Digital Transformation In Construction 4.0

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Abstract. Digital transformation can help address pain points and inefficiencies in the construction and manufacturing industries. In the construction industry, fragmentation is a significant challenge, and companies should focus on fixing pain points rather than just installing IT solutions. In the manufacturing industry, digital transformation can help streamline traditionally time-consuming processes, such as design and testing, and reduce system downtime. Companies should identify specific problems that digital transformation can solve, such as predicting cost, quality, and availability of necessary supplies. Other key considerations for implementing digital transformation in these industries include defining objectives and goals, identifying appropriate technology solutions, building an innovative culture, collaborating with partners and stakeholders, implementing technology solutions, reskilling and restructuring engineering teams, adjusting project baselines to capture value, and connecting projects to unlock impact across the enterprise. Construction companies are increasingly being challenged to transfer and use new technology. However, investigation has been undertaken on technology transfer from the perspective of the small construction company from project to smart construction. The results stress that the technology which small construction companies tend to transfer more successfully is that which can contribute to the modern trend business in an existing organizational capabilities. The policy is that any technology transfer initiatives need to appreciate and actively manage the different motivations and challenges of small construction companies to transform and adopt new technology.
Keywords: construction, manufacturing, digital tranformation, information technology,collaborating

INTRODUCTION

Currently, the construction industry is experiencing a change. According to Ahmad Bukhori Shaharuddin et al., the primary obstacles to the adoption of 4 IR include a lack of a system, financial difficulties, and a low appetite for innovation among SME participants. There are a number of pressing issues facing the building sector these days. Labour shortages, growing material costs, project delays, safety issues, poor risk management, erroneous design, late modification requests, contract violations, organisational risks, frequent staff turnover, inexperienced workers, postponed deliveries, and material shortages are some of the main difficulties [23]. Furthermore, the company is slow to implement new technologies that have the potential to reduce expenses and boost output [20, 21]. Up until the mid-1990s, interest in this link sharply declined [22]. Although the construction industry actively promotes digital transformation, its overall level of digitization is still lower than that of other industries because of the construction process's complexity, fragmentation, and extensive production methods. Construction enterprises also face challenges related to declining profits, rising competition, slowing industry growth, ageing workforces, insufficient appeal to new hires, and a shortage of digital professionals. The term "Industrial Revolution 4.0" describes a technological advance that presents a novel idea with a range of possible benefits. Malaysia has adopted a new concept in technology, and contractors and other building industry participants have their own perspectives in the direction of execution. The study's objective is to examine how Malaysian contractors see the potential benefits and difficulties associated with implementing IR 4.0 in the future. In order to determine the opportunities and obstacles facing contractors in implementing IR 4.0 in the construction industry, a thorough study is conducted. The responders that were chosen came from the G4 and G5 contractor grades in Kelantan (specific sizes measured by the amount of paid up capital and tendering capacity for G4 150,000 < 3,000,000 Medium-Sized Contractors G5 250,000 < 5,000,000.). The emergence of Industry 4.0 technological intervention happened in 2011 and appeared firstly in an article published by the German government [24] .The advent of I4.0 technologies has provided a whole new perspective of effectively collaborating manufacturing functions with I4.0 technologies to achieve significant manufacturing outputs and organizational performances with minimal resource utilization [24, 26, 27]. The technological

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advancements of the fourth industrial revolution have irrefutably enhanced business success and operational excellence [28, 29, 30] .

Problem Statement

The building industry is now falling behind in terms of digitalization have acknowledged the need for the AEC sector to digitise more quickly. In addition, this year's COVID-19 epidemic changed how the construction sector operates, affecting everything from project scheduling to hiring staff to customer consultation. Future commercial advancements will be impacted by the pandemic's aftermath in a number of ways. Digital technology are changing construction sites, increasing contract opportunities and profit margins. Changes and revolutions are causing positions of frontline employees and business professionals to evolve [1] . Compared to most other industries, the construction industry has been slow to change in recent years. While there are disadvantages to this process, businesses must embrace digital transformation in order to thrive in the present competitive market. Organisational resistance to change is one of the challenges impeding digital transformation; many organisations have deeply ingrained cultures, hierarchies, and practices that make change challenging.

The adoption of new technology and the advancement of the digital transition may be hampered by this opposition. Lack of competence in digital fields: Staff members that are skilled at utilising new technologies and adopting digital practices are essential for implementing digital transformation.The construction industry has been sluggish to adapt in recent years, in contrast to the majority of other sectors. Meanwhile companies need to embrace digital transformation to succeed in the current competitive environment, there are drawbacks to this process. Among the obstacles preventing digital transformation are **o**rganizational resistance to change **a** lot of organizations have deeply rooted hierarchies, cultures, and procedures that make change difficult. This opposition may make it more difficult for new technologies to be adopted and for the digital transition to proceed. Absence of proficiency in digital domains: Implementing digital transformation demands a staff that is adept in harnessing new technology and embracing digital procedures. Companies may have trouble finding, keeping, and developing employees with the requisite knowledge and experience in the digital space.

Older technology and legacy systems **a** lot of businesses have made significant investments in these areas, which may serve as obstacles to the digital transition or criteria and alternative settings and evaluation. Decision-makers need more flexible and scalable contextual frameworks for technology selection in digitalization. Since digital technologies offer both benefits and challenges, the decision-making models should reflect this dialectic nature of Industry 4.0 adoption and contextually optimize their decisions**.**Technology forms the basis of digitalization but technology per se, does not provide value to organisations but rather “doing business differently because technology makes it possible” [2] . Chawla and Goyal concurred that technology alone is of no value, but value is generated based on the context that makes technology useful to the organisation. This applies to the project management discipline as well. Project management can be done differently through the application of technology [7] . Kraus et al. stated that digitalization or digital transformation is very specialised and restricted to particular domains. One domain that is not covered in literature is the project management domain [3] . Digitalization is based on technology, but technology in and of itself does not add value to companies; rather, organisations benefit from "doing business differently because technology makes it possible" [2].

Chawla and Goyal in their research agreed that technology is useless on its own; rather, value is created by the context in which it is applied to benefit the company [7]. This also holds true for the field of project management. Technology can be used to change the way that project management is done. According to Kraus et al.[3], digital transformation or digitalization is highly specialised and limited to specific domains. Project management is one area that isn't discussed in the literature. Additionally, digitalization has grown more complicated, challenging to comprehend, and requiring scholarly attention. Chawla and Goyal [7] stated that research progression is missing in the literature. Digitalization is achieved through the application of iterative project management approaches such as Scrum and Lean . Chalons and Dufft [6] also highlighted agility and adaptability as prerequisites for digitalization. Organisations also need to invest in the skills and capabilities of employees. Guinan et al. [4] provided four levers for teams to be successful in digitalization. These levers are (i) diversity, (ii) iterative goal setting, (iii) continuous learning and (iv) talent management. Organisations also need to move from functional silos to cross-functional teams [5]. Chalons and Dufft [6] added two additional requirements. The first is that digital solutions should be simple and intuitive and secondly, organisations should explore digital channels to collect customer information to provide better customer experience. Various frameworks exist to describe the phenomenon of digitalization. These frameworks can be divided into conceptual, transformation or maturity frameworks. Conceptual frameworks describe digitalization in a way for people to understand this concept [8] . Van Tonder, Schachtebeck, Nieuwenhuizen and Bossink [9] designed a conceptual framework that guides organisations to digitalize current business models. The Digitization Piano Digital Business Transformation Framework is also a conceptual model that aids organisations in the application of digital technologies to achieve

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successful transformation [10] . Transformation frameworks on the other hand, explain how digitalization should be implemented in organisations. Martinez [32] referred to it as a path that involves the steps that organisations need to take to implement digital solutions. Kavadias et al. [11] mentioned six keys i.e. (i) a personalised product/service offering, (ii) a closed-loop process, (iii) asset sharing, (iv) usage-based pricing, (v) a collaborative ecosystem and (vi) an agile and adaptive organisation. These six keys are required if organisations want to successfully digitalize its business model. Maturity frameworks describe the maturity levels of digitalization and are valuable to assess the organisations strengths, and weaknesses. An example of a maturity framework is that of [12] . He postulated five maturity levels i.e. localised exploitation, internal integration, business process redesign, business network redesign and business scope redefinition.

The aim of this paper is to investigate the research dynamics related to digital transformation in Industry 4.0 in particularlly, the research questions of this study as:

1. What are the challenges in Digital transformation ?
2. What are the impact Industry 4.0 adoption to construction industries?
3. What are the solution overcome problems occur in digital transformation?

Literature Review

Overview of Industry 4.0

The construction 4.0 brings new technologies such as Cloud Computing, Mobile Information, Data Analytics, Artificial Intelligence (AI), Augmented Reality (AR) and 3D printing, will play a vital role in collaboration, coordination and communication in real-time among construction stakeholders. The concept of Construction 4.0 is mainly to enhance current and future technologies for the construction industry to achieve higher productivity, better safety and towards a more sustainable approach incorporating whole life cycle analysis. Upon reflection, looking into the mom-and-pop shops of half-a-century ago, which have now been replaced by large-scale modern entities with global supply chains and increasing digitised distribution systems; representing a new level of client-customer-consumer trichotomy that has changed the construction industry, and continuing to do so.

Strategically, adopting this technological progression will have an immense impact and will potentially change the operational processes of all construction organisations covering the small and medium-sized enterprise. Klaus Schwab highlighted the Fourth Industrial Revolution is, however, fundamentally different. It is characterized by a range of new 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 being [13] . Now a Fourth Industrial Revolution is building on the Third, the digital revolution that has been occurring since the middle of the last century. It is characterized by a fusion of technologies that is blurring the lines between the physical, digital and biological spheres IR 4.0 will bring changes to our culture and environment of the way we live, work and communicate. Transformational technologies, such as artificial intelligence, Internet of Things (IoT), big data and robotics, have and will continue to drive major changes for the construction industry, and beyond. The impact of the vast technological change will not only affect the economic growth but fosters a more empowering, collaborative, and sustainable foundation for our sociality.

However, the previous three revolutions had both positive and negative impacts on the industry, thus, the new emerging revolution should acknowledge these factors in ensuring IR4.0 will have greater value in liberating workers from automated tasks, freeing and focusing on addressing more complex business issues into one coordination, while being able to provide workers with radically new methods with the aim of achieving more constructive and creative solutions. Smart Integrated technology, innovation and infrastructure are of the highest priority to continuously increase the efficiency and availability of production processes and the utilization of plant equipment. The focus should be on agile and multi-use plants that can deliver both the economies of a large single stream plant, and the flexibility of a batch plant as well as be part of a global production process, while within limits, being able to make multiple products. This would allow for production flexibility and the possibility of ramping up production capacity for specific on demand products. To support the above, the platforms, products, and services used in the production processes will need advanced lifecycle management and collaborative functionality. Here, production related data must be collected and used as input, and integration and interoperability must be improved. Tools for modelling, design and simulation will be necessary and later combined with tools to monitor the production process and its equipment/platforms, connectivity, productivity as well as quality of services used or provided. Certain design steps can be replaced with design automation.

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Importance of Digital Transformation in Construction

Digital transformation is crucial for the construction industry to address the challenges of increasing complexity, cost overruns, and schedule delays. It enables construction companies to streamline processes, improve collaboration, and make data-driven decisions, leading to improved project outcomes and client satisfaction [34].

Internet of Things (IoT) is transforming the way we construct buildings. The Internet of Things in construction can enable data-driven construction, or "smart" construction, to help professionals better manage projects and streamline operations. It does this by connecting devices, people and systems on a digital platform to create an intelligent network. These networks utilize sensors, robotics, connected machinery and software applications to capture real-time data from the construction site. This data can then be used to make informed decisions about project design, safety protocols, resource management and more.

The Internet of Things can also provide remote monitoring capabilities that help reduce risks associated with hazardous work environments. By connecting disparate systems together into one unified network, the Internet of Things allows construction professionals to improve efficiency, communication and collaboration. Ultimately, this helps create safer construction sites, faster project completion times and higher quality end products. With Internet of Things technologies continuing to evolve, the possibilities for data-driven construction are becoming increasingly exciting.

Internet of Things integrate with smart construction.

The Internet of Things has become an integral part of modern construction projects. By enabling data-driven construction through sensors, robotics, connected machinery and software applications, IoT technology can help reduce costs and time associated with traditional building processes. This new way of digitalization allows companies to gain valuable insights into their operations and make better decisions while reducing costs and risks associated with traditional methods.

The advantages of implementing IoT in construction include improved communication between onsite workers, machine-to-machine interaction for more efficient maintenance, reduced manual labor costs due to automation, increased accuracy of data collection through sensors, increased safety due to remote monitoring capabilities and alerts, improved asset tracking and management systems allowing for better analysis of resource utilization, real-time data for better decision-making, and improved labor productivity due to better planning and process optimization.

However, there are some potential drawbacks that should be taken into consideration when looking at the Internet of Things in construction. The technology requires significant upfront costs for implementation, and it can also be vulnerable to cyber threats if proper security measures are not put in place. Additionally, providers may not always offer reliable support for their IoT systems, which could lead to major operational disruptions when something goes wrong. Finally, as with any new technology, there is an element of risk associated with its use what works today may no longer work tomorrow due to changes in the market or other external factors. The Internet of Things (IoT) has the potential to revolutionize smart construction, making it more efficient and cost effective. Data-driven construction is becoming an increasingly popular trend, and with the help of smart technology and connected devices, projects can be completed faster and with less waste. While there are many advantages to using the Internet of Things in construction, there are some potential drawbacks that should be taken into consideration. Security is a major concern, as all connected devices can potentially be vulnerable to cyberattacks. Additionally, data produced by IoT systems may not always be of the highest accuracy and reliability.

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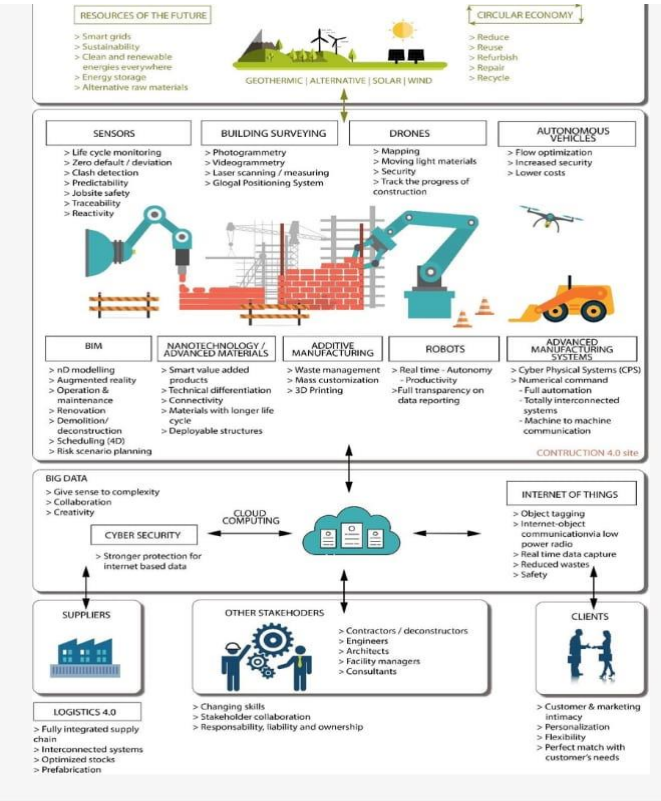

Figure 1

Construction 4.0

FIGURE 1. showed the modern construction that will be happened in our industry

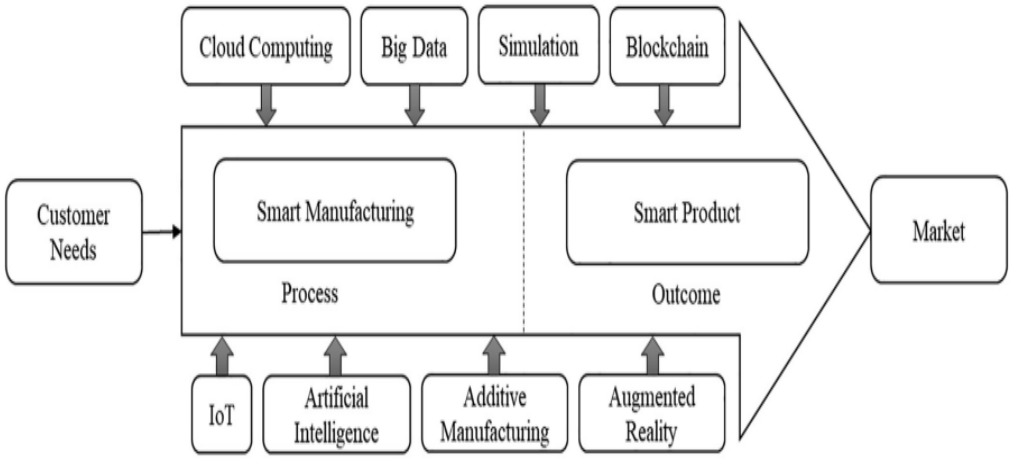

FIGURE 2. Theoretical framework on Smart manufacturing by Vishwas Dohale et al. (2022)

Management focuses on the planning, structuring and efficient execution of an activity, task, or project to achieve a set of outcomes, it is highly organized, monitored and controlled to get the final product or result.

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Impact of digital tranformation

Digital transformation can significantly impact the construction industry, as it can help streamline processes, improve collaboration, and increase efficiency across all stages of a construction project. One of the most critical in the construction industry is Environmental, Social, and Governance (ESG), which is a set of standards that measures a business's impact on society and the environment. It has built an ESG platform that from usage of digital and technologies to simplify this process by having all ESG-assigned tasks and activities across a project in one place. With building sustainable homes of the future dominating conversations, reimagining construction to enable developers to build affordable homes that can be built more efficiently and economically on a global scale. In addition, with the rise of construction data gathering pace allowing site managers to make data-driven decisions based on various metrics such as cost, carbon, and quality.

Artificial intelligence and machine learning are also beginning to impact construction with new estimating software tools such as Kreo that help quantity surveyors, estimators, and contractors save time and secure more business opportunities. Although emerging technologies are dominating the headlines, one of the most exciting start-ups is highlighting the art of possible when IoT sensor data and AI converge as start-ups continue to lead the way forward. How data is reshaping construction as the industry expands, huge data repositories continue to fill with information on everything from blueprints and building models to communications and cost estimates. Unfortunately, these repositories are often unstructured and difficult to access without the right tools. But an increasing number of SaaS solutions are enabling the construction industry to harness big data. Data analytics are unlocking powerful insights that until now were scattered in silos across every construction project. Due to the unique problems in the industry, we are also seeing new solutions designed to solve the most significant issues in construction.

By leveraging AI and blockchain technology to replace guesswork and estimates with data-driven decision-making. Digital tranformation created data-driven project management software to meet the construction industry's unique needs by providing the ability to share real-time updates and design changes. Ultimately, insights unlocked from big data can help reduce risk and waste while increasing efficiency. Every construction company faces pressure to complete jobs faster and cheaper with a shrinking workforce while also having a proactive focus on safety. Technology will play a critical role in bringing together internal teams and subcontractors. Construction teams are also becoming more agile by leveraging communication tools to document real-time updates from field workers and track data instantly to improve collaboration efforts. More and more construction firms are embracing technology and are gaining a competitive advantage by unlocking data-driven decision-making that enhances productivity by producing more efficient workflows. These are just a few impact of how the digital transformation of everything is building the future of construction.

METHODOLOGY

The collected data was then analysed and the results showed that they agreed the main challenges in adopting IR 4.0 concept for the construction were the lack of financial resources, ineffective process change strategy and low experiences in utilizing skilled applications and technologies. Most of the interviewees believed that the important enabler for IR 4.0 in the industry was Building Information Modelling (BIM) and technologies such as cloud technology, Internet of Things (IoT) and BIM is becoming a growing trend in the construction industry. The interviewees also mentioned that the current readiness of the IR 4.0 concept for the construction is still below par yet there is still potential to be improved especially in terms of the organisations management, awareness and implementation level. In order to assist with the planning, designing, and implementation of built environment infrastructure, the Construction 4.0 system focuses on the physical-to-digital transition and subsequently the digital-to-physical transfer.

DISCUSSION

The challenges of digital transformation in Industry 4.0, several solutions have been identified to increase competitiveness is to embracing digital transformation can enhance competitiveness by integrating customers' needs, preferences, and data-sharing with machinery to improve quality and efficiency. Utilize Opportunities and Reduce Risks for Industry 4.0 offers opportunities for flexible customer integration, quality enhancement, and fault avoidance through machine data analysis. Companies need to manage cyber risks and proactively address them. It is also can adjust talent and IT Resources like investing in appropriate skills and IT infrastructure is crucial for successful digital transformation. Many companies lack the necessary staff and infrastructure, highlighting the need for investment in these areas. Develop potential for also focusing on research and development, procurement, production, and warehousing, while leveraging individualized solutions in sales and services, can drive customizations and industry-specific solutions. The usage impetus from exponential technologies such as companies need to leverage key technologies like 3D printing to accelerate their transformation. Investing in technologies like 3D printing can lead to significant advancements in production and logistics

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processes. These solutions emphasize the importance of adapting to the digital transformation brought about by Industry 4.0, enhancing competitiveness, managing risks, investing in talent and IT infrastructure, developing business segments, and leveraging exponential technologies to drive innovation and growth.Implementing Construction 4.0 would change project and corporate frameworks in addition to the construction process creating an integrated building sector from the fragmented one [15] .

The construction sector has some of the lowest levels of R&D intensity, despite growing to be one of the most lucrative industries. Similarly, while employment growth has virtually doubled in other sectors, it has dropped over time in the AEC [14]. In an Industry 4.0 future, the role of human resources is changing from that of a machine operator to that of a strategic decision maker [16] . According to Awais and Henrich , humans must be sufficiently prepared for a successful human-machine collaboration in order for robots to assist them in dangerous, stressful, and time-consuming tasks. Given that it is a labor-intensive business in the Industry 4.0 technologies has far-reaching implications for the whole construction industry, the involved companies, the environment, and employees. Besides the economic benefits for improving productivity, efficiency, quality, and collaboration, their adoption can help to enhance safety, sustainability, decision making and thus to improve the poor image of the construction in the long run [17] .

Despite the advantages, several challenges must be addressed by all involved parties to ensure a successful implementation. To promote the transition to Industry 4.0, and fully reap these benefits, manifold political, economic, social, technological, environmental, and legal challenges have to be embraced, Companies should put industry 4.0 at the core of their strategic plan to gain national and international competitive advantage, The digital transition necessitates the use of a company's innovative ability, as well as new business models, tactics, organizational improvements in human resources, production processes, and management practices, technology styles, and physical infrastructures [18] .companies, should establish a strategic roadmap to take every step and decision more transparent and understandable. Construction industry players need to envision (company specific view of industry 4.0 vision), enable (develop a roadmap and define success factors), and implement [19] . Each phase of strategic management, marketing, human resources, IT maturity, smart manufacturing, and smart supply chain management should have its framework in a comprehensive development plan. In short, despite the challenges, the implementation of IR 4.0 within the Construction Industry would drive the industry’s performance to match with their industry counterparts such as the manufacturing, and automotive industry. Industry 4.0 is indeed the way of the future and must be embraced.

CONCLUSION

The implementation of IR 4.0 for the construction industry is becoming a huge interest around the sector as of this moment. Nevertheless, much work is needed in order to ensure that the implementation can be realized. Based from this study, making sure that the government are involved is critical in maximizing the utilities challenges such as the lack of financial resources and absence of a process change strategy may slow down the implementation efforts and not only that, utilization of new innovative technologies may require trainings. Several technologies have already had its placed in the industry now yet many others such as robotic and automation needs more exposure. Another thing that should be taken note as well is that management in the organization context plays a huge role in ensuring that the implementation could be a success . The sizes of the company can affect how the adoption is going to be executed since the nature of the firms. The Government role, culture and ethnicity, and the company ability limited by cash are also identified as the factors to influence their capabilities to absorb and implement the new technology. Innovation fails most times to deliver it for them because they are being driven by the low price to recognize what will drive them towards innovation. The results from this research can assist in producing a framework for the adoption of IR 4.0 for the construction in the future.

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