TEST Engineering & Management

November-December 2019
ISSN: 0193-4120 Page No. 1816 - 1819

Internet of Things and Big Data: Opportunities for Malaysia's Construction Industry

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Article Info
Volume 81
Page Number: 1816 - 1819
Publication Issue:
November-December 2019

Article History
Article Received: *5 March 2019*
Revised: *18 May 2019*
Accepted: *24 September 2019*
Publication: *10 December 2019*

Abstract
The Fourth Industrial Revolution (IR4.0) is categorized by a different technologies that are new and advanced and fuses physical, digital as well as the biological worlds, thus, impacting all disciplines, economies and industries. At the epicenter of IR4.0 is the ability of machines to learn and create algorithms that can identify patterns in large, evolving Big Data sets, and drawing conclusions from past experiences historical data. The Internet of Things (IoT) establishes networks of smart interconnected devices and services capable of sensing to requests and acting on them. With these capabilities in the future, more machines could autonomously adapt to circumstances, as their environments change improving industries' efficiency and sustainability. This paper focuses on the prospects to be offered by IoT and Big Data in the construction industry of Malaysia.

Keywords*: Fourth Industrial Revolution, Innovation, Performance.*

I. INTRODUCTION

The construction industry contributes significantly towards the socioeconomic development of Malaysia. The educational institutions, government offices, tourist attractions, transportation infrastructure, housing and commercial properties are built and maintained by the construction industry. The demand for construction is highly sensitive to developments in other sectors of the economy. For instance, the expansion of tourism and manufacturing industries has contributed to the industry's growth momentum with their demand for construction of hotels, monuments, factories and infrastructures. Besides enabling socio-economic development, construction activities generate tremendous spill-over opportunities as it contributes to the growth of other industries in its role as a large user of manufactured goods (i.e. building materials, iron, steel, etc.), of specialized tooling and heavy machinery, and the financial services sector. Therefore, a well-functioning construction industry will benefit other economic sectors, culminating in an improved economic performance for the nation.

Malaysia's construction industry registered a growth of 10.1 percent in 2013, and subsequently 11.6 percent in 2014. The growth is at a downward trend when it was at 7.1 and 5.2 percent in 2017 and 2018 respectively. When translated these percentages into projects awarded in the 9th Malaysia Plan (2006-2010), around 26,300 projects were awarded valued at RM380 billion and in the 10th Malaysia Plan which covers the period from 2011 to 2015, RM230 billion development funds out of which 60 percent or RM138 billion have been expended in physical development to be undertaken by the industry [1]. In addition, Malaysia's construction industry has established about 84,000 contractors and employs 700,000 workforces that include the professionals, supervisors, skilled and unskilled workers (Construction Industry Development Board) [2].

Although in terms of Malaysia's GDP, construction industry only accounts for less than 5 percent (Table 1); its performance has great influence on the overall economic growth. Construction industry plays a role as an "essential growth enabler" due to its extensive linkages with other industries namely the manufacturing industry which support in supplying construction materials such as basic metal, cement and electrical machinery. For example, in 1998, when the construction industry experienced a sharp downturn, the metal industry in Malaysia saw a 35.6 percent drop in output [3]. Therefore, it is fundamental for the industry to sustain its growth and attain greater performance as it has spillover effect on other industries.

Table I: Gross Domestic Product (GDP) By Sector (Source: MEA, 2019)

Sector	**Share of GDP (%)**					
	2013	***2014***	***2015***	***2016***	***2017***	***2018***
Construction	3.5	3.9	4.4	4.5	4.6	4.2

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Agriculture	7.2	6.9	8.8	8.1	7.2	7.9
Mining	8.3	7.9	8.9	8.8	8.4	7.9
Manufacturing	25.0	24.6	23.0	23.0	23.0	22.8
Services	54.8	55.3	53.5	54.3	54.5	56.0

In response to the dynamic environment, Malaysia strategically emphasizes innovation as the key factor for greater growth and recognizes the importance of innovation as the catalyst for the country's long-term success particularly in achieving Malaysia's Vision 2020 [4]. CIDB echoed this notion by underlining innovation as one of the strategic thrusts in the Construction Industry Malaysia Plan (CIMP) aiming for industry's superior performance [2]. The CIMP that strategized industry's goals for the year 2006 to 2015 denoted the importance of innovation through research and development and through adopting new construction methods. The Construction Industry Transformational Plan (CITP) continues in emphasizing and promoting mechanization and advanced technology utilization.

II. INDUSTRIAL REVOLUTION 4.0 (IR 4.0)

A new and innovative approach that advanced countries have recently embraced is to capitalize on the Industrial Revolution 4.0 (IR 4.0) - a revolution that is fundamentally changing the way people live, work and relate to one another. It is characterized by a range of state-of-the-art technologies that are fusing the physical, digital and biological worlds, impacting all disciplines, economies and industries, and even challenging ideas about what it means to be human. The exponential explosion in internet bandwidth, processing power and digital storage capacity allows the world the potential to connect billions of people to digital networks, dramatically improve the efficiency of organizations and even manage assets in ways that can help regenerate the natural environment [5]. The epicentre of IR 4.0 is the ability of machines to learn and create algorithms that can identify patterns in large, evolving data sets, and drawing conclusions from past experiences with that data. Two state of the art technologies that trigger this revolution are the Internet of Things (IoT) and Big Data.

IoT allows environment to be surrounded by a network of smart interconnected devices and services capable of sensing or even listening to requests or needs and acting on them [6]. It is a technology that introduces the phenomenon in the rapid rise of interconnected internet-enabled physical and digital machine. Its applications cover many areas including industrial, smart cities, environment, agriculture, energy, tourism, health, retail and logistics. In the construction industry, IoT presents a limitless potential to leverage upon. The adoption of IoTs in project environment contributes towards efficient services, cost reductions, worker safety and predictive maintenance.

Large-scale data namely Big Data can be collected and processed due to the advancement of computing powers and the rise of available data from IoT. Big Data would enable future forecasting to be undertaken based on the amount of data generated, collected and analyzed. With its innate capability to rapidly learn as the project-related activities progress, allows for better adaptation of future changes. It will provide precise data and insights that help all involved in the project environment to optimize their performance. Numerous activities including decision making, remote operation, supply replenishment, equipment servicing, and dangerous tasks can be operated with minimal human intervention. With these capabilities in the future, we will have more machines that can autonomously adapt to circumstances, as their environments change.

The results of these IoT data analyses of the data (Big Data analytics) can be harnessed by governments to govern better, become more accessible and increase transparency and trust. Private sectors will also benefit from the analytics as it provides current and future business trends and behavior. Big Data allows labs and companies produce machines or software with increasing human-like capabilities. Specifically, to the construction industry context, Big Data will radically reshape business processes and establishes innovative automation solutions for enterprise asset management allowing for better control of just-in-time processes, zero-defect delivery and enhanced productivity. As machines become more intelligent and widely utilized, organizations are achieving next level of highly-advanced technology adoption and process automation which helps pave the way for embracing true digital transformation in in construction industry.

III. APPLICATION OF IOT AND BIG DATA FOR CONSTRUCTION INDUSTRY

Adoption of IoT and Big Data is at a nascent stage in Malaysia particularly in the construction industry. These technologies provide tremendous values not only to the construction industry but to the business community and to the public. By aggressively venturing into IoT and Big Data, Malaysia's construction industry will able to leap and drive the nation to greater growth. Among potential applications are described in the subsequent section.

A. Project Management

Analyzing historical data allows for more accurate planning of project implementation in infrastructure developments. For instance, Big Data analytics establish trends that make preliminary project budgets more accurate. This may lead to the irrelevance of the lengthy Value Management exercise; as such process may be embedded in the algorithm of the analytics. Risk management process will be simplified as the analytics provide predictive events and assist in accurate decision making.

Embedding IoT devices in projects design produces smart and intelligence building and infrastructure. Buildings that are equipped with sensors and meters that are connected to the internet provide real time data of every aspect of the building including engineering, environment and human behaviors. The tremendous amount of data gain from the IoT devices are analyzed in providing trends and solutions for design

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improvement, efficient use of resources, effective human behaviors, sustainability and socio-economic value creation.

Big Data analytics may provide assurance in terms of transparency and integrity in procurement process. Analytics assist in tender decision making, as selections of qualified contractors are based on the algorithm outlined in the procurement procedures. This leads to minimizing or even eliminating human intervention – accelerating the procurement process.

IoT and Big Data offer solution to efficient project construction management particularly in precision material selection, material quantity and delivery. Material wastage and requirements for large storage areas will be minimized. Project delivery will be greatly improved as risks are accurately predicted and project managers are assisted with analytics for problem solving.

B. Units

IoT embedded buildings and infrastructure feeds large scale of real-time data. These data are valuable, too valuable to just leave it unused. The data offers greater values than just for the traditional facility management of a building during breakdowns and for servicing purposes.

The analytics of the data create predictive events for facility managers to prevent it from occurring, hence eliminating breakdowns and downtimes. In addition, preventive maintenance is no longer based on routine activities but based on the analytics and trends for every component of the building. Parts and consumables inventory managements will be more accurate and demands less storage requirements. This leads to a more efficient facility management due to reduced corrective and preventive maintenance requirements that ultimately will drastically reduce the contract cost.

Occupants may also participate in contributing to the health and sustainability of the building as information is available to everyone which allows for more effective awareness programs. The occupants' behavior can be analyzed for security management, business creation and monetization of public areas.

C. Smart Transport Solution

Traffic congestion and accidents have resulted in enormous waste of productivity and property loss. With the deployment of IoT meters and sensors in transportation services and integration of real time information from the people, generate tremendous amount of data. Harnessing the flow of data from traffic lights, street lights, CCTV and other IoT devices, help in detecting breakdowns and accidents, identifying congestion and traffic violation as well as detecting disaster such as flood and land slide.

With smarter infrastructure and valuable information established from IoT and Big Data, signal timing adjustments and dynamic rerouting will improve traffic flow in real time. In addition, the analytics of congestion trends based on integrated analysis of the history and current traffic information the relevant authorities and agencies could predict future needs and plan for continuous service. Analytics may also ensure reliable and safe transportation solution including the smarter use of energy and resources. This includes high quality road materials and effective design, efficient and effective street lights and traffic lights, dynamics road signs and accurate vehicle information system.

IV. CHALLENGES AND APPROACHES

New technology demands transformation and change in an organization. IoT and Big Data will not only eliminate certain inefficient processes, but it may also create new activities and demands new knowledge and skills among members of the organization. The fragmented characteristics of the construction industry makes change a complex and challenging exercise.

A. Environment and Culture

In an unprecedented fast-changing world due to the advancement of technology, what is considered normal today could well be obsolete tomorrow. Inevitably, we have to do things differently. Hence, our survival rests on our innate abilities to adapt to changes or risk being side-lined.

Construction industry is regarded as a highly fragmented, loosely coupled, complex and matured industry that change and innovation required involvement of varying combinations of large and small organizations from across the supply chain spectrum. This includes a broad representation of key players in the industry particularly among manufacturers and service providers in the process of transformation materials, knowledge and processes into buildings and infrastructures. Hence, introducing new technology demands involvement various organization setup, which may contribute to the delay of the transformation.

Conventional wisdom has it that matured industry like construction is relatively low in dynamism and most often associated with labyrinthine processes and technological laggard [7]. Coupled with their inherently risk-averse nature, these enduring traits present a less-than-ideal condition to cultivate and inculcate innovative culture and accepting new technology in the workforce. There is an incessant need to rethink the industry's business model that draws on empowering its workforce mastery and emerging technologies in delivering value-laden infrastructure projects.

B. People

One of the major challenges in transformation initiative is people's natural tendency resist to change. There is a need for construction organizations to commit to a fundamental mind-set shift by challenging their underlying assumptions and mental models. Instead of preserving the status quo, that may be applicable during more stable times, greater emphasis should be placed on doing things anew. This requires a transformation in the way the members of the organization respond to change. A generous dose of creativity and innovation is needed especially in delivering cost-effective solutions. Therefore, the only way is to continually develop competencies and having the right kind of mind-set among members namely growth mind-set. This

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ISSN: 0193-4120 Page No. 1816 - 1819

kind of drastic transformation especially in a traditional setup organization like most construction organizations, demands new approaches and incremental improvement. The greater challenge is to establish an incremental improvement that is fast enough with the advancement of technology. A more aggressive approach in competency model and knowledge management needs to be strategized.

C. Elimination of Routine Works

In the context construction projects particularly in implementing infrastructure and building projects, require the development and drafting of architectural and engineering drawings. Although in the beginning, it requires some set of drafting skills, producing these drawings overtime becomes routine and repetitive and will no longer be considered as high skill work. Outsourcing these kinds of lower skill roles to external parties leads to greater efficiencies and allows for construction organizations to focus on high skill field of expertise. Such drafting works can be outsourced to other industries such as computer gaming industry players by extending what they have been doing in developing virtual buildings for computer games into actual, detailed construction designs. In addition, this role can also be outsourced to countries that may provide cheaper solutions such as India. The differences in time zones may provide extra working hours hence "reducing" project implementation period. Technical Vocational Education and Training (TVET) institutions may also participate in this "strategic partnership" allowing the students for real job exposure while providing services to the industry. The transfer of this traditional drafting role to external parties allows resources to venture into higher technological expertise.

The taking over of these routine roles to outsource parties and machines demand new technical skills and 'higher level' capabilities from the present workforce. Leaping from routine activities to new roles especially among the non-professional workforce is a challenging task. One of the approaches is to develop a competency model that is dynamic with the global trends especially in terms of technology revolution.

D. Leadership

Effective leadership is vital and leadership styles and its practice constitute important variables having essential role on achieving success [4]. The fragmented characteristics of the construction industry which requires teaming up of different organizations for a complete implementation of a construction project has made project administration more complex which demands more highly skilled and experienced leaders. In addition, the risk-averse and resistant to change nature of the industry makes leading effectively a challenging task.

The construction industry needs to have more transformational leaders among engineering professionals. Transformational leaders would change or align systems to accommodate their vision rather that work within existing systems. This induces creativity and innovativeness in the organization as leaders promotes their subordinates to creatively explore beyond the existing system for new innovative approaches in achieving the vision. The charismatic characteristics that this type of leaders possesses have substantial influence on organizational climate by intellectually stimulate their followers in championing innovation and new technology and articulating a compelling vision throughout their organization.

V. CONCLUSION

IoT and Big Data offer efficient and effective solutions for construction organizations not only in challenging times but also in the future. As the advancement of these technologies is at nascent stage in Malaysia, particularly in the construction industry, aggressive exploitation of the technologies offers great opportunities. The challenges that come with it demand organizations to leap from its comfort zone, accelerate the development of the workforce technical strength and transforming into a highly dynamic organization. This is the perfect time for Malaysia to grasp this opportunity as almost everyone is at the same starting line.

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