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Implementation of IOT and RFID Technology for Conducting Software in the Construction Industry

Bholanath Mukhopadhyay-BrainwareUniversity,WB
Dr.HiranmoyMondal-MaulanaAbulKalamAzadUniversityofTechnology,WB
Dr.RajuDutta-SushilKarCollege,Champahati,WB
Dr.RajeshBose-BrainwareUniversity,WB
CorrespondingAuthor
BholanathMukhopadhyay
bnmukhopadhyay@gmail.com

Abstract

The article is based on the study of implementing IOT and RFID technology for the smooth operation of the software. The concept of the internet of things provides a wide application in the construction industry. The adaption of new technologies helps in analyzing the process to facilitate the applications of the industry. The phase of the network plays a significant role to relate the analysis of the process. The process of cloud computing is also used in the identification of different levels of information. The establishment of the given technology design a wide variety of technology in building the applications of the software. The complexity of the architecture requires suitable characteristics in order to evaluate different fundamental requirements. The use of cloud computing operates with a frequency of different processes in the context of certain users of the software. The radio frequency identification enables the use of the process on the basis of different valuable information.
Keyword: IOT, RFID, cloud computing, construction industry, and software

Introduction

The IOT helps in interacting with the principles to implement the functions of suitable software used in the construction industry. In this study, different functions of IOT are explained to relate to the estimation in the construction industry. The operations of the frequency access the network to enable the different levels of information. The construction industry is connected with a huge amount of resources on the structure of different characteristics. For the smooth operation of the software, different RFID technologies are also used. The solutions of VSAT play an important role in conducting software. There are different advantages and disadvantages of RFID are explained. Different models of cloud delivery are briefly described in the phase of construction. The models of cloud delivery are IaaS, PaaS, and SaaS i.e. infrastructure as a service, Platform as a service, and software as a service used in the operation of the software. It is necessary to provide information on the context of the software to operate the software in a proper network.

Advantages of IOT in the construction industry

In the construction industry, the Internet of things i.e. IOT plays an important role. The creation of different sites provides a benefit in the framework of different workflows. According to Pane et al. (2018), the process is more consistent in minimizing the role of

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different information related to the construction industry. In implementing the IOT, the networks are more accurate to identify the functionality of the process. Following are the few functions of IOT that are also used in the construction industry. The table below provides brief information about the functions of IOT. In operating the software, the IOT is used to relate the functions on the basis of suitable factors of the development process (Asunsanmi et al. 2018).On the other hand, there are various disadvantages of IOT in the construction industry, such as compatibility, complexity, and privacy. The IOT authorize the use of the resources on the solution of the construction industry. The failure of the system regenerates a issue on the release of different related information on the level of security. The technology of IOT addresses the different concepts to generate the perspectives of the process. The different construction industry acquires the perspectives on the availability of the internet.

SI NO	IOT in the construction industry	Description of the IOT
1	Monitoring the site	The machines construct the practices based on different analysis of the process
2	Controlling the machine	The iot helps in minimizing the availability of the process to control the machine.
3	Safety of construction	The different technologies are used in the safety of construction to enhance the performance of IOT.
4	Management of different resources	The resources are maintained to analyze the functions of IOT on the management of the construction industry.
5	Project management criteria	It facilitates the technique to monitor the project on the devices of IOT.

Following are some advantages of IOT in the construction industry for the easier flow of the network:

- The sites of construction help in generating the phase of the IOT to operate in an easier manner.

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- The operations are maintained to prevent the functionality of the IOT in the construction industry.
- Effective resources are used to enable the usage of different resources for the smooth operation of the network.
- With the use of IOT devices in the construction industry, the different terms relating to the analysis on the coordination of certain factors.
- The efficiency of IOT helps in increasing the quality of construction to access the ability of the industry.
- The procedures of different operations increase the effectiveness in terms of their quality, profitability, and level of efficiency.

The construction industry provides a better service to determine the functionality of the IOT in the process of accomplishment. The process of construction work in a smoother manner to optimize the performance of the IOT sector. These are the advantages of IOT which are used in the construction industry for the smooth functioning of the software (Ghosh et al. 2020).

Importance of cloud computing in construction industry

Cloud computing has brought revolutionary changes in the field of construction industries. According to Oke et al. (2021), in the construction industry there are heterogeneous data generated in the completion of a project. These data can be easily managed through the cloud computing technology and can be easily accessible during the requirement period. Service Oriented Architecture (SOA) in the cloud computing allows the construction industry to share the physical as well as the non-physical aspects of infrastructure used in the project. In today's time, construction industries are shifting towards the online platform in which they require a solution to secure their data as well as assessment of data in the required time. Cloud computing provides remote access features and benefits the construction industry on a large scale. Construction industries are rapidly shifting to the online platform for the improvement of their business as using cloud computing is more cost effective than building up their own house server.

According to Garyaev and Rybakova (2018), cloud computing doesn’t require any server maintenance cost which saves the budget of the construction industry. By adopting the cloud computing technology, the construction industries get flexibility to start work either from the home, office or construction site. It will save the time of the workers and they will properly utilize that time in the project. The major benefit of the cloud computing in the construction sites is that it allows the construction industry to grow as well as shrink as it allows making their own cloud server which is completely scalable and customized. The most important thing about implementing cloud computing technology in the industry is the security of the data. In the construction industries there is lots of travelling involved by the project manager between the field office and worksites. The keeping track of the real-time updates is much more difficult. According to Nunez et al. (2018), cloud computing provides a solution as it provides a way to access the construction software as well as the data whenever required as well as the assessment can be done from any place.

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There is huge data present in the progress of the project which includes data related to the wholesale trade, manufacturing, transportation, and finance and warehousing. These data are in large amounts which are difficult to manage through the traditional method of storing data. In the local office setting up this data will be much more expensive. Cloud computing provides HPC which is known as Higher-Performance Computing to manage all the functions of the construction industry. The variable amount of data storage is required by the construction industry which depends on the project. The infrastructure and the data are not completely utilized due to present in the local hardware which results in low productivity. According to Salhaoui et al. (2019), cloud computing provides a service known as scaling on-demand which provides an effective way to utilize the resources by eliminating the situation of storing the data in the local hardware. On the other hand, there are some drawbacks of cloud computing in the construction industry such as network connection, loss of control, and security. The process of cloud computing needs a suitable network on the dependency of the industry. The data centers and servers measures the estimation of the process to ensure the integrity and the safety functions. The disadvantages of cloud computing are more prevalent in Saas providers than that of hosted providers. The hosted provider are more frequent as compared to that of Saas provider.

Use of RFID technology for the smooth operation of the software in the construction industry

RFID stands for Radio-frequency identification to capture different devices to access the functionality of the software. According to Mahmud et al. (2018), in the operation of software, RFID plays an important role to work on the infrastructure of different processes. There is a different use of RFID technology which helps to enable the functions in terms of certain characteristics. It requires different technologies which are used to provide a wide range of applications. The system of RFID requires different operations of software to reduce the effect of cost-efficiency. The different raw materials used in increasing the estimation of the technology. The construction industry provides a number of information to reduce the estimation of the process. It helps in monitoring the process of construction to facilitate the applications of RFID technology. The use of RFID depends on the analysis of the process in the context of different parameters. The influence of the given technology enables the frequency for implementing the phase of construction (Wang et al. 2020).

The smooth operations of the construction industry are given in terms of the frequency range in the technology of RFID.

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Series Number	Range of frequency	Frequency parameters	Distance range in the construction industry
1	(123-149)KHz	Having a lower range of frequency parameters	<2 m
2	12.55 MHz	The higher range of frequency	<20 cm
3	(431-925)MHz	The lower range of frequency	<100 m
4	(2.43-5.7)GHz	Microwave operations of software	<2 m
5	(2-9.5)GHz	Higher frequency	<10 m

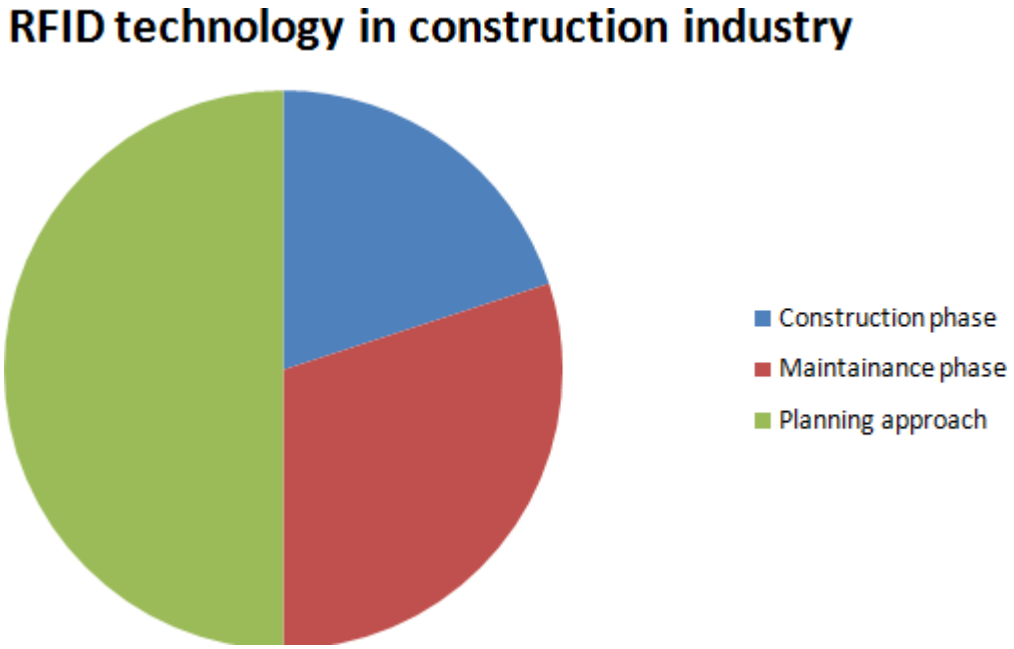

Figure 1. RFID technology in construction industry
(Source : Wang et al. 2020,p.854)

As mentioned in the given table, the information of RFID systems collects different information in the transmission of suitable efficiency of the software. In the construction industry, the different ranges of frequency are given in the parameter of certain construction materials. The RFID is widely used in the phase of construction to provide suitable factors such as planning and design, construction, commission, operation, and maintenance shown in the diagram (Chung et al. 2020). It involves different uses in the applications of the industry

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for the purpose of the software. The level of information is used in the phase of construction to reduce the ability of the software. On the other hand, various researches have stated that, the access use of RFID technology causes different drawbacks such as identification of barcode leads to the problem of scanning devices in the perception of the software.

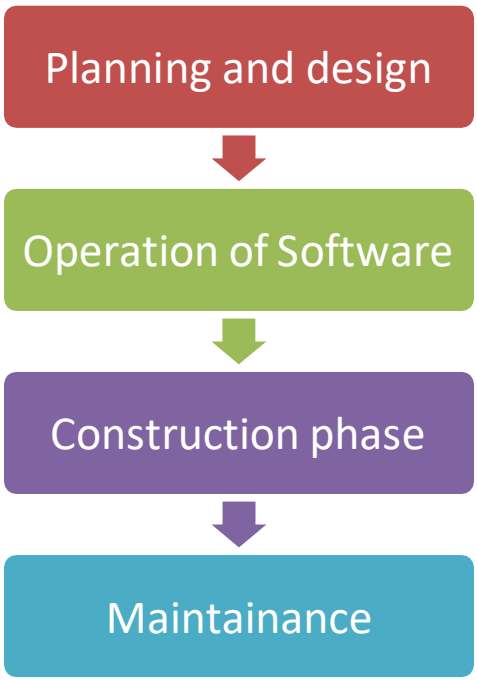

Figure 2. RFID in the operation of the software in the construction industry (Source: Chung et al. 2020,p.837)

Advantages and disadvantages of RFID technology in construction industry

Radio Frequency Identification technology (RFID) has several advantages in the construction industries as implementing RFID can overcome the various issues of the construction industries that occur during the management of the materials. According to Nunes et al. (2019), the various components of the RFID technology are used for tracking the construction materials in the construction sites. The RFID technology used the various data that was collected during the progress of the project in an efficient way which improves the productivity of the industry. According to nayak (2019), the tools that have been checked out and how long the tool was used can be easily tracked through the RFID technology. In the construction site, there is a major requirement of the worker safety which is easily provided by the RFID technology as it provides guardrails and installs readers around the potential hazards which would activate and alert the workers during the danger time. After the completion of the construction RFID can be used as RFID tags on HVAC systems. For controlling the temperature and lighting system the network RFID is paired with the sensor.

On the other hand, there are some disadvantages of implementing RFID in construction industries as implementing RFID readers is very expensive as compared to the bar code reader. According to Elbasani et al. (2020), implementation can be much difficult and also a lot of time is put into implementing this in the construction sites.

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Role of VSAT solutions in conducting software in the construction industry

VSAT plays an important role in conducting the software in the construction industry. It stands for a very small aperture terminal to receive the transmission of data in the smooth functioning of the software. According to Liang and Chen (2018), the transmission of data enables the use of software to provide a connection on the phase of the industry. The infrastructure of the terminal is used in different management processes for the evaluation of the network. It has successfully been used in the scheme of monitoring the construction phase based on the functions of the software. The given VSAT solutions are also used to operate the software in order to reduce the functionality of the network (Gamil et al. 2020).

VSAT is used in the implementation of different networks depending on the sites of the construction industry. The availability of VSAT allows the system to enhance the use of software so that the network works properly. The Reliability of the satellite provides an approach to receive different levels of performance. According to Chen and Aini (2020), the network management of VSAT provides suitable functions related to the quality of the system. There is a suitable advantage of VSAT which offers a unique range of estimation. The advantages are reached mobility, quick deployment, scalability, and reliability. The network of VSAT provides suitable information in a wide range of connections. The requirement of VSAT solutions helps in deploying the process on the technology of certain characteristics. The network phase of VSAT requires connectivity to a range of different technologies. The internet access of VSAT provides a suitable operation on the possible given services (Konikov 2019).

The satellite network accesses the use of the software on the ability of different phases of the construction industry. The terminals of VSAT collaborate with different information which is needed to reflect the estimation of the technology. There are different benefits of VSAT on the analysis of the suitable operation of the software to achieve a better network. The acceptance of VSAT is affected by the plans of the given software to link a suitable module of estimation. It supports better services on the performance of certain levels of efficiency which are used in the sites of construction. These are the various roles of the VSAT in conducting the software in the construction industry (Thibaud et al. 2018). On the other hand, there are various disadvantages of VSAT solutions on the transmission of various packets. Latency of the packet realizes the perspectives on the accuracy of the solutions.

Cloud delivering model

Cloud provider offers a pre-packaged combination of IT resources which is represented through the cloud delivery models. According to Kuamr et al. (2018), infrastructure-as-a-Service (IaaS), Platform-as-a-Service (PaaS) and Software-as-a Service (SaaS) is the common cloud delivery models which are used. All these models are interrelated with each other.

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SI NO	Cloud delivery models	Examples
1	IaaS	Microsoft, CPU and Amazon
2	PaaS	PHP and python
3	SaaS	Excel, Email and word

Infrastructure-as-Service (IaaS) - In the IaaS self-contained IT environment is provided which comprises the network, IT resources, hardware (virtual) and the connectivity. The IT resources have been packaged as well as virtualized however; these IT resources are not preconfigured. According to Ramachandra et al. (2017), the cloud consumer has full administrative control on the environment of cloud based and the cloud consumer is operationally responsible. Amazon EC2 is the example of commercial available IaaS(Infrastructure-as-Service). Cloud consumers will be enabled within a minute to spin up the virtual server. In the IaaS environment, virtual servers are used by the cloud consumer. Cloud providers provide a range of contractual guarantees to the cloud consumer about the characteristics such as performance, availability and the capacity. According to Suryateja (2018), visualization is the fuanmenta basis in which the cloud computing lies. The required computing resources are abstracted from the cluster of the connected servers and the network hardware with the help of the visualization. According to Zheng and Zheng (2018), IaaS provides a facility to the users to choose the computing resources as well as the number of servers, operating software, file storage system and network infrastructure to set up the software applications. Scalability of features, seamless management and the resources required are enabled through the single service delivery point which extend the feature of any user. Cloud computing service providers bundle the virtual networks, load balancers and firewall which are the parts of customized offering or the scaled on demand (Markova et al. 2019). The cloud computing become economically attractive due to the elasticity in computing resources as well as the elasticity present in the hardware. Thisalso makes the it more viable model and commercially strong model. All the three models provide a brief description about the analysis of the process.

Integration-Platform-as-a-Service (iPaaS) - iPass is a cloud based integration platform for deploying and building the solutions among the premise application as well as between the different clouds. ipass is the variation on the Pass deployment model. According to Tadapaneni (2018), in the early stage iPaaS has a big downside and risk of the vendor lock-in gets increased. TIBCO cloud integration (TCI) is the example of commonly available iPaaS. This cloud delivery model was designed for catering to the software developers as well as their growing requirements for deploying, designing and the web applications without having stressed about the configuring the infrastructure requirements. In thismodel the maintenance of the underlying computing infrastructure is needed for the software development.

Software-as-a-Service (SaaS) - The services and the products which exist as a shared cloud Service is delivered through the SaaS delivery model. The cloud services underlying IT resources are maintained through the cloud provider. The IT resources include the cloud services itself.

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SaaS doesn't provide administrative control to the cloud consumer like the IaaS and iPaaS.SalesForce Cloud2 is the example of the commercially available SaaS. This model is most popular among the entire model. Google Docs, Microsoft 365 are the most common example ofSaaS model. In this model the users have to only concern regarding the functional features offersby this model. The given cloud delivery models represents a specific combinations on the sources of cloud computing. The given three models deliver the combination of different resources to offer specific requirements. This model was developed so that the users use the software that was designed across that model. It provides relaxation to the end user as they need not to concern regarding the setup of the software. The end-users are also free to have knowledge about the underlying the hardware as well as with the computing infrastructure.

On the other hand, cloud delivery models provides a disadvantage about the potential security on the concern of different level of information. The different services acquire different information on the need of the construction industry.

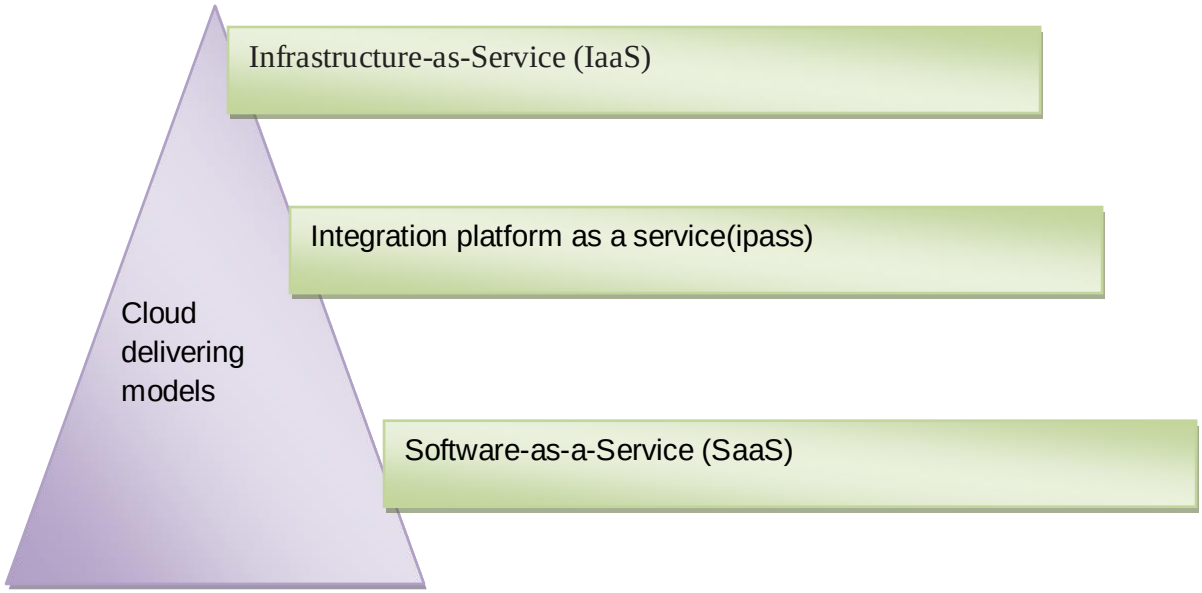

Figure3 : Cloud delivering models
(Source: Kalaiprasath et al. 2017, p.765)

Conclusion

In this article, we have discussed implementing the IOT and RFID in the construction industries. Construction industries are shifted towards the online platform where the IOT, RFID and cloud computing helps the industries to grow higher with enhanced productivity. In the article we have discussed that the IOT technology helps us to implement the software that will reduce the kinds of accidents that happen on construction sites. VSAT provides software which will work in those construction sites where the network is very poor. Cloud computing helps in the construction industries by providing them a large storage to record all the data collected during the progress of the project. RFID provides sensors to protect the workers from the hazards taking place at the construction sites. RFID has several advantages however, its higher price increased difficulties in implementing it in the construction sites.

Cloud delivering models provides three models for representing the pre-packaging IT resources provided by the cloud provider. These all technologies help the construction industries to grow more successfully through the online platform.

References

1. Asunsanmi, T.O., Aigbavboa, C. and Oke, A., 2018. Construction 4.0: the future of the construction industry in South Africa. *Int J Civ Environ Eng*, *12*(3), pp.206-212.
2. Chen, X.W. and Aini, N., 2020. Barriers to RFID Adoption in Material Management of Construction Industry: The Perception of Project Manager. *INTI JOURNAL*, *2020*(7).
3. Chung, W.W.S., Tariq, S., Mohandes, S.R. and Zayed, T., 2020. IoT-based application for construction site safety monitoring. *International Journal of Construction Management*, pp.1-17.
4. Elbasani, E., Siriporn, P. and Choi, J.S., 2020. A Survey on RFID in industry 4.0. In *Internet of Things for Industry 4.0* (pp. 1-16). Springer, Cham.
5. Gamil, Y., Abdullah, M.A., Abd Rahman, I., and Asad, M.M., 2020. Internet of things in construction industry revolution 4.0. *Journal of Engineering, Design, and Technology*.
6. Garyaev, N. and Rybakova, A., 2018. Cloud interaction technologies in the design and construction. In *MATEC Web of Conferences* (Vol. 170, p. 01076). EDP Sciences.
7. Ghosh, A., Edwards, D.J. and Hosseini, M.R., 2020. Patterns and trends in Internet of Things (IoT) research: future applications in the construction industry. *Engineering, Construction, and Architectural Management*.
8. Kalaiprasath, R., Elankavi, R. and Udayakumar, R., 2017. CLOUD SECURITY AND COMPLIANCE-A SEMANTIC APPROACH IN END TO END SECURITY. *International Journal on Smart Sensing & Intelligent Systems*, *10*.
9. Konikov, A., 2019, December. Use of satellite technology for monitoring buildings and structures. In *IOP Conference Series: Earth and Environmental Science* (Vol. 403, No. 1, p. 012223). IOP Publishing.
10. Kumar, P.R., Raj, P.H. and Jelciana, P., 2018. Exploring data security issues and solutions in cloud computing. *Procedia Computer Science*, *125*, pp.691-697.
11. Liang, X. and Chen, Y., 2018. Libraries in the internet of things (IoT) era. *Library Hi-Tech*.
12. Mahmud, S.H., Assan, L. and Islam, R., 2018. Potentials of the internet of things (IoT) in the Malaysian construction industry. *Annals of Emerging Technologies in Computing (AETiC), Print ISSN*, pp.2516-0281.
13. Markova, O., Semerikov, S., Strum, A., Shalatska, H., Nechypurenko, P. and Tron, V., 2019. Implementation of cloud service models in training of future information technology specialists.
14. Nayak, R., 2019. *Radio Frequency Identification (RFID): Technology and Application in Garment Manufacturing and Supply Chain*. CRC Press.
15. Nunes-Silva, P., Hrncir, M., Guimarães, J.T.F., Arruda, H., Costa, L., Pessin, G., Siqueira, J.O., De Souza, P. and Imperatriz-Fonseca, V.L., 2019. Applications of RFID technology on the study of bees. *Insectes sociaux*, *66*(1), pp.15-24.

Annals of R.S.C.B., ISSN: 1583-6258, Vol. 25, Issue 1, 2021, Pages. 5738 - 5748
Received 15 December 2020; Accepted 05 January 2021.

16. Núñez, D., Ferrada, X., Neyem, A., Serpell, A. and Sepúlveda, M., 2018. A user-centered mobile cloud computing platform for improving knowledge management in small-to-medium enterprises in the Chilean construction industry. *Applied Sciences*, *8*(4), p.516.
17. Oke, A.E., Kineber, A.F., Albukhari, I., Othman, I. and Kingsley, C., 2021. Assessment of Cloud Computing Success Factors for Sustainable Construction Industry: The Case of Nigeria. *Buildings*, *11*(2), p.36.
18. Pane, S.F., Awangga, R.M. and Azhari, B.R., 2018. Qualitative evaluation of RFID implementation on warehouse management system. *Telkomnika*, *16*(3), pp.1303-1308.
19. Ramachandra, G., Iftikhar, M. and Khan, F.A., 2017. A comprehensive survey on security in cloud computing. *Procedia Computer Science*, *110*, pp.465-472.
20. Salhaoui, M., Guerrero-González, A., Arioua, M., Ortiz, F.J., El Oualkadi, A. and Torregrosa, C.L., 2019. Smart industrial iot monitoring and control system based on UAV and cloud computing applied to a concrete plant. *Sensors*, *19*(15), p.3316.
21. Suryateja, P.S., 2018. Threats and vulnerabilities of cloud computing: a review. *International Journal of Computer Sciences and Engineering*, *6*(3), pp.297-302.
22. Tadapaneni, N.R., 2018. Cloud Computing: Opportunities And Challenges. *Available at SSRN 3563342*.
23. Thibaud, M., Chi, H., Zhou, W. and Piramuthu, S., 2018. Internet of Things (IoT) in high-risk Environment, Health, and Safety (EHS) industries: A comprehensive review. *Decision Support Systems*, *108*, pp.79-95.
24. Wang, M., Wang, C.C., Sepasgozar, S., and Zlatanova, S., 2020. A Systematic Review of Digital Technology Adoption in Off-Site Construction: Current Status and Future Direction towards Industry 4.0. *Buildings*, *10*(11), p.204.
25. Zheng, Z. and Zheng, Z., 2018. Towards an improved heuristic genetic algorithm for static content delivery in cloud storage. *Computers & Electrical Engineering*, *69*, pp.422-434.