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Radio Frequency Identification (RFID) Implementation for Improving IBS Components Management at Manufacturer Storage Area

Wee May Ying[1], Narimah Kasim[1,2,*], Rozlin Zainal[1,2], Sharifah Meryam Shareh Musa[1,2] & Hamidun Mohd Noh[1,2]

[1]Department of Construction Management, Faculty of Technology Management and Business, University Tun Hussein Onn Malaysia, 86400 Batu Pahat, Johor, MALAYSIA

[2]Centre of Excellence for Facilities Management (CeFM), Faculty of Technology Management and Business, University Tun Hussein Onn Malaysia, 86400 Batu Pahat, Johor, MALAYSIA

*Corresponding Author

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Abstract: Radio frequency identification (RFID) has been broadly applied in various industry but in construction industry the current technology used to identify the components are still barcodes technology. The major issue found in precast manufacturer were the difficulties in locating precast pieces at storage area that stored thousands of different component. With the current barcode technology, it required a line of sight to access each code. Hence, finding pieces becomes very difficult. The objectives of this research are to study the potential, identify the challenges and to determine the improvement ways of radio frequency identification (RFID) implementation for improving IBS components management at manufacturer storage area. To achieve the objectives of this research, quantitative method was adopted by using questionnaire. Questionnaires were distributed to IBS manufacturers in Selangor area to obtain data. The research findings revealed that provide real time tracking of IBS components, provide real time identification of IBS components and reduce manual interference in the management process are top three key potential influencing implementation of RFID technology by the IBS manufacturer. The research also identifies high cost for active tag implementation as key challenges that encountered by IBS manufacturer and main improvement ways of RFID technology implementation is technology promotion by top management. In conclusion, this research can assist the IBS manufacturer who wish to implement RFID technology in IBS component management.

Keywords: IBS components, Manufacturer, RFID, Storage area

**Corresponding author: narimah@uthm.edu.my*

1. Introduction

Radio frequency identification (RFID) is an automatic identification (Auto-ID) system that comprises the radio tags that able to collect and transmit the information through scanner, and finally reach the host computer. RFID also can be said as an advance of barcode technology, where it can further increase the labour productivity (Want, 2006). However, few issues in the research is identified. Therefore, this study is seek to investigate the implementation radio frequency identification (RFID) for improving IBS components management at storage area. Industrialised Building System (IBS) is a construction method adopted by the Malaysian Contractor in construction project. IBS is referred as a component that manufactured at the factories on or off site, transported and then finally assembled it on site (Azman *et al*., 2011). According to Shahzad (2011), the issues that arise during the process of IBS manufacture are component management. The largest components of IBS for example, concrete products led to the difficulties in the logistic and stock management at the storage area. It can be seen that larger storage area is needed for IBS components and area for trailers and cranes movement. The costing for establish a new factories will increase (Badir *et al*., 2002).

IBS system has provided many advantages to the construction industry, but there is a problem when comes to storage area. Most of the IBS project requires a large storage area for plants, trailers, tower cranes as well as the IBS components (Othuman *et al*., 2014). Hence, more factory will establish and rises up the cost to the manufacturer. Besides, the stacked segments pile that collapse cause chaos in the storage area. It is depends on the type of segment where constant height or different height and the base is arranged in parallel or non-parallel rows (Fédération internationale du béton, 2017). Ergen *et al.* (2007) conclude the problem found in precast manufacturer which is difficulties in locating precast pieces in storage area. Finding the required pieces can be very challenging since there is a thousand of various pieces stored in the storage area and line of sight is required for barcode technology. Meanwhile, 10 workers work at storage area and takes about 30 minutes to 1 hour to locate a component in that area. When the workers not able to locate pieces in storage area, the particular pieces have to cast again, resulting delay. The manufacturers pay annual penalties approximately USD 60,000 for late deliveries which mainly due to issues in locating component. In additional, manufacturer also responsible for any possible defects and failures of precast pieces for up to 25 years. The factors such as cement aggregates, the number of times a component is handled, site condition during construction may cause a defect on a precast components. However, manufacturer have to quickly identify these factors when there is defect or failure exist and fix the problem efficiently and prevent similar failures appear in other pieces. The data related to the history of a component currently stored in documents which are not easily to accessible.

This research is focusing on implementation of radio frequency identification (RFID) for improving IBS components management at manufacturer storage area. In this research, radio frequency identification (RFID) could bring advantages in terms of material management to the construction industry. It can improve locating and tracking, effectiveness of material management in the construction industry. By implementing this technology, it also able to reduce time tracking and labor cost while managing their material. The result of the finding can provide a reference to the relevant academic experts about the related topic and issues. It is also expected to be used in assisting related field of academic study in the future. Therefore, this study is carried out to investigate the potential of radio frequency identification (RFID) implementation, the challenges of radio frequency identification (RFID) implementation, and the improvement ways of radio frequency identification (RFID) implementation for improving IBS components management at manufacturer storage area.

2. Literature Review

2.1 Potential of RFID technology implementation in IBS component management

According to Schneider (2003) stated that the application of RFID has the potential for material component tracking. RFID technology provides the incremental improvement compared to the existing methods, it reduced labor costs and provide real time identification and tracking. RFID systems also

have great potential to improve in productivity, quality, safety and economy in the construction industry. Akinci (2002) proposed a system which implementation of RFID technology in a manufacturing plant to locate the precast component, track and delivery components and store components information for future use. This system is able to enhance the efficiency of locating the precast components in manufacture storage area. It also can track the precast components during the delivery process which beneficial for just in time delivery.

Besides, RFID has the function storing component information which enables manufacturers quickly retrieve the history of the component and identify the cause of the problem that possibly occur after the construction phase (Akinci, 2002). RFID also can instantly read large number of RFID tags that mounted on the component within a second without moving physically of the materials or open it. RFID tags are reusable, not easily damage and readable in harsh condition (Prakash *et al*., 2016). In conclusion, the Table 1 shows the potential of RFID technology implementation in IBS components management at manufacturer storage area.

Table 1: Potential of RFID technology implementation in IBS component management

Potential of RFID technology	Description
(a) Improvement of existing tracking technology	Reduced cost and provide real time tracking.
(b) Enhance the efficiency in locating precast pieces	Locate the precast component, track and delivery components and store components information for future use.
(c) Quickly retrieve history of components	Retrieve history of the component and identify the problem of components.
(d) Instantly read large number of tags without a line of sight	Read all the tags within a second without moving physically of the materials.

2.2 Challenges RFID technology implementation in IBS component management

EPC global and International Standards Organization (ISO) are two main standardization bodies with a different purpose. Wal-Mart used EPC global while DoD used EPC for general purposes and ISO standard for air interface. Both standardization bodies were not compatible. Furthermore, there are different classes of tag used by the EPC caused interoperability problem. Lack of compatible standards caused market players refuse to invest in the technology because it requires constant changes and reinvestment. Standardization RFID is important in inter-organizational relationship. However, currently no standard information can facilitate sharing among the other supply chain partners (Lu *et al.*, 2011).

RFID using chipless technology and it cost has been reduced over previous years, but still relatively high price, especially RFID active tags (Majrouhi, 2012). The reading range of RFID increases as the size of components larger and eventually it will rise the cost to the manufacturers (Goodrum *et al.*, 2006). RFID should provide accurate tracking and locating components compare to manual practices. However, it is suitable for identification purposes in tracking individual items, but current applications do not provide sufficient location accuracy (Majrouhi, 2012). Furthermore, the radio signal also can interfere with the metal, steel objects, water or other radio frequency signals. IBS components that store in the open area may cause poor performance (Majrouhi, 2012).

Lu *et al.* (2011) state that there is no research proven that radio frequency is harmful to human at the moment, but there is still a doubt in RFID to health issues. Ethical issues should also take in consideration when handling the components where their positions were tracked or their information was captured. In conclusion, the Table 2 shows the challenges of RFID technology implementation in IBS components management at manufacturer storage area.

Table 2: Challenges RFID technology implementation in IBS component management

Challenges RFID technology	Description
(a) Lack of compatible standards	Market players unwilling to invest in the technology because it require constant changes and reinvestment
(b) High cost of RFID	Active tags cost higher than passive tags. Longer reading range will need to add cost to implement RFID
(c) The accuracy of RFID technology	RFID does not provide sufficient location accuracy like GPS.
(d) Poor performance to metal and water object	Interference of metal and water objects may cause poor performance of radio frequency
(e) Health and ethical issues	Longer exposure to radio fequency may harmful to human. Ethical issues concern when handling the information of components.

2.3 Improvement ways of RFID technology implementation in IBS component management

The IBS manufacturers and Government policy makers can have more collaboration, encourage and promote the implementation of RFID. Government can provide incentive policies as a foundation to motivate technology innovation such as tax exemptions and technology implementation subsidies to encourage the employing of RFID technology and promote transformation of the IBS components management process (Ang *et al*., 2016). In addition, Ang *et al*. (2016) state key element to enhance the implementation of technology in the IBS components management process is the support from top management. Top management provides support and commitment and organize a better training procedure to the skilled employee to develop adequate skills and knowledge in RFID technology.

More academic research on RFID technology need to be carried out for the improvement of implementation RFID technology. For the future years there will be a need for basic supporting research to explore the potential of RFID technology and demonstrate its positive effects on IBS manufacturing process in construction industry. The research probe on how real time data on RFID have and will affect the organization in terms of internal operation and partnership relationship. Meanwhile, expanding of existing relevant education programmes at universities and other training institutions also tends to raise awareness about the RFID solution at construction (Erabuild, 2006).

Setting up in joint public or private institutions in construction industry can initiate pilot projects that showing benefits of using RFID technology for improving manufacturing process or supply chain. This should together with marketing and disseminate results widely which will encourage companies employing the technology. The joint public or private institutions are as a benchmarking on demonstration projects, interchange of results and practical solutions (Erabuild, 2006). In conclusion, the Table 3 shows the improvement ways of RFID technology implementation in IBS components management at manufacturer storage area.

Table 3: Improvement ways of RFID technology implementation in IBS component management

Improvement ways RFID technology	Description
(a) Government policies	Incentive policies such as tax exemptions and subsidies
(b) Top management support	Top management support, commitment and training procedures to employees

(c) Research on RFID technology	Research provide support to explore potential of RFID technology
(e) Demonstration of projects	Joint public or private institutions initiate pilot project showing benefit of RFID technology

3. Research Methodology

3.1 Research Design

Quantitative approach was used in this research. Williams (2007) stated that quantitative research are starting with the problem statement, generating a hypothesis or research question, reviewing related literature and finally an analysis quantitative data. This research consists of 5 phases which illustrate the whole process from the start of the activity until the end of the research (Refer Figure 1). There are two types of data which is primary data and secondary data. All the information is collected from primary and secondary data in this research.

Primary data is using quantitative approach through a questionnaire to obtain data related to the implementation of radio frequency identification (RFID) for improving IBS components management at manufacture storage area. The respondent who participated in this research was IBS manufacturers. Secondary data is the data which already collected or produced by others. Secondary data can obtain in very easy and rapid way via the sources such as government publication, websites, books, journal articles, internal records, proceedings papers, etc. (Ajayi, 2017).

A research population is defined as a group of individuals that consist the same characteristic. The target population for this research are IBS manufacturers in the construction industry. There are a total amount 113 of IBS manufacturers in Selangor area. A research sampling is where a subgroup of the target population that the researcher plans to study for the purpose of making generalizations about the target population. This study will focus on the IBS manufacturer in Selangor area. There are total of 74 IBS manufacturer conducted using the quantitative method.

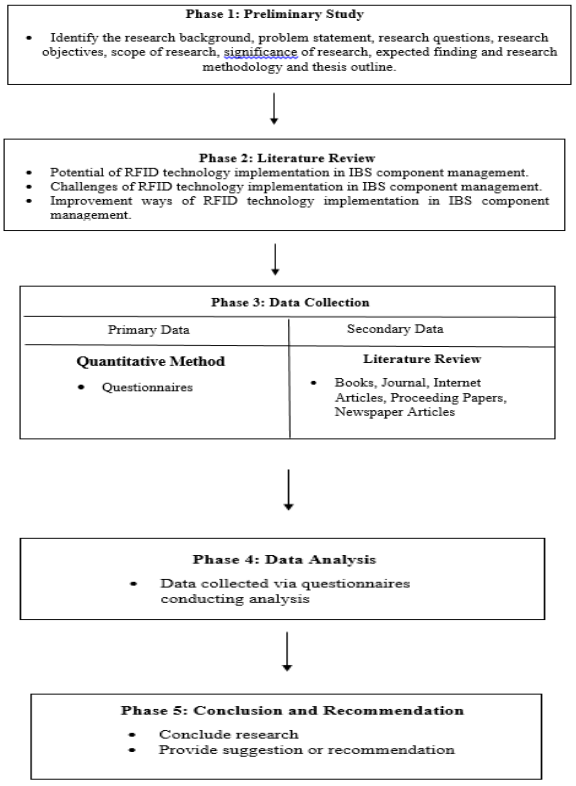

Figure 1: Research methodology flow chart

3.2 Data Collection

Questionnaire is the major instrument in this research. The questionnaire conducted by the researcher consists of three main sections. The first section questions about respondent demographic. Second section investigate the potential of RFID implementation in IBS components management at manufacturer storage area. Third section investigate about the challenges of RFID implementation in IBS components management at manufacturer storage area and fourth is the improvement ways of RFID implementation in IBS components management at manufacturer storage area. A set of structured questions designed and developed to obtain the data that required. The designed questions are focused on IBS manufacturer at Selangor.

3.3 Data Analysis

SPSS software and MS Excel was used to conduct descriptive analysis and present the data in the form of table, bar chart in the research. It provides the sample and the measures a simple summary together with the graphical analysis of the quantitative data that collected. Research involves descriptive analysis provides valuable information about the particular group of individuals (Best & Kahn, 2003).

4. Results and Discussion

4.1 Validity analysis and pilot test reliability

Pilot test refer as a small study to test the research reliability before proceeding to the larger study Lancaster *et al* (2004). It is an important stage in the research and the purpose conducted is to identify the potential problems in the implemented research instruments. There are 5 respondents involved in the pilot study, which include lecturer and PhD student in Universiti Tun Hussein Onn Malaysia (UTHM). Reliability test is to identify the quality of the data in the questionnaire and generate an accurate result. Cronbach's Alpha is a statistic to demonstrate the tests and scale for a research study that has been conducted (Keith, 2017). Table 4 shows the result of reliability test for the research. The Cronbach's Alpha for the actual test reliability test was 0.782 for 36 questions. The total respondents involved was 74 respondents. This means the reliability of the research instrument is good. Table 5 shows the respond rate of the questionnaire distributed 100%, received 65% and not received with 35% percentage respectively.

Table 4: Reliability statistics

Reliability Statistics	
Cronbach's Alpha	N of Items
0.782	36

Table 5: Respond rate

Questionnaire	N	Response Rate
Questionnaire Distributed	113	100%
Questionnaire Received	74	65%
Questionnaire Not Received	39	35%

4.2 Descriptive analysis

(a) Respondent Demographic

The entire of the data of respondents background are include of gender, age, highest academic qualification, position held, working experience for IBS and working experience with RFID as below Table 6. The data in the table below include the frequency and the percentage of the respondent. According to the table shown below, most of the gender are male (63.5%) who holding Bachelor Degree (60.8%) with the position Project Engineer (28.4%). The respondents involved are mostly between 41-50 years old (32.4%) because the research undertaken with respondent which is managerial level. Most of the respondents have working experience for IBS 10 years and above (33.8%) and working experience with RFID 0-3 years (45.9%).

Table 6: Respondent demographic

Item		Frequency	Percentage (%)
Gender	Male	47	63.5
	Female	27	36.5
Age	20-30 years old	20	27.0
	31-40 years old	14	18.9
	41-50 years old	24	32.4
	51 years old and above	16	21.6
Highest Academic Qualification	Bachelor Degree	45	60.8
	Master	29	39.2
Position Held	Factory Manager	11	14.9
	Production Manager	15	20.3
	Project Engineer	21	28.4
	Quality Control Inspector	3	4.1
	Project Manager	14	18.9
	Other	10	13.5
Working Experience for IBS	0-3 years	18	24.3
	3-5 years	11	14.9
	5-9 years	20	27
	10 years and above	25	33.8
Working Experience with RFID	0-3 years	34	45.9
	3-5 years	18	24.3
	5-9 years	13	17.6
	10 years and above	9	12.2

(b) Potential of RFID implementation at IBS components management

According to the Table 7 below, it consists the potential of RFID implementation IBS manufacturer storage area. The highest mean of the potential of RFID implementation is 4.57 which is "Provide real time tracking of IBS components" within 74 respondents, whilst having standard deviation (0.551).

From the result, we can see major respondent agreed with the potential of RFID where it can provide real time tracking of IBS components in the manufacture storage area. Huang *et al* (2007) investigated that RFID have a better real time traceability and visibility when implement in the manufacturing jobsites.

For the lowest mean of the potential of RFID implementation is "Readable in harsh environment" which is 3.99, at the same time highest standard deviation 0.836 in ranking 11. The average mean of this part is 4.127. From this, we can see, least of respondent agreed with this statement because there is no harsh environment in our country such as snow to prove that RFID still readable.

Table 7: Potential of RFID implementation

No	Item	N	Mean	Standard Deviation	Ranking
1	Reduce labour costs.	74	4.30	0.656	8
2	Reduce time spend in locating and tracking.	74	4.39	0.569	7
3	Increase components transparency in the delivery process.	74	4.43	0.551	6
4	Provide real time identification of IBS components.	74	4.55	0.553	2
5	Provide real time tracking of IBS components.	74	4.57	0.551	1
6	Provide data storage for IBS components.	74	4.51	0.555	5
7	Instantly read large number of tags without a line of sight.	74	4.22	0.763	9
8	Reusable and not easily damage in harsh environment.	74	3.99	0.819	10
9	Readable in harsh environment.	74	3.99	0.836	11
10	Reduce human errors in the management process.	74	4.53	0.529	4
11	Reduce manual interference in the management process.	74	4.54	0.554	3
12	Other potentials of RFID implementation for IBS components management.	2	1.50	0.707	12
	Average Mean		**4.127**		

(c) Challenges of RFID implementation at IBS components management

Table 8 below is the summary of challenges of RFID implementation, the question "Higher cost for active tags" has the highest mean value which is 4.57 and obtain the first ranking. Most of the respondent agreed that there is higher cost for active tags to implement in manufacture. According to Lu *et al* (2010), although the price of active RFID tags has been reduced over the past years but it is still relatively expensive compared with barcode technology when comes to the reading distance concern. This makes the RFID technology become less competitive.

On top of that, the lowest mean is "Incompatible standards for global adoption" which is 4.01 with ranking 9. From this statement with lowest mean, we can see that respondents have little or no working experience with RFID, the level of know-how on RFID also lower. The average mean for this section is 4.336.

Table 8: Challenges of RFID implementation

No	Item	N	Mean	Standard Deviation	Ranking
1	Incompatible standards for global adoption.	74	4.01	0.712	9
2	Lack of proper standard information for interoperability among business partner.	74	4.39	0.615	4
3	Higher cost for active tags implementation.	74	4.57	0.643	1
4	Metal and steel objects interference may cause poor performance.	74	4.28	0.820	6
5	Water objects interference may cause poor performance.	74	4.24	0.808	7
6	Human health issues when long term exposure in radio signal.	74	4.28	0.820	5
7	Ethical issues when components information was captured.	74	4.14	0.881	8
8	Higher cost for longer reading range tags.	74	4.57	0.664	2
9	Insufficient location accuracy in tracking IBS components.	74	4.54	0.686	3
	Average Mean		**4.336**		

(d) Improvement ways of RFID implementation at IBS components management

Based on the Table 9 the improvement ways of RFID implementation at IBS manufacturer storage area with the highest mean is the question "Technology promotion by top management" with 4.61 and first in ranking. Most of the respondent agreed to have technology promotion from top management in order to implement new technology in company. Based on the study about Daimler Chrysler, it is said that internal development is crucial in a company, managerial support able to let the knowledge and technology acquisition enhance the company to become more dynamic and competitive (Göker & Roth, 1999). Meanwhile, the lowest mean value is "Research & Development (R&D) enhancement" which is 4.15 and ranking 9. The average mean for this part is 4.396 which is the highest in all question.

Table 9: Improvement ways of RFID implementation on IBS components management

No	Item	N	Mean	Standard Deviation	Ranking
1	Collaboration between government and IBS manufacturers.	74	4.31	0.595	7
2	Tax exemption initiative by government.	74	4.38	0.613	6
3	Technology implementation subsidies by government.	74	4.45	0.622	5
4	Technology promotion by top management.	74	4.61	0.519	1
5	Training development for employee technology skills enhancement.	74	4.51	0.555	2
6	Research & Development (R&D) enhancement.	74	4.15	0.734	9
7	Education enhancement at university and training institution level.	74	4.15	0.676	8
8	Joint public or private institution to initiate project.	74	4.50	0.555	3
9	Joint public or private institution initiate effective disseminate.	74	4.50	0.579	4
	Average Mean		**4.396**		

5. Conclusion

This study demonstrated that all the objectives of the research study has been successfully achieved through questionnaires and data analysis by SPSS software and MS Excel. The results have been shown that the key potential provide real time tracking of IBS components and high cost for active tags implementation as the main challenges of RFID implementation for improving IBS components management at manufacturer storage area agreed by the IBS manufacturer and the improvement for RFID implementation to obtain the technology promotion by top management. This means that the top management decision making is important to adopt the new technology in the IBS manufacturer storage area. There is some limitation faced by researcher when conducting research. Firstly, researcher have a limited time period to collect data. Secondly, researcher faced problem when collecting data. Researchers found that some respondents might not cooperate and unwilling to answer the questionnaire. Some respondent even took longer time to respond to the survey form. This situation might influence the progress to collect data. Hence, recommendation is provided for the better result in future research. Research can be continued by studying about the effectiveness and readiness of implementation of RFID technology among the IBS manufacturer. Researcher that intended to conduct research in this area of study may combine both research methods which are quantitative and qualitative to obtain a more comprehensive and in-depth info and opinion about RFID technology implementation.

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References

Alaghbari, W. A. K., Salim, A. M. R., & Ernawato (2007). The Significant Factors Causing Delay of Building Construction Projects in Malaysia. *Emerald, Engineering Construction and Architectural Management*, *14(2),* pp. 192-206. Retrieved from https://sci-hub.se/10.1108/09699980710731308

Alshawi, M. (2007). Rethinking IT in Construction and Engineering*. Routledge; 1 edition*, pp, 288. Retrieved from https://www.researchgate.net/publication/286211663_Rethinking_IT_in_Construction and_Engineering_Organisational_Readiness

Akinci, B., Patton, M. & Ergen, E. (2002). "Utilizing Radio Frequency Identification on Precast Concrete Components-Supplier's Perspective," *Proceedings. ISARC'02, IAARC, Washington, DC*, pp. 381-386. Retrieved from https://www.iaarc.org/publications/proceedings_of_the_19th_isarc/utilizing_radiofrequency_identification_on_precast_concrete_components_suppliers_perspective.html

Ang, P. S. E., Kasim, N., Goh, K. C. (2016). Drivers to Enhance ICT Uptake in IBS Management Processes in the Construction Industry. *MATEC Web of Conference, 47,* pp. 4. Retrieved from https://doi.org/10.1051/matecconf/20164704016

Azman, M. N. A., Ahamad, M. S., Majid, T. A., & Hanafi, M. H. (2011). Status of Industrialized Building System Manufacturing Plant in Malaysia. *Journal of Civil Engineering, Science and Technology*, *2(2),* pp. 1.

Badir, Y. F., Kadir, M. R. A., & Hashim, A. H. (2002). Industrialized building systems construction in Malaysia. *Journal of Architectural Engineering, 8(1),* pp. 19–23. https://doi.org/10.1061/(ASCE)1076-0431

Berawi M. A., Berawi, A. R. B., & Hadwart, K. A. (2012). Managing construction logistics management: Findings from construction contractors and industrialized building system (IBS) manufacturers. *African Journal of Business Management, 6(5),* pp. 1932- 1944. Retrieved from https://doi.org/10.5897/AJBM11.2047

Best, J. W. & Kahn, J. V. (2003). Research In Education. *Boston: Library of Congress Cataloguing in Publication data*, pp.133-139.

Construction Industry Development Board Malaysia (CIDB) (2020). IBS Portal, IBS manufacturer or suppliers, pp. 1-11. Retrieved from http://ibsportal.cidb.gov.my/Player/Company

Erabuild (2006). Review of the current state of Radio Frequency Identification (RFID) Technology, its use and potential future use in Construction. *Technology representatives, NAES, Tekes, formas and DTI,* pp. 3-96.

Ergen, E., Akinci, B. & Sacks, R. (2007). Tracking and locating components in a precast storage yard utilizing radio frequency technology and GPS. *Automation in Construction, 16(3),* pp. 354-367. Retrieved from https://www.sciencedirect.com/science/article/abs/pii/S0926580506000574

Fédération internationale du béton (2017). Precast segmental bridges: Guide to good practice. *FIB – Féd. Int. du Béton*, *82*, pp. 85-86. Retrieved from https://books.google.com.my/books/about/Precast_segmental_bridges.html?id=a-hetAEACAAJ&redir_esc=y

Goodrum, P. M., McLaren, M. A., & Durfee, A. (2006).The application of active radio frequency identification technology for tool tracking on construction job sites, *Automation in Construction*, *15(3),*pp. 292–302.Retrieved from https://www.sciencedirect.com/science/article/abs/pii/S0926580505000695

Higgin, G. & Jessop, N. (1965). Communications in the building industry. The report of a pilot study, *Tavistock Publications,* pp. 128.

Huang, G. Q., Zhang, Y.F., & Jiang, P.Y. (2007). RFID-based wireless manufacturing for walking worker assembly islands with fixed-position layouts. *Robotics and Computer Integrated Manufacturing 23,* pp. 469–477. Retrieved from https://www.sciencedirect.com/science/article/abs/pii/S0736584506000779

Jabar, I. L., & Ismail, F. (2018). Challenges in the Management of IBS Construction Projects. *Asian Journal of Quality of Life, 3(9),* pp. 37. Retrieved from https://core.ac.uk/download/pdf/229964142.pdf

Keith, S. T. (2017). The Use of Cronbach's Alpha When Developing and Reporting Research

Instruments in Science Education. *Research Science Education*, *48*, pp. 1273 – 1296. Retrieved from https://www.researchgate.net/publication/317777374_The_Use_of_Cronbach's_Alpha_When_Developing_and_Reporting_Research_Instruments_in_Science_Education

Landcaster, G. A., Dodd, S., Williamson, P. R. (2004). Design and analysis of pilot studies: recommendations for good practice. Journal Evaluation in Clinical Practice, 10(2), pp. 307-322. Retrieved from https://www.researchgate.net/publication/227704893_Design_and_analysis_of_pilot_studies_Recommendations_for_good_practice

Lu, W. S., Huang, G. Q., Li, H. (2011). Scenarios for applying RFID technology in construction project management. *Automation in Construction, 20,* pp. 101-106. Retrieved from https://www.sciencedirect.com/science/article/abs/pii/S0926580510001366

Methanivesana, N. (2012). Improving Construction Logistics A case study of Residential Building. *Project Master of Science Thesis*, pp. 190. Retrieved from https://www.researchgate.net/publication/341780159_Improving_Construction_Logistics_a_Case_Study_of_Residential_and_Commercial_Building_Project

Othuman, M. A., Sani, N. M., & Taib, M. (2014). Industralised building system in Malaysia: A review. *MATEC Web of Conferences,10,* pp. 1-9. https://doi.org/10.1051/matecconf/20141001002

Prakash, C. S., Pashelphetha, A. & Ganapathyramasamy, N. (2016). Development of RFID Automation Technique In Material Management For Various Construction Project. *Institution Journal Chemistry Science, 14(1),* pp. 164-174. Retrieved from https://www.tsijournals.com/articles/developing-of-rfid-automation-technique-in-material-management-for-various-construction-project.pdf

Pheng, L. & Chuan, C. (2001). Just in time management of precast concrete components. *Journal Construction. Engineering. Management, 127(6)*, pp. 494–501. Retrieved from https://www.researchgate.net/publication/240072801_Just-in-Time_Management_of_Precast_Concrete_Components

Shahzad, W. M. (2011*).* Off-site Manufacturing as a means of improving productivity in New Zealand and construction industry: Key Barriers to adoption and improvement measures. *Massey University College of Sciences,* pp. 52-54. Retrieved from https://1library.net/document/oz1k25vy-manufacturing-productivity-construction-improvement-requirements-construction-management-university.html

Schneider, M. (2003). Radio frequency identification (RFID) technology and its application commercial in the commercial construction industry. *University of Kentucky*. pp. 30-33. Retrieved from https://core.ac.uk/download/pdf/53139976.pdf

Want, R. (2006). An Introduction to RFID Technology, *IEEE Pervasive Computing*, 5(1), pp. 25-33. https://doi: 10.1109/MPRV.2006.2

Williams, C. (2007). Research methods. *Journal of Business & Economics Research (JBER), 5(3),* pp.66.

Yin, Y. L., Tserng, H. P., Wang, J. C. & Tsai, S. C. (2009). Developing a precast production management system using RFID technology. *Automation in Construction, (18)*, pp. 677. Retrieved from https://www.sciencedirect.com/science/article/abs/pii/S0926580509000193