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An Evaluation of Project Managers' Readiness for the Fourth Industrial Revolution in Tanzania

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Abstract

The Fourth Industrial Revolution (4IR) is changing how we work, study, and interact with one another and how we live. However, project managers and the general Tanzanian population are still not sufficiently aware of the 4IR, which results in a lack of readiness to conceptualize, carry out, and manage 4IR-related initiatives. This study aimed to evaluate Tanzanian project managers' readiness for 4IR. The evaluation has four dimensions: social-economic effect, technological awareness, human capital development, and strategy and governance structure. The diffusion of innovations theory was the lens through which the research's quantitative methodology was used. Data were gathered using an online survey to determine whether project managers were prepared and ready for the 4IR. Project managers completed the 50 valid samples from various industries, including manufacturing, consulting, construction, education & training, government, healthcare, and information technology. SPSS was used to analyze the data. The findings showed that despite a general lack of knowledge about 4IR, several project managers in Tanzania have varying knowledge about 4IR technologies like chatbots, drones, artificial intelligence, the Internet of Things (IoT), data analytics, blockchain, robotics, and cryptocurrency. The findings also showed that Tanzania's project managers were not sufficiently prepared to begin, develop, and deploy 4IR goods and services due to inadequate 4IR-related governance structure, strategy, and human capital development skills. As a result, several suggestions for improvement are provided within the context of the four assessed readiness dimensions. The primary contribution of this research is to project managers' level of 4IR preparedness and the recommendations that follow for policymakers, practitioners, academics, donors, the business sector, and young people interested in digital innovation. Additionally, the study advances our understanding of 4IR, project management, and digital transformation.

Keywords:Fourth Industrial Revolution; 4IR; Project managers; Readiness Assessment; Strategy and governance structure; Technology awareness; Human capital digital skills development; Social-economic Impact.

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1. Introduction

The Fourth Industrial Revolution (4IR) is a technological revolution that combines physical, digital, and biological technology to produce unheard-of goods and services in brand-new and developing industries [1]. It has changed how we live, work, and interact with one another and has reshaped humanity [2,3]. The production and delivery of goods and services are radically altered. It substantially impacts export potential, socio-economic development, and national and institutional competitiveness [4,5]. Artificial intelligence (AI), robotics, the Internet of Things (IoT), blockchain, autonomous vehicles, virtual and augmented reality, big data, cloud computing, simulation, nanotechnology, biotechnology, materials science, energy storage, quantum computing, and additive manufacturing, such as 3D printing, are just a few of the technologies that are included with it [1]. According to [6], 4IR technologies are used to monitor, evaluate, and automate operations to provide significant socio-economic benefits. These technologies are collectively referred to as cyber-physical systems (CPS), which are computer systems with mechanisms controlled by computer-based algorithms. These technologies are also altering how projects are created and carried out in both public and private companies with regard to their planning, organizing, directing, and monitoring from the beginning to the end while assuring the essential quality and done within time, budget, and scope [6,7].

There is a need for 4IR readiness, defined as the extent to which organizations can benefit from and take precautions about 4IR technologies [8]. As a result of these developments, the entire system of production, service delivery, and governance in the nation is transformed [1]. Project management in the classic sense is insufficient in the 4IR era since so many fresh and creative interventions are being launched as projects. Project managers must be aware of these changes and prepared to embrace them, particularly by creating plans for starting and overseeing projects in the 4IR era for sustainability, effectiveness, and competitiveness [7,8].

In a typical developing nation like Tanzania, the readiness of project managers to start, implement, and manage projects in the 4IR era is still lower. Additionally, there are issues with governance, connectivity, accessibility, and digital skills [5, 9, 10, 11, and 12]. Few studies have been conducted on 4IR-related project management, and no specific research has been conducted on the readiness of Tanzanian project managers to take on these 4IR-related difficulties. Such a readiness assessment will advance this field and promote wider 4IR use nationwide.

With the research question "Are the project managers aware and ready for the 4IR in Tanzania?" this study sought to evaluate project managers' 4IR readiness in Tanzania. The assessment is primarily based on four readiness characteristics documented in the literature: strategy and governance, technology awareness, development of digital skills in human capital, and social and economic impact [10,11,13,14]. Following this introduction, section 2 discusses a survey of related literature, and section 3 discusses methodology. Section 4 presents and discusses the findings, and Section 5 draws conclusions.

2. Literature Review

Organizations have aligned their business strategy with their initiatives to achieve strategic objectives and create value. In the Fourth Industrial Revolution (4IR), however, digital technologies such as artificial intelligence, the

Internet of Things (IoT), blockchain, cloud computing, and additive manufacturing have disrupted project management [1,15]. These 4IR technologies are influencing the business practices of both the public and private sectors. These changes include the shift in consumer expectations, the productivity of assets, new forms of collaboration and partnerships, and the transformation of operating models into new digital models [4]. Therefore, traditional project management should be modified to align with 4IR practices so that organizations and society can receive benefits [8,16]. Consequently, project managers in this era of 4IR should ideally be able to initiate and manage 4IR-related initiatives. Therefore, it was necessary to evaluate the project managers' readiness to initiate and manage 4IR-related initiatives in Tanzania, a typical developing nation. The 4IR readiness assessment is based on four dimensions determined by the literature and the country context: strategy and governance structure, technology awareness, human capital digital skills development, and social and economic impact [1, 4, 5, 7, 9, 10, 11, 13, 14,16, 17, 18, 19, 20, 21, 22, 23].

2.1. Strategy and Governance Structure

The 4IR is advancing with global interest and active participation from government and non-government organizations. The national strategy and governance structure for leveraging 4IR can provide direction and leadership for implementing digital technologies to attain digitally enabled socio-economic development in a nation [13,23,24]. In addition, they can give an organization with strategic guidance on achieving its goals and objectives and how to assist with and measure performance. Consequently, it is necessary to consider strategy and governance structure when evaluating 4IR responses. China's national 4IR policy framework, for instance, consists of its *"Manufacture 2025 and Internet plus strategies, and the promotion of Artificial Intelligence (AI) programs, with a focus not only on promoting investment but also on enhancing firms' innovation capability to establish incubating facilities, a credit management system, and improving protection for intellectual property rights"* [7]. Table 1 contains the evaluation items for this dimension.

Table 1: 4IR readiness assessment items for strategy and governance structure

No	4IR readiness assessment items	Some sources
ST1	Developed policy for the 4IR	[1,20,25]
ST2	Developed strategy for the 4IR	[2,10,13,14,17]
ST3	Established Governance structure to oversee implementation of the 4IR Strategy	[13,23]
ST4	Organizational readiness in the 4IR	[14,10,11]
ST5	The government has a National Plan for the 4IR	[5,23]
ST6	The government has a Commission to spearhead the 4IR	[5,23]
ST7	The existing awareness campaign for the 4IR	[14,18]
ST8	The budget allocated for adopting 4IR technologies	[13,23]
ST9	Leadership made efforts to translate the digital vision down to all levels of the organization	[1,11,13]
ST10	Willingness to act as stewards of the 4IR development	[11,23]
ST11	4IR has created innovation and a value chain in an organization	[11,17]

2.2. Technology Awareness

The 4IR is accompanied by disruptive technologies that have altered the way we live, conduct business, learn, interact with one another, and manage socio-economic development on a global and regional scale [2]. Lifelong learning, workplace awareness, and training initiatives that bring to light and convey new skills at the same rate as technology development [26] are essential. Many forms of development are launched and completed as projects, and project managers are responsible for overseeing their inception and execution. According to [11] and [14], to oversee the implementation of new 4IR-enabled products and services, project managers must have the necessary skills, reskilling programs, and experience. Additionally, they must understand how to integrate existing and new project technologies within and across enterprises. The evaluation criteria for this criterion were as follows (Table 2):

Table 2: 4IR readiness assessment items for technology awareness

No	4IR readiness assessment items	Some sources
TA1	Aware of the technologies in the 4IR	[2,13]
TA2	Ability to integrate the project's technology with the existing ones in the organization	[13,14,17]
TA3	Understand how these technologies will change the workforce, operations, & organizational structure.	[11,14]
TA4	The business case for the new technology solutions	[1, 11]
TA5	Understand how these technologies will change the way organizations deliver goods and services.	[13,14]
TA6	Aware of challenges in adopting new technology	[5,27]
TA7	Understand how to integrate organizational solutions within the external infrastructures (e.g., smart cities, banking, and government)	[11,14]
TA8	Ready to adopt and effectively use intelligent and autonomous technologies within an organization.	[11,13]
TA9	Capability to use emerging technologies to solve pressing organizational challenges	[14,27]
TA10	Internal alignment among business and technology people & a focus on long-term plans	[11,28]
TA11	Collaboration internally among all players and externally with stakeholders in 4IR technologies for transformative benefits	[11,28]

2.3. Human Capital Digital Skills Development

The *"4IR creates the push for transformation in people strategies and human resources practices, as well as the implications of certain change drivers for businesses and their workforce"* [4]. Human capital must possess digital capabilities to develop a digital economy and society. Globally and regionally, the government and organizations require such qualified human resources [22]. Organizations should also foster a culture of lifelong learning to provide their employees with the skills necessary to manage digital goods and services, enhance productivity and efficiency, create corporate value, and foster economic growth [29]. Moreover, digital skills are a precondition

for a digital economy and society. Therefore, individuals and organizations must possess the necessary digital skills to realize the latter [14]. The following evaluation items comprise this dimension: (Table 3).

Table 3: 4IR readiness assessment items for human capital digital skills development

No	4IR readiness assessment items	Some Sources
HC1	Program to develop employees' skills in the 4IR technologies	[1,4,9,13,17]
HC2	Equipped with the necessary skills and awareness ready to implement the 4IR technologies	[4,13,16]
HC3	Organization's strategies in place to retain employees in the 4IR	[10,14]
HC4	Management that supports a culture of lifelong learning	[11,13,14]
HC5	Workforce willingness to learn and be trained to embrace changes that 4IR brings	[4,9, 11,13]
HC6	Innovative I.T. integration, application & practices culture in the organization	[1, 17]
HC7	Dynamic recognition mechanisms to capture and optimally use employees' talents and experience over time	[10,14]

2.4. Social-Economic Impact

The 4IR comprises the physical, digital, and biological realms. Its technologies, including artificial intelligence, robotics, blockchain, digital currencies, big data, virtual and augmented reality (VR/AR), drones, internet of things, 3D/4D printing, cloud computing, mobile technologies, and biotechnology, among others, are enabling a transformation of the entire systems and processes in and across organizations, industries, countries, and societies, including a contribution to the achievement of the Sustainable Development Goals [1,30]. This transition provides governments and organizations with social and economic equality, stability, and the opportunity to shape their future commercial operations. For instance, they have formed new businesses that provide employment and promote global socio-economic progress [29]. The evaluation of socio-economic impact is shown in Table 4.

Table 4: The 4IR readiness assessment items for social-economic impact

No	4IR readiness assessment items	Some Sources
SI1	Readiness to work in partnership	[5,13]
SI2	Role of Organization in Influencing the 4IR	[10,14]
SI3	Role of Organization in Influencing Society on Embedding 4IR	[1, 5]
SI4	Focus on opportunities to create new business values for the organization and society.	[1,14,21]
SI5	Considering alignment of 4IR with best cyber-ethics practices	[13,14]

In summary, in our evaluation, the four dimensions of project managers' readiness for 4IR, namely strategy and governance structure, Technology awareness, Human capital digital skills development, and Social-economic Impact, were used as independent variables, and the dependent variable was Project managers' readiness for 4IR.

The relationship between these variables is illustrated in Figure 1 of a conceptual study framework:

a) Strategy and governance structure are requirements for Project managers' 4IR readiness.
b) Technology awareness is a requirement for Project managers' 4IR readiness.
c) Human capital digital skills development is a requirement for Project managers' 4IR readiness.
d) The socio-economic impact is a requirement for Project managers' 4IR readiness.

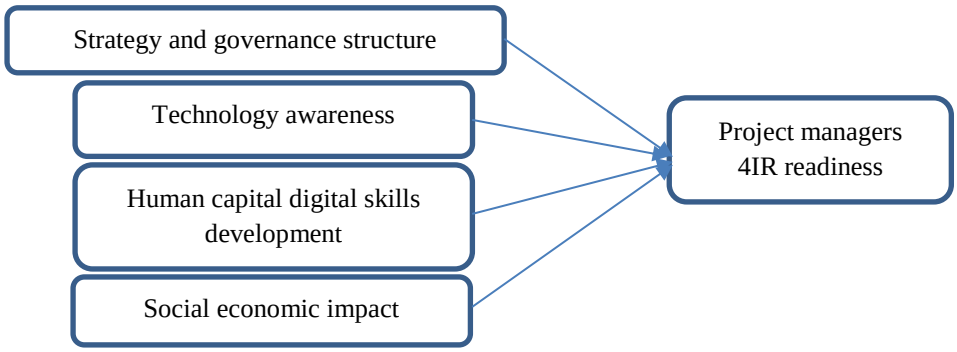

Figure 1: Research conceptual framework

3.Research Methodology

This study aimed to evaluate the 4IR readiness of project managers in Tanzania mainly using quantitative research methods in accordance with [31].

3.1Research Method and Data Collection

The research was based on a quantitative research methodology and the diffusion of innovations theory perspective on how innovation, in this case, 4IR, spreads interactively throughout a profession, organization, and society [31, 32]. This is accomplished using questionnaire-based survey research [33]. The survey questionnaire was based on a conceptual framework depicted in Figure 1 and associated research propositions derived from the literature with the perspective of the cited theory; it was designed to answer research questions regarding project managers' preparedness for the 4IR prevalent in Tanzania. The five-point Likert scale with weights ranging from 1 ("Not at all") to 5 ("Very Great Extent") was applied to all 34 items of the four applied dimensions, i.e., 11 items on Strategy and governance structure, 11 items on Technology awareness, seven items on Human capital digital skills development, and five items on Social-economic impact. Respondents utilized the measure to rank 4IR project-related awareness and preparedness. The survey instrument was pre-tested to evaluate content validity, the findings were examined, and modifications were integrated into the final questionnaire. It was distributed online and offline using convenience sampling, and the questionnaire was filled out by 50 project managers in Tanzania who influence, conceptualize, implement, and manage projects.

2.5. Reliability Tests

Cronbach's alpha coefficient was used to evaluate the questionnaire's reliability, which consisted of 11, 11, 7, and 5 questions in assessment dimensions, and Cronbach's alpha coefficient was determined accordingly. Table 5 reveals that Cronbach's alpha coefficient was more significant than 0.7, indicating internal consistency and strong reliability of tests and measurements, demonstrating how response values for each participant were consistent throughout a set of questions [34].

Table 5: Reliability test results

Assessment dimension	No. of items	Cronbach's coefficient
Strategy & governance structure	11	0.911
Technology awareness	11	0.933
Human capital digital skills development	7	0.917
Socio-economic Impact	5	0.884

3. Results and Discussion

The survey results and accompanying discussion are presented in a generic information descriptive analysis, which uses current and historical data to identify trends and relationships, and a specific Fourth Industrial Revolution (4IR) readiness assessment focusing on four (4) readiness dimensions.

3.1. Generic Information Descriptive Analysis

This dimension's results included respondents' gender, industry distribution, and years of experience managing projects. It also had general awareness and the initiation of 4IR technology projects.

3.1.1. Respondents - Gender Distribution

A total of 50 responses were received from project managers in Tanzania. A profile of the respondents indicated that 62% were male and 38% were female.

3.1.2. Respondents – Distribution by Industry

Figure 2 summarizes industry and respondent organization responses, revealing that most respondents (22%) came from the banking/financial business, 16% from the education and training and information and communications technology sectors, and the least 2% of responders were from the agriculture and manufacturing industries. According to these findings, most respondents were from the banking/financial, education/training, and ICT/telecommunications industries which as such enables the rest.

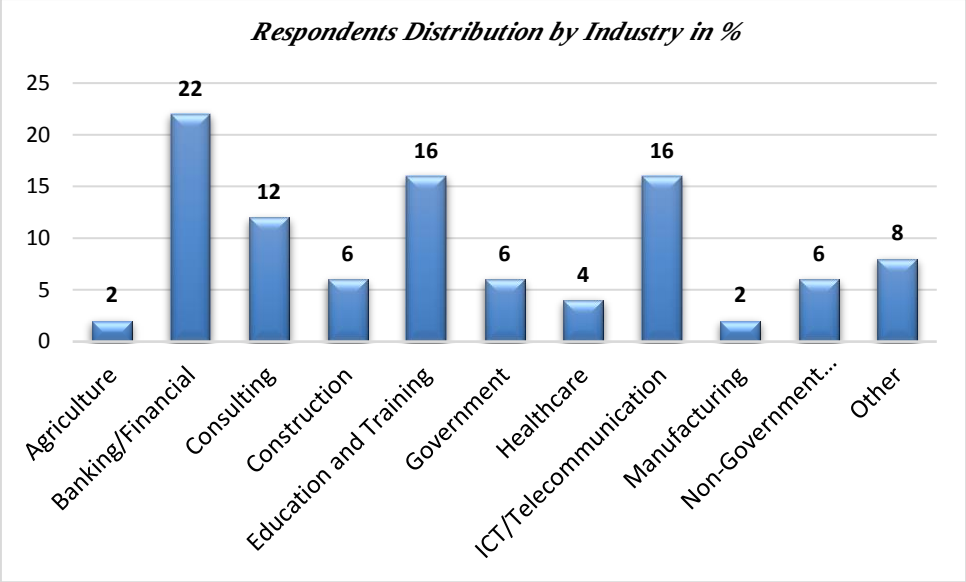

Figure 2: Respondents' distribution by industry

3.1.3. Respondents' Years of Experience in Managing Projects

Figure 3 shows that 34% of the respondents had less than five years of experience managing projects, 42% had 5 to 10 years, and 24% had more than ten years. Generally, results show that most project managers have 5 to 10 years of project management experience already thus rather in need of emerging technologies skill enhancement such as AI, IoT, and blockchain to succeed in the 4IR era [46].

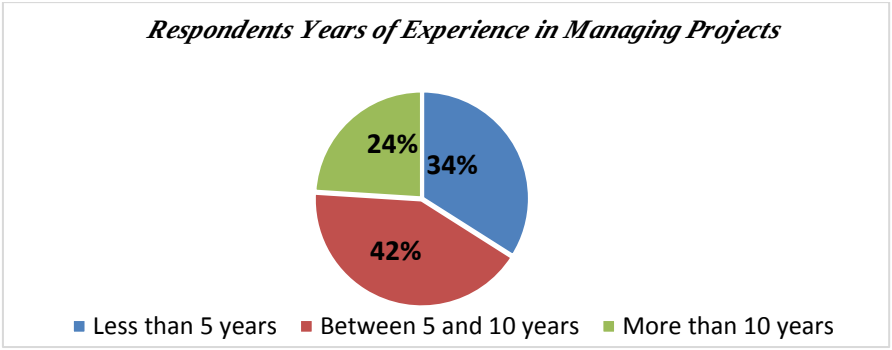

Figure 3: Respondents' years of experience in managing projects

3.1.4. Respondents' Awareness of the Fourth Industrial Revolution

Figure 4 shows that 64% of the respondents were aware of the 4IR, while 36% were unaware despite the transformative potential of 4IR. This result shows that awareness of the 4IR is still required to increase the 4IR in Tanzania, and it is in line with a study in South Africa [11] that indicated the overall project management change readiness to be 67.76% thus also still indicating the awareness need.

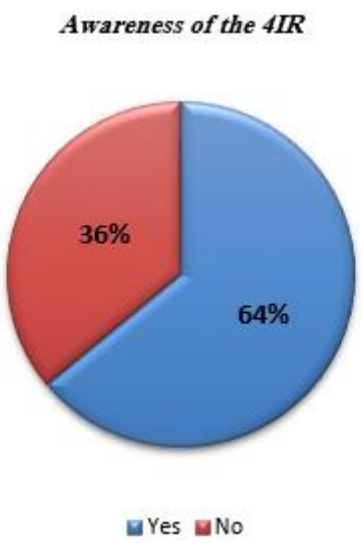

Figure 4: Awareness of the 4IR

The results also revealed that respondents were familiar with technologies such as artificial intelligence, the Internet of Things, big data/data analytics, blockchain, robotics, cloud computing, 3D printing, virtual and augmented reality, intelligent mobile devices, chatbots, drones, and digital currencies such as cryptocurrency. The awareness of these 4IR technologies can be capitalized on and further developed into implementable value-added projects that could contribute to these organizations' advancement and the country's socio-economic development. It includes agriculture, such as assisting farmers in optimizing productivity and reducing waste through data-driven "precision farming" techniques, and the financial sector, such as fostering greater financial inclusion in the digital economy [3]. Others may be in education, such as empowering engaged skills development with VR/AR and 3D printing and in-service delivery with new biometrics that improve identification for various uses [16].

3.1.5. Initiated Projects Using the 4IR Technologies

20% of the respondents initiated projects utilizing 4IR technologies, while the remaining 80% had yet to start a project utilizing 4IR technologies. In addition, respondents were requested to list the few projects that had been initiated using these 4IR technologies, which included cloud computing, machine learning, supply chain digitization, drones, 3D printing, and artificial intelligence. According to a study by [11], 80% of project managers are not yet prepared to adopt and incorporate intelligent and autonomous technologies into their projects. It indicates that more effort is required to initiate 4IR-related value-added projects to advance these organizations and the country's socio-economic development.

3.2. Fourth Industrial Revolution Readiness Assessment

The results in this dimension are in 4 readiness dimensions, i.e., Strategy and governance structure, Technology awareness, Human capital digital skills development and Social-economic Impact.

3.2.1. Strategy and Governance Structure

This dimension comprised 11 items, as it was shown in Table 1, and Figure 5 summarises the responses. Twenty-seven respondents, representing 54% of the total, had not established a governance structure for 4IR (ST3). This also applies to 22 (44%) that indicated the government to not have in place a national plan for 4IR (ST5), 21(42%) had not assessed organizational readiness for 4IR (ST4), 14 (28%) had not seen the budget allocated for adopting 4IR technologies, and 44 (88%) had not developed a strategy for 4IR.

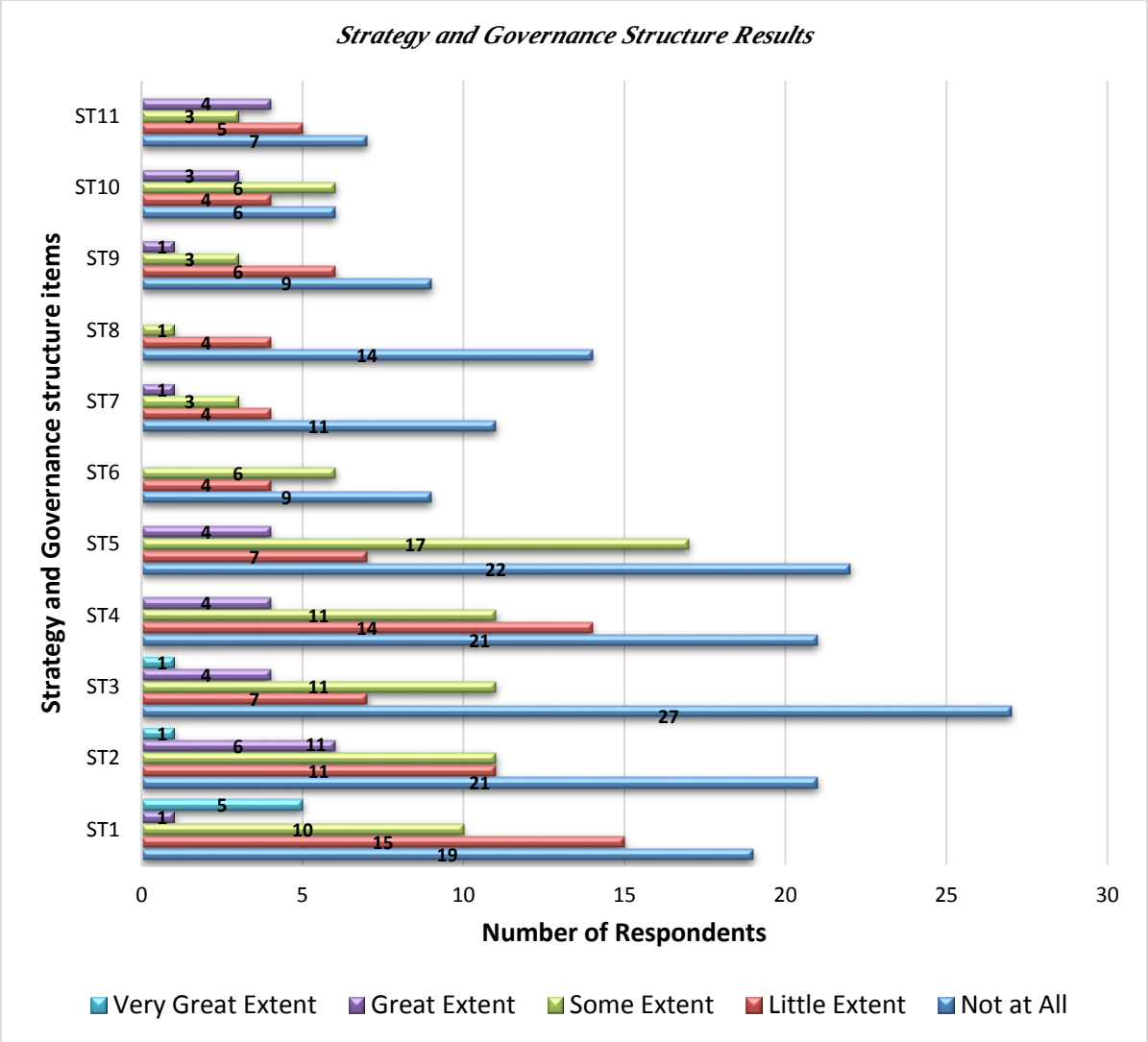

Figure 5: Strategy and governance structure results

The results generally indicated little on Tanzania's 4IR strategy and governance structure. At the national level, there is a limited 4IR-related plan and a body spearheading 4IR, and most organizations have limited 4IR-related readiness, budget, governance structure, leadership, policy, and innovations. However, through a desk/literature review, the national Vision 2025 and ICT policy showed the need for a digital-based or ICT-driven economy that could be a starting point for national-oriented development and application of 4IR technologies [35]. This also applies to the president and minister of this portfolio's willingness to embrace 4IR

and encourage further the digital economy to accelerate socio-economic development in the country [36,37]. Moreover, we found a Digital transformation strategy in action and a roadmap towards the 4IR in Africa [38,39], a South Africa 4IR strategy in our SADC region [40] and a Uganda 4IR strategy in our EAC region [41] as examples of a benchmark.

3.2.2.Technology Awareness

Eleven items from Table 2 were used to assess the project managers' technology savvy in developing and deploying 4IR products and services. Figure 6 demonstrates that respondents were somewhat aware of the emerging/intelligent technologies in the 4IR (TA1). Few have also shown the ability to integrate the project's technology into the existing business and technology (TA2) and to prioritize long-term planning in this section (TA10). However, a solid understanding of integrating existing cloud computing, IoT, and data analytics solutions is required (TA7). In addition, having a solid business case for adopting 4IR technologies as part of the awareness (TA9) was deemed essential, as indicated by [42] and [43] regarding Africa's development adapting to the 4IR.

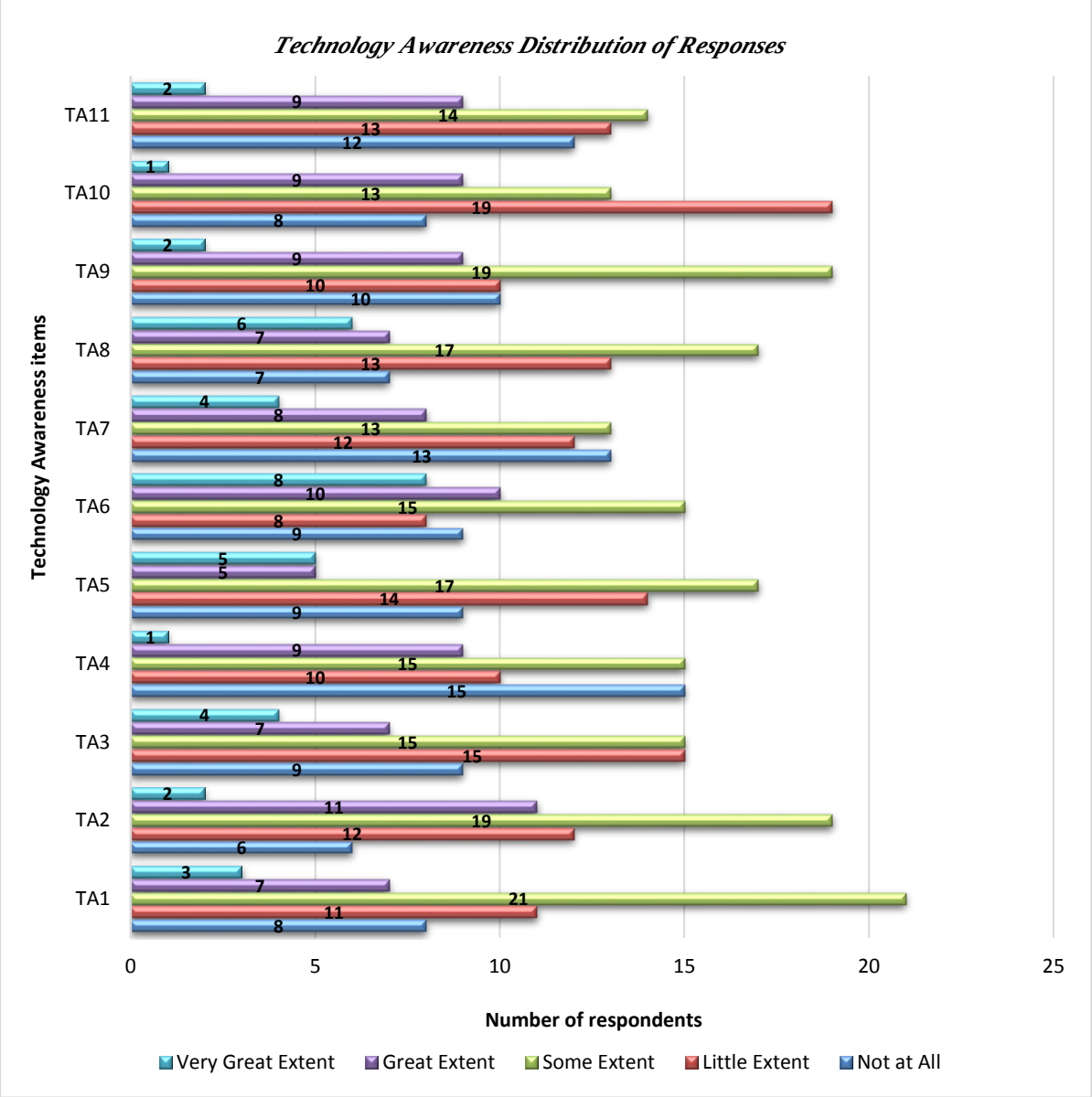

Figure 6: Technology awareness results

3.2.3.Human Capital Digital Skills Development

Developing human capital digital skills for the 4IR is essential for the country's socio-economic growth. It was evaluated using the seven factors shown in Table 3. Figure 7 indicates that most organizations have insufficient human capital digital development skills for the Fourth Industrial Revolution since few respondents indicated having a program to develop employees' skills and awareness of 4IR technologies (HC1). In addition, fewer respondents reported having no strategies to retain employees with expertise in 4IR technologies (HC3) and to equip them with the necessary skills and awareness to implement 4IR technologies (HC2). Nevertheless, there are indications that management will support a culture of lifelong learning (HC4) and a willingness to learn and be trained to adapt to the changes that 4IR will bring (HC5). Additionally, there are innovative ICT integration and application culture (HC6) and dynamic recognition mechanisms for capturing and optimizing employees' skills

and expertise (H7). As indicated by [43] and [44] on digital citizens and the skilled workforce required to embrace 4IR, these aspects should be capitalized upon.

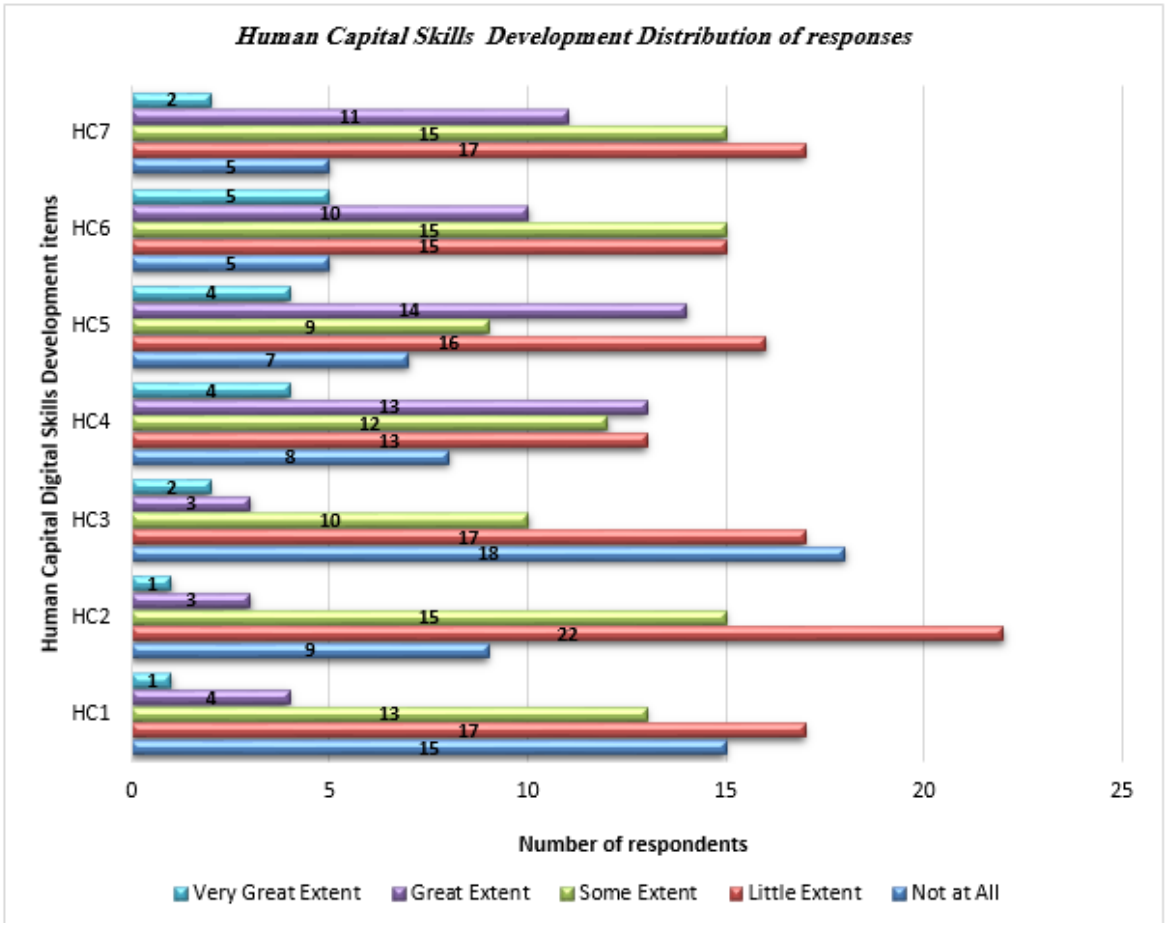

Figure 7: Human capital skills development results

3.2.4.Social-Economic Impact

The social and economic impact of the organization on the 4IR in the country was analyzed using the five items in Table 4. Figure 8 depicts findings that generally indicate a degree of preparedness for the socio-economic effects of the Fourth Industrial Revolution (SI1 to SI3). As also emphasized by [13] and [14], the result can be concretized and expanded significantly by ensuring the alignment of 4IR with the best cyber-ethics practices (SI5) and a focus on opportunities to create new business values for organizations and society (SI4).

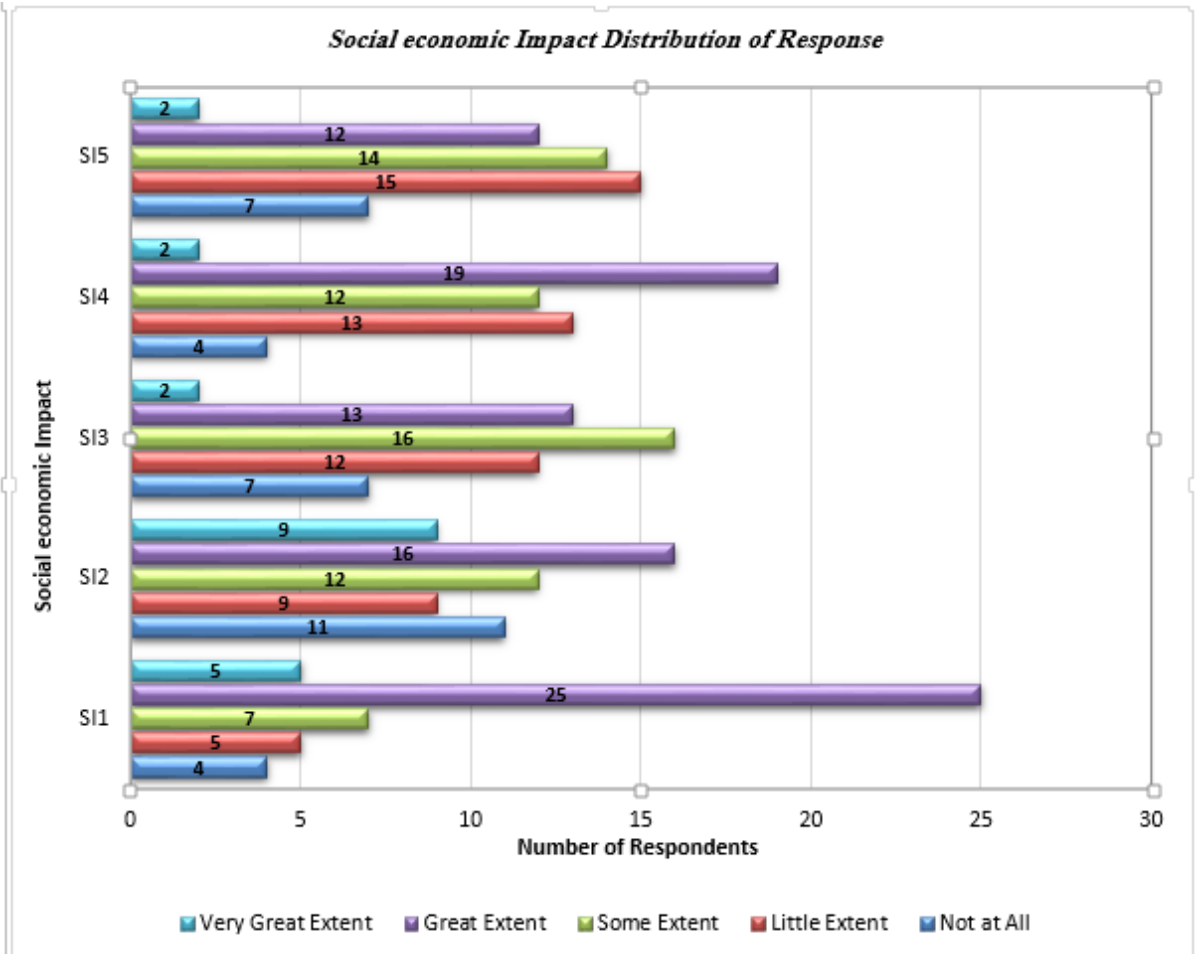

Figure 8: Socio-economic impact results

4. Conclusions

This section consists of the conclusion and recommendations coming out of this study.

4.1. Conclusion

The Fourth Industrial Revolution has altered how we live, work, learn, and interact. It has spread across countries, including Tanzania, which has begun to feel its effects in several socio-economic development sectors. Consequently, like other nations, it should be prepared and ready for a radical transformation in technological environments involving project managers. This study mainly evaluated the 4IR readiness of project managers in Tanzania using survey research. There were four primary assessment dimensions: strategy and governance structure, technology awareness, human capital digital skills development, and the 4IR's social and economic impact.

Despite the generally low awareness of 4IR, according to the findings, several project managers in Tanzania have diverse understandings of 4IR technologies such as artificial intelligence, IoTs, data analytics, blockchain, robotics, chatbots, cryptocurrencies, drones, and other digitalization platforms. Due to insufficient 4IR-related

awareness, human capital digital skills development, strategy and governance structure, and social and economic impact, project managers were also unprepared to initiate, develop, and implement 4IR products and services. The results indicate that project managers must be educated and trained significantly more on the Fourth Industrial Revolution. They should also be aligned with 4IR's required strategies and structures and how to embrace this revolution for more significant social and economic impact.

This study contributes to the existing body of knowledge on digital transformation and 4IR in particular, as well as what could be done to exploit its opportunities more effectively. It provides project managers with a level of preparedness that may benefit 4IR-related socio-economic development, including policymaking, practices, research, and innovation. Therefore, improved 4IR strategy and governance, technology awareness, human capital, digital skills development, and social-economic impact will add value to the country's industrialization and drive the achievement of Vision 2025 and SDGs 2030.

4.2. Recommendations

This study aimed to assess the 4IR readiness of project managers in Tanzania in terms of the four different readiness dimensions: strategy and governance structure, technology awareness, human capital digital skills development, and socio-economic impact. Several recommendations are made based on the results of this study and the discussion that followed.

a) Strategy and governance structure

- Government and private organizations should have a policy and strategy for the Fourth Industrial Revolution, including coordinated, innovative, and effective 4IR implementation mechanisms, incentives, and sanctions for wide-ranging socio-economic impact.
- To successfully implement the 4IR, the government should establish an innovative and effective national governance structure, leadership, plan, budget, and M&E mechanisms.

b) Technological Awareness

- Key Further identification and provision of 4IR technologies, their strong business cases, and integration with existing solutions-related awareness are essential to project management efforts to deliver aligned innovative products and services in industries such as education, health, agriculture, and manufacturing, which are required for 4IR adoption.
- For the successful implementation and widespread social and economic impact of 4IR, project managers and teams should be made aware of the required internal and external organizations, as well as existing and emerging digital and supporting infrastructure, such as affordable fixed and mobile broadband, integrated digital platforms and devices, power, workforce, and partners.

c) Human capital digital skills development

- Government should develop the necessary 4IR-related digital skills through a futuristic, competency-

based, and contextual educational curriculum at all levels, as well as a culture of lifelong learning (reskilling) on how technology can be a force for good and not fear, to reap the benefits of 4IR.

- Critical project management skills crucial to 4IR should be identified in greater detail, and project managers and teams should be innovatively equipped to use them to identify, conceptualize, develop, and implement business models and opportunities related to 4IR.
- The government and private sector should collaborate with providers of high-quality professional short courses, such as Coursera, to cultivate workforce skills for 4IR-related projects, including data analytics, project management, agile development, and artificial intelligence.
- In the Fourth Industrial Revolution (4IR) era, organizations should have strategies to further motivate, recognize, and retain talent and valuable experiences.

d) Social-economic impact

- Organizations should invest in a 4IR ecosystem that aligns with corporate and stakeholder goals for a more significant socio-economic impact.
- The country should have a legal framework for policing digital space and best cyber-ethics practices to ensure the social and economic impact of the increased processing, storing, and transmission of data and information in the fourth industrial revolution (4IR) era is safe and optimal.
- Government and the private sector should be encouraged to collaborate, co-innovate, and create new business values and advance, incorporate, and optimize the socio-economic impact of 4IR technologies on organizations and society.

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