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CURRENT-READY INDONESIAN ENGINEER IN THE INDUSTRY 4.0 ERA

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ABSTRACT:

The Indonesian construction industry provides qualified regional infrastructure and human settlements. However, the disparity between the quality of infrastructure products and the competence of construction professionals to meet this, particularly in the Industry 4.0 era, still needs to be addressed. This paper reviews the existing government regulations on the construction engineer profession, who are leaders and managers to ensure the execution of construction project activities meet certain specifications, overcome all obstacles and problems from global changes and further contribute to the progress and independence of the nation. A relook at existing regulations in terms of (1) engineer professional programs, (2) engineer registration, (3) engineer institution, (4) engineer professional organization, and (5) rights and responsibility is necessary to help the construction industry in improving the roles and competitiveness of Indonesian engineers in this current 4.0 era. The outcome of this review can serve as an approach to developing a technical concept for the Indonesian engineer to take critical roles in effective quality control and management and create sustainable development in Indonesia.

Keywords: Construction, Industry, Engineer, Industry 4.0 Era

INTRODUCTION

The Indonesian construction industry is currently challenged with constructing regional infrastructure and human settlements. The government and its partners have focused on promoting qualified construction projects; however, the quality of the workforce affects the quality of construction projects since it is about the skills and abilities of construction workers that contribute to the success of construction projects (Dewi et al., 2022). As a country with a large market in the construction sector, Indonesia needs to be more prepared to face the global construction market, including the ASEAN market, by focusing on the availability of skilled construction workers and construction professionals with qualified managerial abilities (Pamulu, 2010).

Concerning the dynamic operation of the construction business services, human resources in this industry should be able to cope with the emergence of advanced technologies, the need for skilled professionals, and the increasing number of engineers. As stated by the Head of the Indonesian Engineers Union (Persatuan Insinyur Indonesia-PII), Mr. Danis Hidayat Samadilaga, "In this era of digitalization, automation, and artificial intelligence, Indonesian engineers need to be more agile and innovative in providing their engineering services." (Jiao et al., 2021). This thoughtfulness aligns with the concern of the ASEAN Federation of Engineering Organizations (AFEO), which has paid attention to the changing roles of engineers

in the Industry 4.0 era. Industry 4.0, represented by technologies such as big data and automation, penetrates the construction industry, which eventually affects how people work according to complex forms of technology emerging and need soft skills to support technical skills (Low et al., 2021).

This study aims to review the existing government regulation on Indonesian engineering professionals to discuss its effectiveness and whether the program can strengthen the competence of construction professionals and answer the challenges of engineers facing the industry 4.0 era (Tan et al., 2020). It covers (1) engineer professional programs, (2) engineer registration, (3) engineer institutions, (4) engineer professional organizations, and (5) rights and responsibilities. Finally, it proposes approaches for developing more technical concepts for the Indonesian engineer to be ready for industry 4.0, take critical roles in effective quality control and management, and create sustainable development in Indonesia.

RESEARCH METHODS

This research used a literature review as a critical analysis and synthesis of existing research and scholarly articles on a particular topic. It serves several purposes, such as identifying gaps in the current knowledge, understanding the state of the research, and providing a context for your research or study.

RESULTS AND DISCUSSION

Challenges and opportunities of engineers in the industry 4.0 era

The construction industry relies heavily on human resources to carry out its operations, making it difficult whenever it has a reputation for poor performance workforce, resulting in poor construction projects performed within the agreed budget, schedule, and quality (L. M. Aghimien et al., 2023); (D. Aghimien et al., 2022). Several developing countries have carefully considered human resources management strategies to deal with challenges, especially among construction professionals. The South African construction industry recommends compensation packages to attract and retain the required skills of their human resources and other related policies to allow for flexibility in working hours (D. Aghimien et al., 2021). Eswatini construction professionals are supported by health and wellness, work flexibility, and days off/shared work to improve the service delivery of the construction industry (D. Aghimien et al., 2021). At the same time, Malaysian human resources strategies focus on appointing the right people for the right job (Dom et al., 2012). It can be summarized that construction professionals' welfare and appropriate assignment currently are the most considered factors to enhance their productivity and quality of work.

In the context of construction project leadership, in particular, civil engineering professionals indeed play an essential role in

ensuring the success of construction projects. Current studies have revealed that construction practitioners' policies have been revisited to improve their workforce quality and productivity. Women construction professionals have been supported leave of pay for maternity leave, work flexibility, days off/shared work (D. Aghimien et al., 2022), improved employee and family welfare, and opportunities for career development (L. M. Aghimien et al., 2023); (Ayodele et al., 2022), and conflict management skills (Irfan et al., 2019). This attention and policies of the construction industry for construction professionals without gender discrimination will create a work-life balance strategy to enhance their soft and technical skills.

Moreover, the advent of advanced technology will also change how individuals work, especially in the era of Industry 4.0. Industry 4.0, represented by technologies such as big data and automation, has permeated the construction industry and exacerbated the changing expectations gap that construction professionals must bridge (Low et al., 2021). Industry 4.0 is also characterized by a hallmark of the fourth industrial revolution, which is robotic processes, automation, and machine-to-machine communication (Stek, 2022). Meanwhile, the future strategies and mindsets of employees to prepare for the changes of Industry 4.0 have been largely unstudied (Low et al., 2021). Three parties – Government, educational institutions, and industry are crucial partners in response to these challenges, hence to anticipate. It is

time to examine the readiness of Indonesia's engineers, particularly civil engineers in the construction industry, to adapt to 4.0 technologies to prepare its current-ready Indonesian engineers for the industry 4.0 era.

Higher education's role also determines Indonesian engineers' readiness to face the 4.0 era. Evidence has shown that higher education mainly focuses on knowledge (know-what) and theory-based (know-why) outcomes; however, competent professionals require knowledge (know-what), understanding of the theory (know-why), professional (know-how), interpersonal skills (know-how and know-who), and need intrapersonal traits such as creativeness, persistence, a result-driven attitude (Stek, 2022). In other words, engineering graduates need competencies of interpersonal skills and intrapersonal characteristics as parts of personality development in the era of Industry 4.0 (Stek, 2022); this is why civil engineering professionals seem to lack the soft skills needed by Industry 4.0. Construction 4.0 will incorporate cognitive abilities to detect complex and unpredictable actions and reasoning about dynamic process optimization strategies to support decision-making (Kor et al., 2023). There is a need for socially responsible operations in the Industry 4.0 era by demonstrating social and organizational performance (employment practices, health and safety, and business practices) and community social performance, quality of life and social welfare, social governance, and economic

welfare and growth (Asokan et al., 2022). Technical competencies, soft skills, and social responsibility can complement civil engineering construction professionals to be ready for construction 4.0 in different phases of the project lifecycle (design–procurement–planning–structure). The opportunities remain as Indonesian engineers promote professionals' skill-upgrading in adapting to industry 4.0's requirements.

The existing government regulations on fostering engineering professional

1. Indonesian Professional Engineer Program (PPI)

The professional engineer program (PPI) is one of the seven professional areas stipulated in the Decree of the Minister of Education and Culture of the Republic of Indonesia number 036/U/1993, Law No. 12/2012 concerning Higher Education, Presidential Decree No. 8/2012 concerning KKNI, Law No. 11/2014 concerning Engineering, and Permenristekdikti No. 44/2015 concerning SNI/TKTI. With the professional education of engineers, it is expected that the competency standards of engineers in Indonesia can meet the needs and challenges of developing technology, industry, and infrastructure. In addition, since the Indonesian Engineers Association (PII) has become a member of world-class engineering organizations, such as the World Federation of Engineering Organizations (WFEO) and the ASEAN Federation of Engineering Organizations (AFEO), it is expected that the competency standards of

engineers in Indonesia can respond to global needs and challenges. Hence, Indonesian engineers can compete with engineers from other countries worldwide.

PPI is a higher education program that can be taken after completing an undergraduate program to build engineering competence. Obtaining a PPI degree is also a prerequisite to applying for professional certification. The undergraduate engineering program has to complete a learning load of 144 credits within four years (8 semesters), where graduates have academic abilities of analytical and synthetic critical thinking and creative design. However, to be qualified as a professional engineer, the graduate needs to continue professional engineering education for a minimum of one year with a load of 24 credits, called the PPI study program (PSPPI). The PSPPI curriculum consists of 84% of practical engineering activities, including industrial internships, case studies, and problem-solving, and 16% of face-to-face lectures in class. For example, Sam Ratulangi University, located in Manado, North Sulawesi Province, has designed its PSPPI curriculum as follows:

1. Code of Ethics and Professional Ethics of Engineers (2 credits)
2. Professionalism (2)
3. Occupational and environmental safety, health, and security (2)
4. Engineering practice (12)
5. Philosophy of engineering in industry
6. Industry development direction and status
7. Industrial system (Engineering)

8. Engineering problems
9. Troubleshooting tasks
10. Writing engineering practice reports
11. Case study (4)
12. Speakers at seminars, workshops, and discussions (2)

Engineering graduates who take part in the PSPPI will obtain a professional engineer diploma and are entitled to use the title Engineer (Ir.).

2. Engineer registration

A person who already has a professional engineer diploma can take a professional engineer competency test conducted by a professional certification body. Engineers who have passed the professional engineer competency test will obtain a certificate of competence as experienced engineers. A certificate of competence is a document acknowledging competence to practice in engineering fields. Engineer registration is a requirement to obtain an engineer registration certificate issued by PII, called STRI.

3. Professional engineering program institution

The Indonesian Government, through the Ministry of Education, Culture, Research, and Technology, has mandated 40 universities to organize the PPI study program (PSPPI) to accelerate the need for professional engineers. In the western part of Indonesia, there are 32 universities, seven universities in the central region and only one in the eastern part of Indonesia.

4. Engineering professional organization

As a professional engineering organization, the Indonesian Engineers

Association (PII) must prepare Indonesian engineers to be more ready to enter the world of work professionally, following the required competency standards. PII is a forum for synergizing Indonesian engineers to develop engineering competencies that have a strategic role in society and make a real contribution to national development.

5. Rights and Responsibility

It is time to improve the roles and responsibilities of Indonesian engineers in this current 4.0 era. A civil engineer is responsible for using their civil engineering background to plan and oversee the development efforts of the various areas of this field. They will apply civil engineering principles to ensure structures are constructed safely and sturdily.

Approaches for the readiness of Indonesian engineers in the industry 4.0 era

The competence of construction professionals is academically carried out after they have gone through higher education institutions with a certain period of industrial experience. Given the emerging technological advances and the need for complex project management competencies, while the number of construction professionals who can cope with this is minimal, additional formal and non-formal education and training are expected to play a more significant role.

The Indonesian Government, through the Ministry of Public Works, the Ministry of Manpower, the Ministry of Education, Culture and Research, together with its partners - the Indonesian Engineers

Association (PII), needs to focus on the policy and take actions regarding improving the competence of construction professionals both on a national and international, particularly, nowadays, the readiness of Indonesian engineer in the industry 4.0 era. The national construction industry is expected to have a role in liberalization opportunities by expanding the construction workers to enter the global market (Dewi et al., 2022). This penetration should include construction professionals.

In conducting Indonesian professional engineering programs by certain higher education institutions, namely PSPPI, the curriculum must be adapted to technology adoption, such as big data analytics, digital twins, augmented reality, blockchain, 3D printing, artificial intelligence, and the Internet of Things. It is demonstrated how these technologies can help to improve socially responsible operations performance in the Industry 4.0 era, covering employment practices, health and safety, business practices, quality of life and social welfare, social governance, and economic welfare and growth (Asokan et al., 2022).

Moreover, deep learning and digital twins toward construction 4.0 are used to integrate data from different environments in real-time through the interplay of optimization and simulation during the lifecycle (design-planning-construction) (Kor et al., 2023). The current syllabus contains discipline, work attitudes, international language, and professional engineering work ethic that must be kept up,

while the implementation should prioritize practice over theory. The method used in teaching and learning must be able to present knowledge, skills, and work attitudes to engineering participants using available facilities.

On the other hand, in another effort to improve the quality of competence and professionalism of Indonesian engineers, the teaching and learning in PSPP must contain people-related soft skills features, from the capability of personnel to attracting and retaining digital talent and the organization's digital culture (Aghimien *et al.*, 2022) to soft skills capabilities of resilience, curiosity, adaptability, entrepreneurial thinking, pursuing convictions and vision (Low *et al.*, 2021). The purpose of these factors is to help construction professionals better deploy digital tools and the attainment of digital

transformation while improving soft skills for Industry 4.0. Three parties – Government, educational institutions, and industry – were identified as crucial partners in change. Construction professionals require current-ready strategies and mindsets to prepare for the changes brought by Industry 4.0. Likewise, the government and universities' one-sided focus on promoting professionals-upgrading leaves many to wonder about the soft skills needed to stay professional and competitive. Hence, it is timely to examine the readiness of Indonesian professionals in engineering programs and graduates in the construction industry to adapt to Industry 4.0's requirements in terms of soft skills and advanced technology. Figure 1 shows the approach in the Industry 4.0-based professional engineer program.

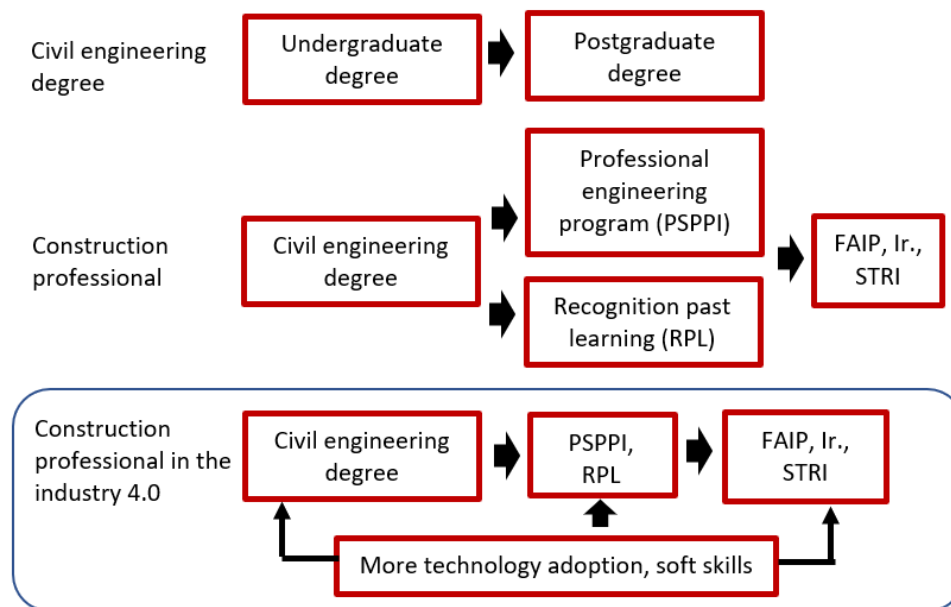


Figure 1. Infographic of construction professionals 4.0.

CONCLUSION

From the description of the existing government regulations on fostering engineering professionals and approaches for the readiness of Indonesian engineers in the Industry 4.0 era. Construction professional workers must be demonstrated in current needs towards construction 4.0. Construction professionals must be competent in technology adoption and soft skills, covering big data, automation, resilience, curiosity, adaptability, entrepreneurial thinking, and organizational social performance. Improving the competence of construction professionals can be done by revisiting the PSPPI curriculum and accessible training and education on soft skills and technology adoption.

Apart from the government, universities' role and human resources and supporting facilities are significant. It is expected that this will increase the professionalism of the construction workforce. It is necessary to review existing legislation on professional engineering programs, focus more on improving workforce professionals based on current needs, and develop an incentive system such as additional income or getting remaining operating results if the contractor earns a higher profit due to excellent workforce performance.

The outcome of this review can serve as an approach to developing a technical concept for the Indonesian engineer to create sustainable

development in Indonesia. The adoption of industry 4.0 technologies for improving Indonesian engineer professionalism highlights current best-practice examples and presents future research pathways.

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