Productivity Link

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Contents

Productivity in the Construction Industry

1. Introduction – An Overview

Do you realise that the home you are living in, the school that you obtain your education from, the office where you work and the complex with shopping or entertainment that you enjoy are contributed by the construction industry? Hence, it is in the interest of many people to know what the outlook is like for the construction industry in Singapore and how the construction industry could be more productive to better serve the needs of the country.

The Building and Construction Authority projected that construction contracts for the built environment sector in Singapore is expected to reach between $29 billion to $36 billion in 2015, given a sustained pipeline of public sector projects. The total construction demand set a new record of $37.7 billion in 2014 due to a higher volume of institutional and engineering contracts. The construction demand from the private sector is anticipated to moderate to between $11 billion to $15 billion compared to $18 billion in 2014 because developers may adopt a cautious stance in the midst of a slowdown in private home sales and global economic uncertainties.

The average construction demand is expected to be sustained between $27 billion to $36 billion in 2016 and 2017 and $26 billion to $37 billion in 2018 and 2019 per annum, in view of mega public sector infrastructure projects required to meet the long-term needs of our population and maintain the competitive advantage of Singapore's economy.

2. Why is Productivity important to Construction companies?

Although construction jobs are projected to grow in nearly every country, the number of people seeking construction jobs is falling, leaving a deficit of workers.

Many people perceive construction jobs to be ‘low technology’ when compared to other fields, seeing them to be less progressive technology-wise and primarily tedious in nature, requiring tough manual labour.

This mindset may have resulted in the construction industry being ranked 244th place out of 250 possible careers.

With the forecast rise in demand coupled with and a shortage of labour in the construction industry, it provides the impetus for the industry to enhance its productivity, so as to compete for more projects with less human resources.

Based on Price Waterhouse's 17th Annual Global CEO Survey conducted in 2013, it was found that Engineering and Construction chief executives identified advances in technology to be the key business transformation method that could dramatically improve productivity in the construction field. Before we explore the available technological advances that construction companies could leverage, it would be helpful to first understand the challenges faced by the industry in improving its productivity.

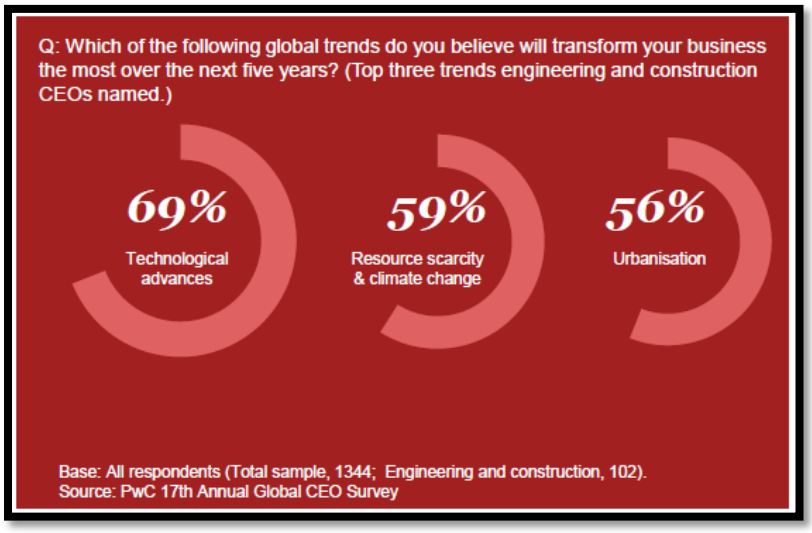

Figure 1: PwC 17th Annual Global CEO Survey
Source: http://www.pwc.com/gx/en/ceo-survey/2014/assets/pwc-17th-annual-global-ceo-surveyengineering-and-construction-key-findings.pdf

3. What are the Challenges Affecting Productivity in the Construction?

In the United States, making improvements in the construction industry has been a very long standing problem. It may be more so in Singapore. As far back as 1983, the Business Roundtable identified some obstacles that they considered to be barriers to improving productivity in construction

The problems that they have identified seem to be still relevant even today. These included:

a. Adversarial relationships between contractors, owners, labourers, business and government
b. Lack of proper and accurate information about construction technologies
c. Under-trained workers and job-site managers
d. Disinterested supervisors with regards to adoption of new technology

While improvements in construction technology have taken place by leaps and bounds, many companies have yet to take advantage of it. The issue is that many in the construction field are reticent to embrace these changes or found it not cost effective for them to do so. This has led to a lower productivity at a time when there is the need to increase it locally and globally.

Perhaps one of the main barriers to productivity growth in construction industry is the diversity and fragmentation of the construction industry. The various construction sectors, be it industrial, commercial or residential, are often different from each other. They are different in what they do, in their mindset, techniques, sophistication, complexity and source of capital to invest in new technologies.

The construction industry as a whole has a diversified group of workers ranging from masonry workers, builders, suppliers, labourers, electricians, carpenters, roofers and other technicians. They are a diverse group who uses unique processes to carry out their work.

Nearly every sub-sector of construction shares some common issues in improving productivity, which when addressed would improve the bottom line for construction companies. These barriers must be removed across the construction value chain to boost the productivity of the industry.

Another critical barrier to construction companies is the knowledge deficit and the myths about the use of construction-related technologies.

In a 2004 study, it stated that lack of interest in some of the new technologies available stemmed from two areas:

i. The cost of some new technologies that could save time was prohibitive to smaller construction companies.

ii. The belief that some of the workers would be made redundant by new technologies. The use of technology could improve productivity and lower the need for additional manpower, leading to fears of job losses. With these challenges in mind, how could we improve productivity in the construction industry?

In addition, it does not help when there is also a lack of an industry-wide strategy to help improve the efficiency and productivity of the construction industry.

4. How can we remove the Barriers and Leverage the Power of Technologies to Improve Productivity in Construction Companies?

In July 2013, Singapore Senior Minister Lee Yi Shyan shared that a quantum leap in construction productivity is possible with advanced technologies and having productivity culture, as the industry faces a smaller foreign workforce going forward.

What technologies are available to enhance productivity of construction companies?
We list some of these game-changing technologies below.

Cross Laminated Timber (CLT) has been in use in Europe for more than 15 years, with the demand for CLT in the United Kingdom rising over the last seven years. CLT is manufactured by bonding layers of timber at right angles to produce solid timber panels that can be used as structural components in buildings. The use of CLT has led to significant reductions in construction time as well as manpower on site.

For example, the 8-storey Stadthaus at Murray Grove in London required 9 weeks to construct using CLT, approximately 35% faster compared to conventional concrete construction. Also, it only required 4 skilled workers and 1 supervisor on site, compared to about 22 workers if the structure was constructed using reinforced concrete.

Prefabrication is a process that involves fabricating significant portion of building off-site and transporting them to the site to be put together. This helped reduce the construction time of the 10-storey YMCA building at South London by 21 weeks. Also, the British Petroleum's international headquarters in Sunbury on Thames was built at one-third the price and three times faster compared to a building constructed traditionally. All 99 modules were installed and the building made water-tight in just 10 days during the 14 week construction period on site.

BIM (Building Information Modeling) also known as n-D Modeling or Virtual Prototyping Technology, is a revolutionary development that is quickly reshaping the Architecture Engineering-Construction (AEC) industry. BIM is both a technology and a process. It has been identified as one of the key methods to help to integrate the construction chain. The technology component of BIM helps project stakeholders to visualise what is to be built in a simulated environment to identify any potential design, construction or operational issues. The process component enables close collaboration and encourages integration of the roles of all stakeholders on a project. Off-site construction involving suppliers and manufacturers will be helpful in reducing costs and raising productivity.

Drones could be used to provide aerial views for inspection of work where it could be dangerous and time consuming for human inspections. Purveyors of residential and commercial solar panel arrays, like Toronto's Kiosk Solar, have used drones to accurately inspect clients' structures to create proposals for installations. Manufacturer Siemens envisions a future in which drone fly through existing structures to obtain comprehensive building information for creating 3D digital models. The Swiss firm Gramazio & Kohler (www.gramaziokohler.com) recently collaborated on Flight Assembled Architecture, a large-scale art installation at the FRAC Centre in Orléans, France, in which a team of as many as 50 flying robots built a structurally stable, six-foot tower out of 1,500 Styrofoam blocks. The potential of using drones to automate construction processes, for example, carry bricks and dispense mortar to automate masonry construction, is being explored by scientists and researchers.

Figure 2: Flying drones with multiple propellers - quadcopter.
Source: http://www.bdcnetwork.com/robots-drones-and-printed-buildings-promise-automated-construction

Robotics, when used in collaboration with human workers provides a faster and safer way to build. It allows for the creation of structures in a way that does not stress the human worker and keep them safe. Gramazio & Kohler helped create R-O-B Technologies (www.rob-technologies.com), which developed a mobile fabrication unit that fits in a modified freight container and can perform several construction tasks. In the U.S., Construction Robotics (www.construction-robotics.com) is doing years-long R&D process and working on making Semi-Automated Masonry system become commercially viable.

The picture below shows, ERO, a demolition robot on caterpillar-style treads, uses water jets to "erase" concrete into aggregate and leave behind pristine, recyclable rebar. Developed in Sweden, the robots can be algorithmically automated to work in teams to quickly take down concrete structures.

Figure 3: Demolition Robot
Source:http://www.bdcnetwork.com/robots-drones-and-printed-buildings-promise-automated-construction

3D Printing is being leveraged in many upscale construction companies. Large scale 3D printing has been used to build entire houses today. Contour Crafting (www.contourcrafting.org) is a computerised construction method that 3D Prints large-scale structures directly from architectural CAD models. Walls are built up by forming their outer surfaces via extrusion of a paste-like material, such as concrete, and the use of a robotic trowel to provide a smooth contoured surface. CC is a very flexible technique, capable of constructing aesthetically pleasing "organic" curvilinear shapes and, as such, it has attracted strong interest from leading architects.

It is a major innovation that automates the construction of whole structures; and radically reduces the time and cost of construction. The result would be a revolution in the construction industry that would lead to affordable construction of high quality low-income housing, the rapid construction of emergency shelters and on-demand housing in response to disasters.

Figure 3: Large scale 3D Printer
Source: http://contest.techbriefs.com/2014/entries/machinery-automation-robotics/4737

Figure 3: Large scale 3D printing - 'prints' quick-setting concrete from a computer controlled gantry.
Source:http://www.theguardian.com/artanddesign/architecture-design-log/2014/mar/28/work-begins-on-the-worlds-first-3d-printed-house

IoT (Internet of Things) applications can be used to productivity in construction companies, such as:

Equipment Monitoring and Repair: Equipment repairs are one of the largest operating costs in the construction industry. With the advanced sensors available now, machinery can self-detect the impending need for a repair before it becomes a larger issue.

Equipment Inspection: Lost/late forms, low accuracy and undue internal processing time are no longer an issue with electronic processes.

Inventory Management and Ordering: Downtime caused by low supply stock or personnel wasting time on site is another major drain on construction companies. With an IoT solution, site managers will be alerted when resources are getting low and support is needed.

Energy Conservation: Implementing a sensor system that monitors the lighting on a site reduces wasted energy costs construction companies regularly incur. Temperature monitoring can also conserve energy for indoor construction. Eliminating paper processing also saves on printing and contributes to tree conservation.

GPS Tracking: With advanced tagging and tracking of materials and trucks, technology can vastly reduce the cost incurred by businesses for lost or misrouted items. Monitoring a truck driver's activity enables accurate time logging and safer driving.

Electronic Time Logging: Electronic time logs are much more difficult to falsify, especially when connected to a GPS tracking device.

Wearables: A truck driver can be required to wear a "wearable", which may come in the form of an activity band. Drivers and management can be alerted if a driver is falling asleep/falls asleep. Construction workers on-site can wear a helmet and vest with RFID, vitals monitoring, GPS sensors, motion sensors, etc.

Safety: Job site and trucking safety is your top concern. Keep procedures and reports easily accessible at all locations. Making a job site safer potentially reduces insurance and training costs.

For more details on IoT and its impact on productivity, please refer to our January 2015 issue of Productivity Link.

5. What are the possible immediate actions?

The key to creating an environment where technology is used in a positive way by construction companies will be to address the knowledge deficit.

Some steps that could be taken in addressing this issue are:

a. Coordinate between disciplines and create a construction group in given geographic areas whose sole purpose for existence is to introduce and to drive the use of new technology. In other words, have someone to play the role of technology champions. Ultimately driving change will take place through collaboration and bringing together different players of the construction value chain. A meeting of the minds between the smaller companies and the various types of contractors, including roofers and siders and stone masons may be necessary to have a holistic view of challenges and possible solutions.

b. Identify the different types of technologies, the various processes, the unique and innovative methods and equipment that will give the best benefit to the construction industry.

c. Address the needs of each company and have an in-company person/team who will be accountable and responsible for improving the productivity of the company and for driving change within it.

d. Find ways to mitigate the risks to owners, suppliers, contractors and labourers for using advanced technology in construction.

Case Study

Case Study 1: Singapore Study – Tiong Seng Construction

BIM (Building Information Modeling) technology has been under-utilised although it has been shown to be a key enabler in the improvement of construction chain integration.

Tiong Seng Construction implemented BIM technology and achieved an average of more than thirty percent improvement in their productivity. The reason for this was a reduction in errors, increase in consistency and careful documentation, better conflict resolutions and better visualisation of the construction project as a whole.

Case Study 2: 3D Print Canal House in Amsterdam by Dus Architects

A team of ambitious architects are using the additive manufacturing technique to build an entire house. They are using an industrial scale 3D printer called a room builder to engineer the plastic parts that will be fused together to create everything from walls to the furniture.

The 'world's first' 3D printed house, which is being built by a canal in north Amsterdam in the Netherlands, will boast 13 rooms when it is finished and concrete will only be used to provide structural support - at least at the moment. Amsterdam-based firm Dus Architects's futuristic building is described as 'an exhibition, research and a building site for 3D printing architecture', which connects the science, construction and design communities.

Using the 3D printer to make the home means that there is no waste at all and the printer can create blocks of a building that are up to 3.5 meters high. Using bioplastic, the building will create no waste during the building process and may well be a revolutionary new way to create our cities and our dwellings.

6. Conclusion

The use of advanced construction technologies listed in this article promises to yield significant manpower and time savings. They could also bring about intangible benefits such as less noise and dust during construction, safer workplaces and better quality homes. Getting educated on the potential of these technologies is a good step forward addressing knowledge gaps. Seeking partners and exploring collaboration with them may bring about win-win benefits and reduce the cost barriers to technology adoption for your company.

Recommended Readings

Title: The Integration of Industrialized Building System (IBS) with BIM: A concept and Theory to Improve Construction Industry Productivity
Author Saeed Banihashemi Namini
Publisher Lap Lambert Academic Publishing
Year of Publication 2012
ISBN 978-3659263309

Title: Robotic Industrialization: Automation and Robotic Technologies for Customized Component, Module, and Building Prefabrication
Author Thomas Bock , Thomas Linner
Publisher Cambridge University Press
Year of Publication 2015
ISBN 978-1107076396

Title: Productivity Improvement for Construction and Engineering: Implementing Programs That Save Money and Time
Author J.K. Yates
Publisher American Society of Civil Engineers (ASCE) Press
Year of Publication 2014
ISBN 978-0784413463

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