the argument on the definition of IoT, sensors and communication devices are rapidly developed by many organizations. Basically, the IoT can be treated as a combination of the Internet, near field communications, and networked sensors.

In order to accomplish their study, university student have to complete the entire course specified and cover activity participation schedule. The activity is for life and social skill enhancement. Traditional time record of activity participation was paper and teacher signed to assure student participation. The advantages of using ICT for higher education stated above, the researcher developed the system architecture of digital activity portfolio via internet of things for digital university to support student activity participation. Digital activity portfolio was instrument for activity recording and participation information (Ashikin et al., 2015; Fong et al., 2014). It was for each student graduation evaluation. And it also was felicitation; decrease teacher burdensome and increase student satisfaction. Some researchers revealed that student satisfaction caused good recommendation of university to others (Bala et al., 2012).

The objectives of this study are sf follows:

- To design system architecture of digital activity portfolio via internet of things for digital university.
- To evaluate the system architecture.

2. Methodology

Phase 1 System architecture design:

- Design system architecture of digital activity portfolio via internet of things for digital university.
- Create an instrument for assessing the appropriateness of the system architecture of digital activity portfolio via internet of things for digital university.

Phase 2 evaluate of the appropriateness of system architecture of digital activity portfolio via internet of things for digital university.

2.1. Research scope

Population, samples groups and variable

- Population is the experts in the field of information technology, internet of things, and higher education.
- Samples are 10 experts in the field of information technology, internet of Things, and higher education. Chosen by purposive sampling. They are highly-experienced experts in these fields for at least 5 years.
- Variable:
  - Independent variable is the system architecture of digital activity portfolio via internet of things for digital university.
  - Dependent variable is the appropriateness of the system architecture of digital activity portfolio via internet of things for digital university.

2.2. Research tool and data analysis

The research instruments were an evaluation of system architecture of digital activity portfolio via internet of things for digital university.

The data obtained from the experts were collected and analyzed by using the statistics as follows:

- Arithmetic mean
- Standard deviation

3. Findings

The researcher designed conceptual framework to explain and make clear understanding of system architecture of digital activity portfolio via internet of things for digital university system working processes. The system consisted of 4 processes (Fig. 1: Conceptual framework of digital activity portfolio via internet of things for digital university).

For revealed conceptual framework of digital activity portfolio via internet of things for digital university; consisted of 4 processes as follows:

1. Set up event and Activity: This process is the beginning of the digital activity portfolio via internet of things for digital university. The user set up the default of the activity including the detail of is recorded through the application. Then the transmitter sensor was installed at the activity location. The user was able monitor each past performance and the system accuracy.
2. Synchronizing Signal: This process accrued after user completely set up the activity. At the beginning of the activity, students joined and got into the restricted location. The system sent the connection signal with students' card to identify that students participated the activity.
3. Transfer Data: This process followed the synchronizing signal process. It was signal connector between transmitter sensor and students' card, the receiver. This meant the data in students' card which was connected was sent to application. The data recorded in cloud database including activity data set up in process 1.
4. Reporting: Reporting is the final process. It was the process that students checked the activity participation status through the application. Students checked the number of activity they already participated. They could print the report and send it to the unit that needed the data.

After the explaining the framework to show the detail of the system working processes, the researcher presented the system architecture of digital activity portfolio via internet of things for digital university as show in Fig. 2.

The generally accepted architecture of IoT consists of three layers: perception (sensing), network, and application (Ray, 2018; Ju et al., 2016). Therefor the system architecture of digital activity portfolio via internet of things for digital university included 3 tiers as follows:

3.1. Application tier

Application Tier the interface that connected with user while using the digital activity portfolio via internet of things for digital university. It is consisted of 3 components as follows:

- Application layer was the interface working as connector with user in set up activity, monitor accuracy of activity and overall system (Lee and Lee, 2015).
- Middleware layer was system data management part for information management, service management and technical management.
- Intelligent computer technology was the needed hardware and technology system such as database server, cloud severs service oriented, platform technology, and security technology (Gubbi et al., 2013).

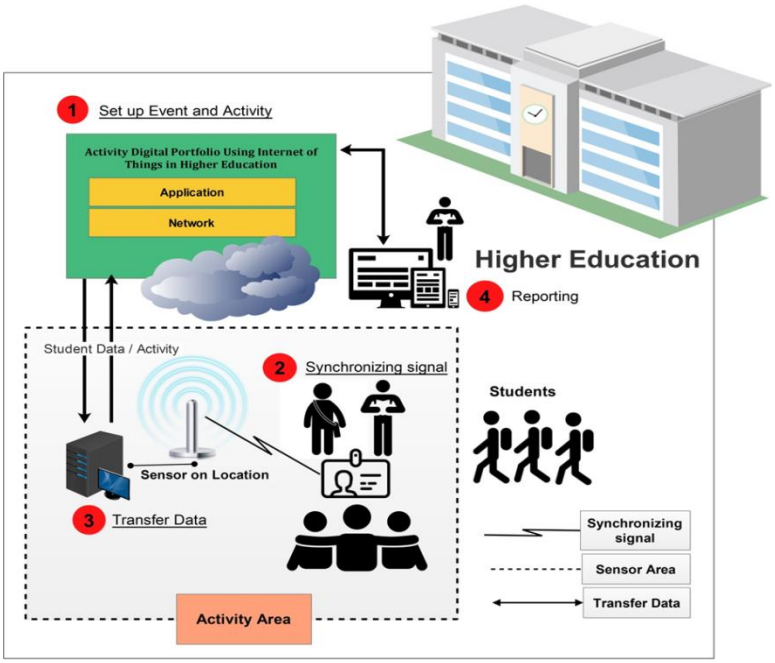

Fig. 1: Conceptual framework of digital activity portfolio via internet of things for digital university

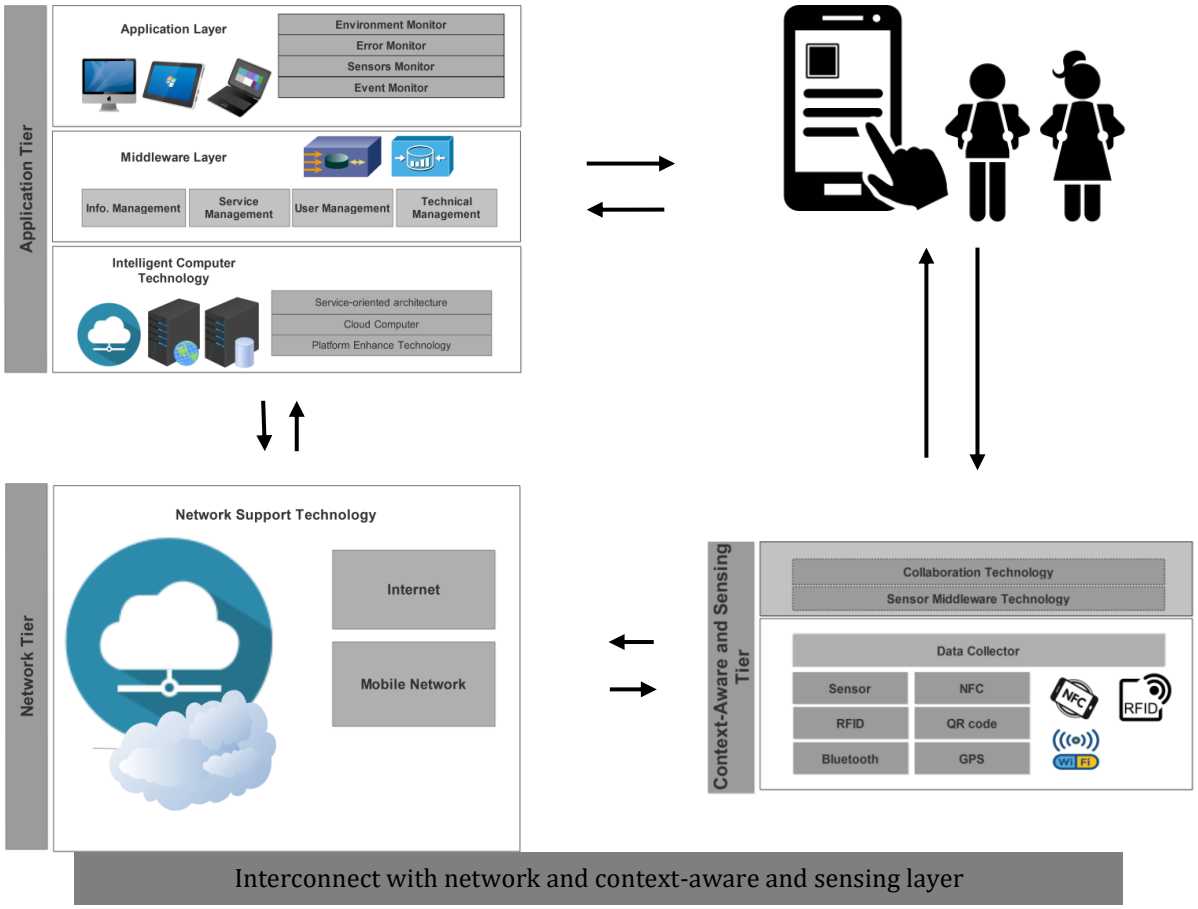

Fig. 2: System architecture of digital activity portfolio via internet of things for digital university

Cloud computing is a model for on-demand access to a shared pool of configurable resources (e.g., computers, networks, servers, storage, applications, services, software) that can be provisioned as Infrastructure as a Service (IaaS) or Software as a Service (SaaS) (Deugd et al., 2006).

Service oriented architecture (SOA) is an approach which is used to create architecture based on the use of system services. The inbuilt SoA approach is currently being invoked in IoT domain, utilizing the concept of middleware i.e., a software layer superimposed between application and technology layer which hides the unnecessary pertinent details from the developed hence reducing the time of product development, helping the design workflow be simpler to ease the process of marketing the commercial outcomes in short time duration.

3.2. Network tire

Network Tire the network for connecting with such parts as mobile network, Wifi and internet. And it worked as the connector with the next part; Context-Aware and Sensing Tier (Gubbi et al., 2013).

3.3. Context-aware and sensing tier

Context-aware and sensing Tier was sensing hardware worked as both signal transmitter and receiver. It was installed in activity location. The type of signal can be chosen based on suitability organization (i.e., RFID, Wifi, Internet and GPS). Sensing hardware has to have ability to collect data following context-aware principle. Radio frequency identification (RFID) allows automatic identification and data capture using radio waves, a tag, and a reader. The tag can store more data than traditional barcodes. The tag contains data in the form of the Electronic Product Code (EPC), a global RFID-based item identification system developed by the Auto-ID Center. Stage 2 the results of appropriateness evaluate of the system architecture of digital activity portfolio via internet of things for digital university.

The system architecture of digital activity portfolio via internet of things for digital university is rated as absolutely appropriate in overall ($\overline{X}$ =4.60, S.D. = 0.51) (Table 1).

4. Conclusion

Higher education intensive competition makes the organization realize of academic development. Therefore, higher education uses ICT such as E-learning, Mobile Learning, Cloud Technology, Augmented Reality, Virtual Reality and Iot in teaching and learning process. One of the most importance aspects is using ICT to create student satisfaction. Activity or instrument development for learning helps create the satisfaction so the researcher designed System architecture of digital activity portfolio via internet of things for digital university. The objective of the design is to automatically record student hour of activity

participation. The result of the design was 3 tiers: Application Tier, Network Tier and Context-Aware and sensing Tier. The design was accorded with P.P. Then the developed architecture was examined of its appropriation by 10 experts. The result revealed that the architecture appropriation was at "Most appropriation level. The next step of research is implementation system.

Table 1: Appropriateness evaluate of system architecture of digital activity portfolio via internet of things for digital university

System architecture of digital activity portfolio via internet of things for digital university consisted of 3 main tier	$\bar{X}$	S.D.	Appropriateness
1. Application tier consisted • Application layer • Middleware layer • Intelligent technology computer	4.70	0.48	Most appropriate
2. Network Tier consisted of • Network support technology	4.60	0.51	Most appropriate
3. Context-aware and sensing tier consisted of • Collaboration technology • Sensor middleware technology • Data collector	4.60	0.51	Most appropriate
4. Workflow sequence of system architecture of digital activity portfolio via internet of things for digital university	4.60	0.51	Most appropriate
5. Suitability to use system architecture of digital activity portfolio via internet of things for digital university	4.50	0.52	Most appropriate
	4.60	0.51	Most appropriate

Acknowledgment

Support for the new capacity building plan and the development of new researchers. Strategic Research and Innovation: Graduate category from the National Research Council of Thailand (NRCT), 2018.

Compliance with ethical standards

Conflict of interest

The authors declare that they have no conflict of interest.

References

Ashikin HT, Ruhizan MY, and Rohani S (2015). E-portfolio model development for the professional practice bachelor of teaching (PISMP) in Malaysia. Procedia-Social and Behavioral Sciences, 174: 1262-1269. https://doi.org/10.1016/j.sbspro.2015.01.746

Atzori L, Iera A, and Morabito G (2010). The internet of things: A survey. Computer Networks, 54(15): 2787-2805. https://doi.org/10.1016/j.comnet.2010.05.010

Bala SS, Mansor WFAW, Stapa M, and Zakaria MH (2012). Digital portfolio and professional development of language teachers. Procedia-Social and Behavioral Sciences, 66: 176-186. https://doi.org/10.1016/j.sbspro.2012.11.259

Deugd S, Carroll R, Kelly K, Millett B, and Ricker J (2006). SODA: Service oriented device architecture. IEEE Pervasive Computing, 5(3): 94-96. https://doi.org/10.1109/MPRV.2006.59

Fong RWT, Lee JCK, Chang CY, Zhang Z, Ngai A. CY, and Lim CP (2014). Digital teaching portfolio in higher education: Examining colleagues' perceptions to inform implementation strategies. The Internet and Higher Education, 20: 60-68. https://doi.org/10.1016/j.iheduc.2013.06.003

Gholami H, Saman MZM, Sharif S, and Zakuan N (2015). A CRM strategic leadership towards sustainable development in student relationship management: SD in higher education. Procedia Manufacturing, 2: 51-60. https://doi.org/10.1016/j.promfg.2015.07.010

Gubbi J, Buyya R, Marusic S, and Palaniswami M (2013). Internet of things (IoT): A vision, architectural elements, and future directions. Future Generation Computer Systems, 29(7): 1645-1660. https://doi.org/10.1016/j.future.2013.01.010

Hrnjic A (2016). The transformation of higher education: Evaluation of CRM concept application and its impact on student satisfaction. Eurasian Business Review, 6(1): 53-77. https://doi.org/10.1007/s40821-015-0037-x

ITU (2005). ITU internet reports: The internet of things. International Telecommunication Union, Geneva, Switzerland.

John SP (2015). The integration of information technology in higher education: A study of faculty's attitude towards IT adoption in the teaching process. Contaduría y Administración, 60: 230-252. https://doi.org/10.1016/j.cya.2015.08.004

Ju J, Kim MS, and Ahn JH (2016). Prototyping business models for IoT service. Procedia Computer Science, 91: 882-890. https://doi.org/10.1016/j.procs.2016.07.106

Kranenburg VR (2008). The internet of things: A critique of ambient technology and the all-seeing network of RFID. Institute of Network Cultures, University of Amsterdam, Amsterdam, Netherlands. **PMCid:PMC4618437**

Lee I and Lee K (2015). The internet of things (IoT): Applications, investments, and challenges for enterprises. Business Horizons, 58(4): 431-440. https://doi.org/10.1016/j.bushor.2015.03.008

Madakam S (2015). Internet of things: Smart things. International Journal of Future Computer and Communication, 4(4): 250-253. https://doi.org/10.7763/IJFCC.2015.V4.395

Mukwasi CM and Seymour LF (2016). Customer relationship management in IT service delivery: A practitioner-based inquiry in a higher education institution. In the Annual Conference of the South African Institute of Computer Scientists and Information Technologists, ACM, Johannesburg, South Africa. https://doi.org/10.1145/2987491.2987497

Rahatgaonkar S and Parmanand K (2017). ICT in higher education: Opportunities and challenges. International Journal of Research in Science & Engineering, 2(3): 4-7.

Ray PP (2018). A survey on internet of things architectures. Journal of King Saud University-Computer and Information Sciences, 30(3): 291-319. https://doi.org/10.1016/j.jksuci.2016.10.003

Rigo GE, Pedron CD, Caldeira M, and Araújo CCSD (2016). CRM adoption in a higher education institution. JISTEM-Journal of Information Systems and Technology Management, 13(1): 45-60. https://doi.org/10.4301/S1807-17752016000100003

Srivastava SK (2006). Radio frequency identification technology in retail outlets: Indian scenario. International Journal of Manufacturing Technology and Management, 10(1): 71-91. https://doi.org/10.1504/IJMTM.2007.011402