The role of the 4th Industrial Revolution (4IR) in enhancing performance within the construction industry

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Abstract. Construction continues to experience challenges in terms of a range of issues, namely an archaic process and activities, following procedures, data gathering and recording, monitoring, availability of skilled labour, and a declining interest in pursuing careers in the industry. Then, challenges are experienced in terms of performance relative to the project parameters of cost, environment, health and safety, productivity, quality, and time. Given the challenges and the advent of Industry 4.0, a study was conducted to determine the challenges experienced, performance relative to the project parameters, and the potential of Industry 4.0 to contribute to resolving the challenges. The study was quantitative in nature and entailed a self-administered questionnaire survey of medium to large general contractor members of the East Cape Master Builders Association (ECMBA) in the Port Elizabeth region. The findings include: respondents do understand Industry 4.0; a range of challenges, which negatively impact project and organisation performance, and the sustainability of organisations and the industry, are experienced in construction, and Industry 4.0 is perceived as having the potential to address the challenges experienced. Conclusions include that that there is: a need for improvement in performance in construction; potential to improve; a perceived need for the implementation of Industry 4.0, and a need for interventions to raise the level of awareness, and to integrate such technologies into built environment / construction education and training. Recommendations include: employer associations, professional associations, and statutory councils should raise the level of awareness relative to the potential implementation of Industry 4.0 in construction; case studies should be documented and the findings shared; tertiary built environment education programmes should integrate Industry 4.0 into all possible modules, and continuing professional development (CPD) should address Industry 4.0.

Keywords: 4th Industrial Revolution, Construction, Performance.

1. Introduction
The scope of work of the construction industry is diverse and ranges from the construction of residential, industrial, and commercial projects to the construction of infrastructure. More importantly, is the contribution of the industry to a country’s Gross Domestic Profit (GDP). According to the World Economic Forum (WEF) [1], the construction industry realises almost US$10 trillion total annual revenues, and US$3.6 trillion in added value, and accounts for approximately 6% of global GDP. Furthermore, it accounts for approximately 5% of total GDP in developed countries, and more than 8% of GDP in developing countries.

The Construction Industry Development Board (cidb) [2] highlighted a range of performance issues in the South African construction industry: client dissatisfaction with respect to the performance of
contractors, including schedule-related performance; the prevalence of defects; the standard of tender documentation, including specifications; financial conclusion of variation orders; payment delays experienced by contractors, and H&S performance including the transformation of worker.

Change is imminent in the construction industry, which has in many ways stayed relatively stagnant during recent decades, performance needs to be enhanced, and the industry introduced to a new paradigm. Notably, Enshassi, Mohamed & Abushaban [3] stated eleven years ago that current trends in the industry are in the form of new technologies, increasing scale and size of works, and variances in the demands of clients.

The Fourth Industrial Revolution (FIR), also known as Industry 4.0, is being driven by the rapid rise and convergence of emerging technologies [4]. The WEF [1] contends that by adopting innovations such as 3D printing and scanning, advanced building materials, augmented reality, autonomous equipment, Building Information Modelling (BIM), and drones, firms will improve productivity, streamline their management of projects and procedures, and enhance quality and health and safety (H&S).

Given the challenges experienced, and the advent of 4IR, a pilot exploratory study was conducted to investigate the perceived potential of 4IR technologies to improve aspects of performance in the South African construction industry, the objectives of the study being to determine the:

- Perceptions with respect to productivity, profitability, and 4IR;
- Frequency at which phenomena such as project delays, poor productivity, and poor profitability occur;
- Perceptions with respect to project delay, performance, and 4IR;
- Perceptions with respect to labour, and 4IR, and
- Perceptions with respect to the construction process and activities, and 4IR.

2. Review of the literature

2.1. The Fourth Industrial Revolution
The 4IR involves the automation of processes and data exchange between physical systems, in manufacturing technologies and humans [6]. This also includes cyber-physical systems, the internet of things, cloud computing, and cognitive computing [6].

The 4IT technologies have the potential to enhance the quality of buildings, improve H&S, working conditions, sustainability, in addition to improving construction productivity, and mitigate delays on projects [1].

2.2. Productivity
The WEF [1] states that productivity in the construction industry has remained constant for the last 50 years, and that labour productivity in the American construction industry has actually declined over the last 40 years. Farmer [7] contends that a critical issue in the construction industry is its extremely poor productivity, and highlights both the stark difference relative to other industries in absolute terms, and how the gap has widened over time.

A lack of skills among employees (40%) and talent shortages (39%) predominated in terms of barriers to productivity in respondents’ organisations courtesy of a study conducted in the United Kingdom [8]. Furthermore, inefficiency (55%), followed by correcting non-conformances / rework (50%) are the primary contributors to non-value adding activities. Inadequate information in terms of decision making (28%), and correcting mistakes (50%) predominate in terms of factors marginalising productivity.
The evolution of digitalisation has enabled novel approaches to addressing construction challenges. Building Information Modelling (BIM) together with the Internet of Things (IoT) is transforming design, construction, and operation in the built environment [9]. Through exploiting these digital advancements, the opportunity of increasing productivity arises [10]. Furthermore, a manufacturing-oriented production process has the potential to increase productivity tenfold [11].

2.3. Project delays
Delays occur on construction projects globally, and constitute a recurring problem [3]. In terms of the experience of delays, global research established that over a period of three years, 25% of construction projects were completed within 10% of their scheduled completion dates [11].

A challenge with respect to mitigating delays is the current method of monitoring progress on sites. A study conducted by Sachin, Benny, and Kalyan [12] investigated the possibilities of integrating BIM into a project management framework to monitor construction progress. They state that the use of BIM and progress monitoring software has improved efficiency levels on construction sites; mainly due to making information easily accessible.

2.4. Skilled labour shortages
According to the WEF [1], the construction industry is experiencing a shortage of talented young people. 50% of general contractors responding to a survey expressed concern with respect to recruiting experienced workers [1]. ‘Squeezed access to labour’ was identified by 45% of construction firms during a United Kingdom survey in terms of challenges in the year ahead [8]. This is due to people having the perception that the construction industry is of a poor nature in terms of employment with reference to inadequate gender diversity and limited job security. Furthermore, the undesirable nature and harsh, hazardous working conditions in the construction industry is one of the key factors pertaining to skilled labour shortages [13].

2.5. Profitability
With the construction market being highly competitive and economic conditions world-wide in recession, profit margins in the industry have been reduced to improve chances of winning project bids [14]. Therefore, under-performance results in reduced profitability, as well as poor profit results in the case of public companies which are underperforming [15]. Furthermore, there is a pronounced relationship between productivity and profitability. For example, if the workforce is 10% less productive than required, profits are reduced by at least 5% [11]. Research conducted by the Get It Right Initiative determined that avoidable errors constituted approximately 5% of project value, which is greater than the average profit margins in construction. Furthermore, the total impact of the indirect costs of errors, latent defects, and unrecorded process waste equates to 21% of project cost [16].

2.6. Future construction methods
Activities in the construction industry are characterised by their approaches being of a traditional nature with minimal implementation of ICT. Consequently, the resultant infrastructure is questionable in terms of quality, which affects the overall performance of the construction industry [17]. However, technology is being increasingly used to address these challenges. Research conducted in the United Kingdom construction industry in 2019, determined that 75% of construction firms reported using file-sharing tools to share and access drawings, compared to 52% in 2018 [8]. However, a limited number (7%) of respondents use technology to manage the entire process. Furthermore, there is a profound difference between firms that approach investments in new technology on a strategic vis-à-vis an ad hoc basis – 26% do not having a strategy, and 36% of firms simply invest on an ad hoc basis.

The construction process in the industry is leaning towards digitalisation and the inclusion of technology. The construction industry should actively, and where appropriate, apply suitable software or computer systems that are able to exchange and make use of information, for example BIM. In line
with this, they should apply demonstration installations, prefabrication, pre-assembly, modularisation, and off-site fabrication technologies in their construction activities [15]. Autodesk & CIOB [5] contend that successful organisations will be those whose leaders integrate digital technologies into their corporate strategy, and implement initiatives to break down barriers to adoption.

3. Research

3.1. Research method and sample stratum

The study was quantitative in nature and entailed a questionnaire survey of 125 medium to large general contractor members of the East Cape Master Builders Association (ECMBA) in the Port Elizabeth region. Fifty members were surveyed by directing them to an online link, 45 via e-mail, and 30 were handed print copies, of which, 15 delivered online, 4 delivered per e-mail, and 5 print, were fully completed and returned to the researcher, representing a response rate of 19.2%.

3.2. Research findings

Table 1 indicates the extent of respondents’ agreement with seven productivity-, profitability-, and 4IR-related statements in terms of a scale of strongly disagree to strongly agree, and a MS ranging between 1.00 and 5.00. Six of the seven statements are ‘true’ whereas one is ‘false’. It is notable that all the MSs relative to all the ‘true’ statements are > 3.00, which indicates that in general the respondents agree, and that the MS relative to the ‘false’ statement is ≤ 3.00, which indicates that in general, the respondents disagree.

The highest MS (4.46) is relative to ‘Poor labour productivity negatively impacts project profitability’, which is > 4.20 ≤ 5.00, and thus the agreement can be deemed to be between agree to strongly agree / strongly agree. The impact of poor labour productivity on profitability, is well documented in the literature [15].

Given that the MSs relative to four statements are > 3.40 ≤ 4.20, the agreement can be deemed to be between neutral to agree / agree: ‘The construction industry is faced with poor levels of project performance’; ‘Benefits of 4IR can mitigate poor levels of productivity’; ‘Concepts of 4IR have relevance to productivity in the construction industry’, and ‘The construction industry experiences poor levels of productivity’. The poor levels of project performance, and poor productivity are well documented in the literature [11; 15], and despite the ‘novelty’ of 4IR, the potential of 4IR to enhance productivity [1; 11].

Given that the MS (2.35) relative to the seventh statement is > 1.80 ≤ 2.60, the agreement can be deemed to be between strongly disagree to disagree / disagree: ‘Implementing 4IR is too costly and the benefits do not outweigh the initial capital outlay’. As stated, this statement is false, as the literature indicates [11].

Table 1. Extent of respondents’ agreement with productivity-, profitability-, and 4IR-related statements.

| Statement                                           | Response (%)            |
|-----------------------------------------------------|-------------------------|
| Poor labour productivity negatively impacts project profitability | 0.0 0.0 8.3 4.2 20.8 66.7 4.46 |
| The construction industry is faced with poor levels of project performance | 0.0 0.0 4.2 45.8 29.2 20.8 3.67 |
Table 2 indicates the frequency at which two phenomena occur in terms of percentage responses to a scale of never to daily, and a MS ranging between 1.00 and 5.00. It is notable that both the MSs are ≤ 3.00, which indicates that in general the phenomena can be deemed to occur infrequently as opposed to frequently. However, given that the MSs are > 2.60 ≤ 3.40, the phenomena can be deemed to occur between monthly to fortnightly / fortnightly.

Table 2. Frequency at which phenomena occur according to respondents.

| Phenomenon                                                                 | Response (%) | MS    |
|----------------------------------------------------------------------------|--------------|-------|
| Project delays                                                             | 8.3 0.0 41.7 29.2 12.5 8.3 2.86 |       |
| Projects being completed late / not on proposed date because of performance related issues | 8.3 8.3 41.7 12.5 20.8 8.3 2.77 |       |

Table 3 indicates the extent of respondents’ agreement with project delay-, performance-, and 4IR related statements in terms of a scale of strongly disagree to strongly agree, and a MS ranging between 1.00 and 5.00. Six of the seven statements are ‘true’ whereas one is ‘false’. It is notable that all the MSs relative to all the ‘true’ statements are > 3.00, which indicates that in general the respondents agree, and that the MS relative to the ‘false’ statement is ≤ 3.00, which indicates that in general, the respondents disagree.

Given that the MSs relative to five statements are > 3.40 ≤ 4.20, the agreement can be deemed to be between neutral to agree / agree: ‘Software such as BIM can lessen delays on projects’; ‘Project delays are becoming an increasing occurrence’; ‘Principles related to 4IR have the potential to alleviate major project delays’; ‘Poor performance is a resulting factor why projects experience delays and late completion’, and ‘Principles related to 4IR can control issues such as time and budget overruns’. The potential of BIM and 4IR technologies to contribute to mitigating poor schedule- and budget-related performance is documented in the literature [11].

The MS relative to ‘The industry will be able to successfully implement 4IR to monitor and deal with delays’ is > 2.60 ≤ 3.40, therefore the agreement can be deemed to be between disagree to neutral / neutral.

Given that the MS relative to the seventh statement ‘Principles related to 4IR have no relevance to project delays and the improvement thereof’ is > 1.00 ≤ 1.80, it can be deemed that the respondents strongly disagree to disagree therewith. The statement is contrary to research findings documented in the literature [11].
Table 3. Extent of respondents’ agreement with project delay-, performance-, and 4IR-related statements.

| Statement                                                                 | Response (%) |
|---------------------------------------------------------------------------|--------------|
| Statement                                                                 | Unsure | Strongly disagree | Disagree | Neutral | Agree | Strongly agree | MS  |
| Software such as BIM can lessen delays on projects                        | 16.7   | 4.2              | 8.3      | 8.3     | 33.3  | 29.2          | 3.90 |
| Project delays are becoming an increasing occurrence                      | 4.2    | 8.3              | 0.0      | 25.0    | 29.2  | 33.3          | 3.83 |
| Principles related to 4IR have the potential to alleviate major project delays | 16.7   | 4.2              | 4.2      | 20.8    | 50.0  | 4.2           | 3.55 |
| Poor performance is a resulting factor why projects experience delays and late completion | 0.0    | 4.2              | 12.5     | 33.3    | 25.0  | 25.0          | 3.54 |
| Principles related to 4IR can control issues such as time and budget overruns | 4.2    | 4.2              | 4.2      | 41.7    | 33.3  | 12.5          | 3.48 |
| The industry will be able to successfully implement 4IR to monitor and deal with delays | 8.3    | 12.5             | 8.3      | 37.5    | 25.0  | 8.3           | 3.09 |
| Principles related to 4IR have no relevance to project delays and the improvement thereof | 12.5   | 45.8             | 20.8     | 20.8    | 0.0   | 0.0           | 1.71 |

Table 4 indicates the extent of respondents’ agreement with fourteen skilled labour- and 4IR-related statements in terms of a scale of strongly disagree to strongly agree, and a MS ranging between 1.00 and 5.00. Twelve of the statements are ‘true’ whereas two are ‘false’. It is notable that 10 / 12 (83.3%) MSs relative to the ‘true’ statements are > 3.00, which indicates that in general the respondents agree, and that the MSs relative to the ‘false’ statements are ≤ 3.00, which indicates that in general, the respondents disagree.

The highest MS (4.63) is relative to ‘Skilled labour plays a vital role in the completion of projects’, which is > 4.20 ≤ 5.00, and thus the agreement can be deemed to be between agree to strongly agree / strongly agree. The role of skilled labour in construction is well documented in the literature [1; 11]. Given that the MSs relative to six statements are > 3.40 ≤ 4.20, the agreement can be deemed to be between neutral to agree / agree: ‘Skilled labour shortage is a current issue in the construction industry’; ‘Skilled labour affects project performance’; ‘The lack of skilled labour has resulted in poor project performance’; ‘Introduction of 4IR will create new and specialised roles in the industry’; ‘4IR’s result on skilled labour will increase project performance’, and ‘The industry is faced with a poor image of dangerous and labour-intensive work’. The non-attractiveness of construction due to its image is documented by, inter alia, WEF [1] and Windapo [13].

A further six statements have MSs > 2.60 ≤ 3.40, therefore the agreement can be deemed to be between disagree to neutral / neutral: ‘4IR will shift responsibilities from previously unsafe jobs to safer less labour-intensive works’; ‘Younger generations show lack of interest in construction as a career’; ‘4IR boasts opportunities to increase the share of woman working in the industry’; ‘Implementation of 4IR will result in an increase of skilled labour’; ‘4IR technologies will result in the automation of undesirable / unpleasant jobs’, and ‘Companies supplement and endorse enhancement of skills amongst their labour force’.

The MS relative to the statement ‘4IR will result in job losses’ is > 1.80 ≤ 2.60, therefore the agreement can be deemed to be between strongly disagree to disagree / disagree.

Table 4. Extent of respondents’ agreement with skilled labour- and 4IR-related statements.
| Statement                                                                 | Response (%) |
|---------------------------------------------------------------------------|--------------|
| Skilled labour plays a vital role in the completion of projects           | 0.0 0.0 0.0 0.0 37.5 62.5 4.63 |
| Skilled labour shortage is a current issue in the construction industry   | 0.0 8.3 0.0 8.3 33.3 50.0 4.17 |
| Skilled labour effects project performance                                 | 0.0 4.2 0.0 4.2 62.5 29.2 4.13 |
| The lack of skilled labour has resulted in poor project performance       | 0.0 0.0 8.3 12.5 37.5 41.7 4.13 |
| Introduction of 4IR will create new and specialised roles in the industry | 8.3 8.3 8.3 12.5 33.3 29.2 3.73 |
| 4IR’s result on skilled labour will increase project performance          | 4.2 4.2 0.0 37.5 33.3 20.8 3.70 |
| The industry is faced with a poor image of dangerous and labour-intensive work | 4.2 4.2 4.2 45.8 29.2 12.5 3.43 |
| 4IR will shift responsibilities from previously unsafe jobs to safer less labour-intensive works | 8.3 8.3 4.2 33.3 37.5 8.3 3.36 |
| Younger generations show lack of interest in construction as a career     | 8.3 12.5 4.2 29.2 33.3 12.5 3.32 |
| 4IR boasts opportunities to increase the share of woman working in the industry | 20.8 8.3 4.2 37.5 25.0 4.2 3.16 |
| Implementation of 4IR will result in an increase of skilled labour        | 12.5 4.2 12.5 58.3 8.3 4.2 2.95 |
| 4IR technologies will result in the automation of undesirable/unpleasant jobs | 13.0 13.0 8.7 39.1 26.1 0.0 2.90 |
| Companies supplement and endorse enhancement of skills amongst their labour force | 4.2 8.3 29.2 37.5 12.5 8.3 2.83 |
| 4IR will result in job losses                                             | 20.8 25.0 20.8 12.5 16.7 4.2 2.42 |

Table 5 indicates the extent of respondents’ agreement with twelve construction process- and activities-related statements in terms of a scale of strongly disagree to strongly agree, and a MS ranging between 1.00 and 5.00. Ten of the statements are ‘true’ whereas two are ‘false’. It is notable that all the MSs relative to the ‘true’ statements are > 3.00, which indicates that in general the respondents agree, and that the MSs relative to the ‘false’ statements are ≤ 3.00, which indicates that in general, the respondents disagree.

The MSs relative to ‘Automation of labour-intensive activities will increase productivity and enhance project performance’, and ‘The human element in construction activities will always remain a key component’ are > 4.20 ≤ 5.00, and thus the agreement can be deemed to be between agree to strongly agree / strongly agree. The literature unequivocally supports the former finding in terms of the potential of automation to increase productivity and enhance performance [1; 11]. Despite the former, semi-autonomous equipment still requires considerable human controlling, whereas in the case of autonomous equipment, humans will still be required, however, more so in a monitoring role [1].

Six statements have MSs > 3.40 ≤ 4.20, which indicates that the agreement can be deemed to be between neutral to agree / agree: ‘Improved job site efficiency can be achieved through implementation of 4IR’; ‘The greatest opportunity to reduce costs is through increasing productivity of the labour component’; ‘Mechanisation of machinery in the industry has supplemented many traditional means of construction’;
‘Current construction methods experience many unexpected problems’, and ‘The industry needs change in terms of methods of construction’. The aforementioned are highlighted in industry reports [1; 11].

Four statements have MSs > 2.60 ≤ 3.40, therefore the agreement can be deemed to be between disagree to neutral / neutral: ‘Modern construction methods will result in improved performance’, ‘Software and computer systems can manage job sites more efficiently and monitor works accurately’, ‘The construction industry in terms of methods of construction has stagnated’, and ‘The industry is willing to introduce new methods which are related to 4IR/Construction 4.0’. The concurrence relative to the statements is supported by the literature, including the ‘stagnation’ and ‘willingness’ statements [1; 11].

The MS relative to the statement ‘The construction industry does not have the ability to implement improved methods of construction’ is > 1.80 ≤ 2.60, therefore the agreement can be deemed to be between strongly disagree to disagree / disagree. This concurrence is supported by the literature [1; 11].

**Table 5.** Extent of respondents’ agreement with construction process- and activities-related statements.

| Statement                                                                 | Response (%) |
|---------------------------------------------------------------------------|--------------|
| Automation of labour-intensive activities will increase productivity and enhance project performance | Unsure 0.0 | Strongly disagree 0.0 | Disagree 0.0 | Neutral 13.0 | Agree 43.5 | Strongly agree 43.5 | MS 4.30 |
| The human element in construction activities will always remain a key component | 4.3 4.3 | 0.0 17.4 | 21.7 52.2 | 4.23 |
| Improved job site efficiency can be achieved through implementation of 4IR | 4.3 4.3 | 0.0 34.8 | 34.8 21.7 | 3.73 |
| The greatest opportunity to reduce costs is through increasing productivity of the labour component | 0.0 8.3 | 8.3 33.3 | 20.8 29.2 | 3.54 |
| Mechanisation of machinery in the industry has supplemented many traditional means of construction | 0.0 0.0 | 4.2 41.7 | 50.0 4.2 | 3.54 |
| Current construction methods experience many unexpected problems         | 0.0 4.2 | 16.7 33.3 | 16.7 29.2 | 3.50 |
| The industry needs change in terms of methods of construction             | 0.0 4.2 | 16.7 25.0 | 41.7 12.5 | 3.42 |
| Modern construction methods will result in improved performance           | 0.0 8.7 | 8.7 30.4 | 39.1 13.0 | 3.39 |
| Software and computer systems can manage job sites more efficiently and monitor works accurately | 0.0 13.0 | 8.7 30.4 | 39.1 8.7 | 3.22 |
| The construction industry in terms of methods of construction has stagnated | 0.0 12.5 | 8.3 37.5 | 29.2 12.5 | 3.21 |
| The industry is willing to introduce new methods which are related to 4IR/Construction 4.0 | 8.3 8.3 | 37.5 29.2 | 8.3 8.3 | 2.68 |
| The construction industry does not have the ability to implement improved methods of construction | 4.3 43.5 | 21.7 13.0 | 8.7 8.7 | 2.14 |

**4. Conclusions**
Due to the size of the sample stratum, and the response rate, the findings cannot be considered definitive in any way, but rather indicative of what might be issues and challenges.

The construction industry is fraught with challenges relating to poor performance and the improvement thereof. Poor performance is attributable to, inter alia, current construction methods and activities, and skilled labour shortages. These issues have detrimental effects on the industry operations, and engender poor productivity, project delays, and poor profitability. Furthermore, the industry has a poor image and is not attractive to the younger generation in terms of a potential career, which exacerbates the situation.

4IR technologies hold the potential to mitigate the various factors which negatively affect project performance within the industry. Its implementation boasts improvements in all facets and activities undertaken in the industry, and constitutes the way forward in terms of enhancing performance in the industry.

The study focused on the link between performance and the improvement thereof through the application of 4IR technologies. The literature indicates that 4IR has the potential to improve performance within the industry and that there is a need for such improvement. The research, which is perception based, supports the findings reflected in the literature.

5. Recommendations

The benefits of 4IR, and the technologies and advancements, which have the potential to facilitate planning, monitoring, and controlling of various aspects related to industry performance need to be welcomed and introduced in the built environment and on projects. The level of awareness relative to the potential implementation of 4IR in the built environment should be raised by statutory councils, and professional and employer associations, who in turn, should promote and facilitate related continuing professional development (CPD). Case studies entailing the deployment of 4IR technologies should be documented, and the findings shared, which are likely to consolidate the positive perceptions with respect to the potential of such 4IR technologies. Tertiary built environment education programmes should integrate 4IR technologies into all possible modules, and the extent of such integration should be reviewed during accreditation visits.

In terms of project delays, a proper construction progress monitoring system should be implemented. This will enable informed decision making through timeous determination of the status quo on sites in terms of, not only progress, but rework and productivity by linking progress to deployed resources. Further potential benefits include linking progress to ‘information required’, which will facilitate timeous provision of such information, thereby promoting productivity and the meeting of schedule requirements. Furthermore, a study should be conducted to determine the causes of construction delays, and the potential of 4IR technologies to mitigate same.

Given the shortage of skilled labour and the increasing shortage of young, skilled persons entering the construction industry, the poor image of the industry must be improved, along with investment in education and training of managers, supervisors, and workers. 4IR technological advancements will contribute to creating a healthier and safer working environment, and more challenging careers, thereby enhancing the image. An attractive image will be more inviting to the ‘tech-savvy’ generation, and will contribute to eliminating the perception that the industry is for ‘hard labour’ type individuals only. However, the advancements will create demand for new specialised roles and responsibilities, and tertiary education institutions will have to develop a cohort of ‘digitalised’ graduates to drive the process.

Furthermore, current construction activities should employ greater mechanisation and automation of laborious, tedious, and often hazardous tasks. Doing so is likely to contribute to improving total productivity, and the meeting of schedule requirements.
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