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Engineering-Driven Workforce Readiness for Industry 4.0: Key Influencing Factors in Sri Lanka's Industrial and Service Sectors

W.M.D. Chandrajith, V.P.T. Jayawardane and H.A.D. Saumyadi

Abstract: This study explores the key factors influencing workforce readiness for Industry 4.0 technologies in Sri Lanka's manufacturing, IT, telecommunications, and services sectors. A quantitative survey of 150 professional primarily engineers, was conducted to assess variables such as organizational contribution, government involvement, education and training programs, human resource development, and skills gap. The findings reveal that strategic leadership, supportive government policies, and tailored educational initiatives significantly improve workforce preparedness, while persistent skills gap poses a critical challenge. Notably, younger employees exhibit higher adaptability to technological change, underscoring the importance of generational factors in readiness. The study highlights the central role of collaboration among policymakers, industry leaders, and educational institutions in fostering a digitally capable workforce. It recommends strengthening technical and vocational education, enhancing employee engagement, and implementing inclusive policies to support women and differently - abled individuals. A key implication of the research is the need for sector - specific and inclusive strategies, especially in under - researched industries such as healthcare, agriculture, and finance. Additionally, the study calls for longitudinal research to evaluate the long - term impact of interventions and evolving readiness levels. These insights are vital for developing countries aiming to achieve sustainable digital transformation through effective workforce development.

Keywords: Industry 4.0, Technological Adaptability, Government Involvement, Sri Lanka

1. Introduction

The rapid advancement of Industry 4.0, also known as the Fourth Industrial Revolution, is transforming the integration of emerging technologies such as Artificial Intelligence (AI), the Internet of Things (IoT) and automation into traditional manufacturing and service sectors. These technological advancements are reshaping operational processes and significantly impact workforce dynamics. Industry 4.0 relies on interconnected systems, real - time data processing and smart manufacturing, making workforce readiness a crucial factor in its successful implementation [1].

In the Sri Lankan context, industries such as manufacturing, information technology, and telecommunications have begun adopting Industry 4.0 technologies. However, workforce deficiencies continue to pose challenges to effective implementation. This study aims to examine the key factors influencing workforce readiness for Industry 4.0 in Sri Lanka, including organizational contributions, government interventions, education and training programs, skills gap, and human resource development [2]. Understanding these factors will help Sri Lanka leverage Industry 4.0 technologies to enhance competitiveness and drive industrial growth [3].

Industry 4.0 has become a widely discussed topic in global economic and technological development [4]. Industries are increasingly prioritizing the adoption of advanced technologies such as big data analytics, robotics and cloud computing, recognizing their role in enhancing efficiency and driving innovation

***Eng. W.M.D. Chandrajith**, AMIE(SL), AEng., BSc Eng. Hons (Ruhuna), MBA (Moratuwa), Department of Management of Technology, University of Moratuwa, Email:dilchandrajith@gmail.com*
ORCID ID: https://orcid.org/0009-0008-5879-0523
***Eng. (Dr.) (Mrs). V.P.T. Jayawardane**, AMIE(SL), AEng, BSc Eng. (New Zealand), LLB(Hons)(London), LLM, MPhil, PhD, Senior Lecturer, Department of Industrial Management, University of Moratuwa.*
Email:thesaraj@uom.lk
ORCID ID: http://orcid.org/0000 0002 0493 114X
***Eng. (Mrs.) H.A.D. Saumyadi**, AMIE(SL), AEng, BSc Eng Hons, (Moratuwa), PhD Student, Department of Industrial Management, University of Moratuwa.*
Email:danusisaumyadi@gmail.com
ORCID ID: https://orcid.org/0000 0001 8224 2609

[2]. These technologies introduce cutting-edge advancements in production systems, fundamentally reshaping industrial operations.

1.1 Knowledge Gap, Study Aims, Objectives and Significance

Despite growing global interest in Industry 4.0, limited research has been conducted in the context of developing countries like Sri Lanka, particularly concerning workforce readiness across diverse industrial sectors. Most prior studies emphasize technology adoption without fully accounting for the human capital and organizational readiness aspects that are vital to successful digital transformation. Furthermore, there is a lack of research integrating organizational, governmental, and educational perspectives in a single framework to assess workforce preparedness.

This study aims to examine key influencing factors that determine workforce readiness for Industry 4.0 in Sri Lanka's industrial and service sectors. Objectives are To evaluate the role of organizational contribution, government involvement, education and training programs, skills gap, and human resource development on workforce readiness and to assess the moderating effect of age in shaping workforce adaptability to Industry 4.0 technologies.

The findings will contribute to policy and strategic frameworks that strengthen the capabilities of Sri Lanka's workforce to meet the demands of the Fourth Industrial Revolution. This study also addresses a notable gap in scholarly literature concerning inclusive workforce development in a developing country context.

2. Literature Review

The literature review examines global and Sri Lankan perspectives on workforce readiness frameworks for Industry 4.0, identifying key gaps in existing research. This section establishes a theoretical foundation by exploring critical factors that influence workforce preparedness for Industry 4.0 technologies, along with their broader global and local implications.

2.1. Understanding Industry 4.0: Global Context and Technological Foundations

Industry 4.0 represents a transformative paradigm at the forefront of the Fourth Industrial Revolution. It integrates emerging technologies such as the Internet of Things (IoT), Artificial Intelligence (AI), big data analytics and robotics into traditional industrial processes, creating interconnected real-time systems that enable autonomous decision-making. This shift is reshaping both manufacturing and service industries, driving increased productivity through mass-customized and highly efficient production. Developed countries such as Germany, the United States and Japan have successfully adopted Industry 4.0, largely due to their advanced technological infrastructure and highly skilled workforce. For example, Germany's Industry 4.0 initiative focuses on automating production lines and developing cyber-physical systems to facilitate real-time decision making. Strategic government policies, alongside private sector investments, have played a crucial role in driving Industry 4.0 adoption in these nations. The integration of AI and IoT into manufacturing processes has significantly enhanced production speed, quality and precision, positioning these economies at the forefront of technological innovation.

While Industry 4.0 offers transformative potential, its implementation is not without challenges. Schumacher [4] proposed a maturity model for assessing Industry 4.0 readiness, identifying nine key dimensions, including strategy, leadership, operations and technology. The model emphasizes that a clear strategic vision, combined with strong leadership commitment, is fundamental to the successful adoption of Industry 4.0 technologies. Additionally, factors such as organizational culture, technology infrastructure and operational processes play a crucial role in creating an Industry 4.0 ready environment.

2.2. Challenges in Industry 4.0 Readiness: Insights from Developing Nations

Despite technological advancements, many developing countries struggle to transition to Industry 4.0 due to inadequate infrastructure, skills shortages, and resource constraints. For example, research on Vietnam's textile and clothing sector highlights the absence of government policies, weak industry collaboration and insufficient workforce training as major barriers to adoption. These challenges are particularly pronounced in countries where industries are still reliant on traditional manufacturing practices and lack access to high-end technologies [5].

From a broader perspective, global research underscores the importance of workforce readiness in facilitating Industry 4.0 adoption. While digital transformation is often associated with technological advancements, workforce adaptability plays an equally critical role. As automation and AI-driven processes replace traditional labor-intensive tasks, a digitally skilled workforce will be essential [3]. Studies suggest that Industry 4.0 readiness is not solely determined by technical expertise but also by the workforce's ability to adapt to rapid technological change.

2.3 Sri Lanka's Industry 4.0 Landscape: Opportunities and Constraints

The transition toward Industry 4.0 in Sri Lanka remains in its early stages, presenting both opportunities and challenges. While interest in these technologies is growing, particularly in the manufacturing and IT sectors, widespread adoption is hindered by several barriers, including the absence of a national strategy, inadequate policy support and limitations in technological infrastructure [5].

Sri Lanka's manufacturing sector, particularly in textiles, apparel and food processing, plays a crucial role in the national economy. However, the shift toward Industry 4.0 has been slow. Jayatilake [6] highlighted that the apparel industry's ability to integrate automation and smart manufacturing technologies is constrained by skill shortages and insufficient government support, limiting its capacity to compete globally.

In contrast, the IT sector has shown higher adoption rates of Industry 4.0 technologies. However, implementation still lags behind global standards due to a shortage of skilled professionals in AI, robotics and data analytics. A significant portion of Sri Lanka's workforce lacks expertise in advanced digital technologies [2], creating a major obstacle to the effective deployment of cutting edge automation systems. Addressing these skills gap and enhancing policy support will be critical to accelerating Industry 4.0 adoption across all industries [1].

The Labour Force Sur**vey** [7] indicates that over 60% of manufacturing employees in Sri Lanka lack the technical skills required for Industry 4.0 technologies. This skills gap presents a significant challenge, as workers must not only operate advanced technologies but also manage and maintain complex systems integral to Industry 4.0. Supporting this claim, Weerabahu [2] highlighted financial constraints, inadequate infrastructure and insufficient training programs as major barriers to closing this gap.

Beyond technical limitations, cultural resistance poses another obstacle to workforce readiness. Many employees in Sri Lanka continue to perceive manufacturing as a traditional, labor intensive industry with limited recognition of the need for digital transformation. A general lack of awareness and motivation toward adopting Industry 4.0 technologies further exacerbates the issue.

Older generations, in particular, tend to resist technological changes due to concerns over job security or the perceived complexity of new systems [8]. To overcome this barrier, both organizations and the government must prioritize digital literacy initiatives and reskilling programs to foster a culture of innovation and adaptability.

Despite these challenges, positive developments are emerging. The Sri Lankan government has acknowledged the importance of digital transformation and has taken initial steps toward creating a more supportive environment for Industry 4.0 adoption. However, the current scale of these initiatives remains limited and insufficient to drive widespread impact. Expanding these efforts through targeted policies, industry-academic collaboration [9] and workforce training programs will be crucial for accelerating the country's transition to Industry 4.0.

2.4 Workforce Readiness Models for Industry 4.0: A Theoretical Overview

Several models and frameworks have been developed to assess workforce readiness for Industry 4.0. These models focus on key dimensions such as technological adoption, leadership support, training programs [10] and workforce skills. Below are some of the most prominent models.

Maturity Model is one of the most widely referenced frameworks for evaluating Industry 4.0 readiness [4]. It defines nine critical dimensions necessary for successful adoption including strategy, leadership, culture, technology, operations, governance and people. This model emphasizes that aligning technological advancements with workforce development is essential for organizational success.

Arnold's framework highlights the role of top management and strategic investment in workforce readiness [1]. It underscores the importance of continuous training and upskilling to eliminate skill deficits, ensuring that employees can effectively operate within automated and technology-driven systems.

Lepikson's model focuses [8] on human resource development as a key driver of technology adoption. It suggests that organizations should not only invest in new technologies but also prioritize workforce training and development to enhance adaptability and motivation. According to Lepikson, a technologically competent and engaged workforce is essential for the successful implementation of Industry 4.0.

2.5 Identifying Research Gaps and Contextual Needs for Sri Lanka

The existing literature on Industry 4.0 primarily focuses on developed countries, leaving a significant gap [5] in research concerning developing countries like Sri Lanka. In particular, Sri Lanka faces challenges related to limited technological infrastructure and financial constraints, hindering its ability to accelerate digital transformation. These unique challenges require context-specific solutions tailored to the country's circumstances.

Additionally, while various models for assessing Industry 4.0 readiness exist, most are sector-specific, addressing industries such as manufacturing, IT or apparel [11]. There is a lack of a standardized, universal model applicable across all sectors in Sri Lanka, preventing a comprehensive approach to workforce readiness.

Moreover, many existing models overlook socio-cultural factors such as age differences, attitudes toward technology and language barriers [12]. These dimensions are critical in shaping workforce readiness, particularly in diverse contexts like Sri Lanka, where such factors play a significant role in the successful adoption of Industry 4.0 technologies.

The Sri Lankan construction industry faces challenges in workforce performance and productivity, often due to insufficient training and supervision. To address this, apprenticeship programs led by the National Apprentice and Industrial Training Authority (NAITA) aim to enhance workers' skills. Competency - based training models focusing on critical knowledge, skills, and abilities have been developed to improve labor productivity. The Sri Lankan construction industry faces challenges in workforce performance and productivity, often due to insufficient training and supervision. Research by [13] emphasizes the importance of competency assessment mechanisms and structured apprenticeship models for enhancing productivity and skill levels in the construction sector. Their work highlights how targeted performance-based evaluation frameworks and government-led apprenticeship initiatives can drive effective workforce development. These insights are directly applicable to broader Industry 4.0 readiness strategies across sectors.

This study explores the influence of organizational, governmental and educational interactions on workforce readiness in Sri Lanka. Furthermore, the research highlights the significant skills gap [10] within the Sri Lankan workforce, raising important questions about the country's ability to adapt to emerging technologies. This work provides a foundation for future research aimed at developing models tailored to Industry 4.0 readiness in developing countries, with a focus on identifying gaps and proposing effective solutions.

3. Methodology

This study employs a quantitative research approach to examine the relationships between independent variables (organizational contribution, government involvement, education and training programs, skills gap, and human resource development) and workforce readiness for Industry 4.0. A deductive approach is adopted, where hypotheses derived from existing theories are tested through data analysis. A survey design is chosen for its ability to gather data efficiently from a large population, using a cross - sectional time horizon to capture data at a single point in time [4].

The conceptual framework (Table 2) was developed by synthesizing Schumacher's Industry 4.0 Maturity Model [4], Arnold's workforce readiness model [1], and localized insights from Sri Lankan workforce literature. The model integrates five independent variables, one moderating variable (age), and the dependent variable (workforce readiness), aligning with theoretical and empirical findings.

Table 1 - Demographics of Respondents

Demographic Variable	Category	Frequency (n)	Percentage (%)
Gender	Male	87	63.0%
	Female	51	37.0%
Age Group	Below 30	35	25.4%
	30–50	79	57.2%
	Above 50	24	17.4%
Education Level	High School	26	18.5%
	Diploma	48	34.8%
	Bachelor's	50	36.2%
	Postgraduate	14	10.1%
Work Experience	Less than 5 yrs	40	29.0%
	5–10 yrs	55	39.9%
	Above 10 yrs	43	31.1%

Table 2 - Conceptual Framework

Variable Type	Variable Name	Definition / Description	Relationship
Independent Variable	Organizational Contribution	Effort and attitude of higher management in supporting and investing in Industry 4.0 initiatives.	Direct impact on workforce readiness
Independent Variable	Government Involvement	Government policies, support, and incentives for implementing Industry 4.0 technologies.	Direct impact on workforce readiness
Independent Variable	Education Training Programs	Programs aimed at enhancing technical and managerial skills for Industry 4.0 readiness.	Direct impact on workforce readiness
Independent Variable	Skills Gap	The difference between current skills and those required for Industry 4.0 technologies.	Negative impact on workforce readiness
Independent Variable	Human Resource Development	Initiatives focusing on enhancing workforce capabilities at organizational and national levels.	Direct impact on workforce readiness
Moderating Variable	Age	The influence of different age groups on the relationship between independent variables and workforce readiness.	Moderates relationship
Dependent Variable	Workforce Readiness	The ability of the workforce to adapt and implement Industry 4.0 technologies effectively.	Outcome variable

Table 3 - Regression Analysis Summary

Variable	Beta Coefficient (β)	p-value	Relationship
Organizational Contribution	0.315	0.002	Significant Positive
Government Involvement	0.285	0.005	Significant Positive
Education & Training Programs	0.402	0.000	Highly Significant Positive
Skills Gap	-0.286	0.008	Significant Negative
Human Resource Development	0.215	0.015	Significant Positive

The study focuses on employees in Sri Lanka's manufacturing sector, with a sample size of 150 respondents, selected using stratified random sampling. A sample size of 100–200 is generally acceptable for studies aiming to detect medium effect sizes with sufficient statistical power. Compared to surveying the entire population, random sampling offers a practical and economical way to gather meaningful data with limited resources [14]. Table 1 includes age groups, job roles, and educational attainment to ensure a representative sample [15].

Data is collected using a structured self - administered questionnaire, designed on a 5-point Likert scale. The questionnaire is divided into sections on demographics, independent variables and workforce readiness. A pilot study with 20 respondents is conducted to test the reliability and validity of the instrument. The questionnaire is distributed via email ensuring ethical considerations are met.

Data analysis for this study is conducted using Statistical Package for the Social Sciences (SPSS) incorporating several statistical techniques [16]. Descriptive statistics are used to summarize demographic data and respondents' perceptions of the variables. Reliability analysis is performed to assess the internal consistency of the questionnaire. Correlation analysis [17] is applied to examine the relationships between independent and dependent variables. Multiple regression analysis is employed to test the hypotheses and investigate the moderating effect of age on these relationships. ANOVA is used to compare workforce readiness across different demographic categories [18]. Finally, hypothesis testing is carried out at a 95% confidence level to evaluate the hypotheses derived from the conceptual framework [19].

4. Results & Discussion

4.1 Demographic Characteristics

The demographic analysis (Table 1) of this study provides key insights into the engineering work within Sri Lanka's manufacturing sector. The majority of the respondents are engineers, with 63% being male. The largest age group falls between 30 and 50 years (57.2%) Additionally, 71% of participants hold a diploma or a higher-level qualification, reflecting a well-educated engineering talent pool. Moreover, over 70% of respondents have at least five years of industry experience, underscoring a workforce with substantial technical expertise. While these engineers possess strong formal qualifications and professional exposure, their readiness for Industry 4.0 technologies may still require targeted training and skill development.

4.2 Conceptual Framework

The conceptual framework illustrates the relationships among all the variables under consideration. The dependent variable is workforce readiness for Industry 4.0 technologies. Additionally, age serves as moderating variable, as it is examined for its impact on the relationship between the independent and dependent variables.

4.3 Hypothesis Testing

The study (Table 2) examined the relationship between various independent variables and workforce readiness for Industry 4.0 using multiple regression analysis. The findings highlight critical factors influencing readiness underscore need for a multi-faceted approach involving strategic leadership, policy support, education and workforce development to enhance Industry 4.0 readiness.

(H1) Organizational Contribution : plays a vital role, demonstrating that proactive leadership strategies and investment foster an adaptable moderating variable, as it is examined for its impact on the relationship between the independent and dependent variables.

(H2) Government Involvement : shows a positive impact through policy incentives, although challenges such as bureaucratic delays can hinder progress.

(H3) Education and Training Programs : emerge as the most significant factor, emphasizing the necessity of tailored programs that directly address specific skills gap [20].

(H4) Skills Gap : on the other hand, act as a negative determinant, reinforcing the need for targeted interventions to bridge workforce deficiencies [6].

4.4 Key Determinants of Workforce Readiness for Industry 4.0

The study identified several key factors (Table 3) influencing workforce readiness for Industry 4.0 technologies.

Organizational Contribution:

Strategic leadership is a major determinant, aligning with Li Ling [21], who notes that adaptive leadership accelerates digital

capability. Similar findings in Indonesia's textile sector underscore the value of executive investment in innovation [4]. Organizations that proactively allocate resources [22] for Industry 4.0 integration tend to develop a more agile and adaptable workforce.

Government Involvement:
While our study confirms positive government influence, the impact is moderated by bureaucratic inefficiencies. Hamada [23] similarly found that decentralization in developing countries weakens policy execution for Industry 4.0.

Education and Training Programs:
Targeted Industry 4.0 training programs are the most influential enablers of workforce readiness. These programs help bridge the gap between technical and managerial competencies, ensuring employees are equipped with the necessary skills [24].

Skills Gap:
A strong inverse relationship exists between skills gap and workforce readiness. Addressing this challenge requires structured interventions to enhance employee competencies and bridge the technological skills deficit (Table 3).

Human Resource Development:
Workforce development initiatives, particularly those focused on career progression and employee engagement, contribute positively to readiness. Organizations that invest in continuous learning and professional development create a more prepared workforce. Consistent with Moraes and Lepikson [9], we find that structured HR development is vital to readiness.

Age as a Moderating Factor:
Younger employees demonstrate higher adaptability to Industry 4.0 technologies, highlighting the need for age-specific training strategies to ensure inclusivity in digital transformation efforts.

4.5 Practical Recommendations for Workforce Readiness in Industry 4.0
Practical recommendations for workforce readiness in Industry 4.0 are presented as follows.

Engineers play a pivotal role in shaping Sri Lanka's transition to Industry 4.0, acting as key drivers of innovation, automation, and technological integration. Their expertise in advanced manufacturing processes, data analytics and system optimization is crucial in bridging skills gap and accelerating digital transformation. By fostering a culture of continuous learning and upskilling, engineers can significantly enhance workforce adaptability and efficiency, ensuring that Sri Lanka's manufacturing sector remains competitive in the global market.

Enhancing Government Involvement
The government's role in supporting the adoption of Industry 4.0 technologies is crucial. Policies and incentives should be streamlined to help organizations overcome financial barriers to technology investment. Offering tax holidays, grants or subsidies on investments in Industry 4.0 technologies can motivate companies to adopt these advancements more readily [25]. Moreover, establishing public-private partnerships can foster knowledge exchange and resource sharing, benefiting both sectors. This would further help in coordinating efforts, monitoring progress, and ensuring that initiatives are being implemented effectively. This task force could also facilitate collaboration between various stakeholders, ensuring a unified approach to driving workforce readiness and technological adoption across industries.

Addressing Skills Gap:
To effectively address the skills gap within the workforce, organizations should conduct regular assessments to evaluate both technical and managerial capabilities. This will help identify areas that require targeted interventions, ensuring that employees are equipped with the necessary skills to succeed in an Industry 4.0 environment. Training modules should be designed to be inclusive, addressing the needs of employees from different age groups and skill levels. Tailoring these programs will ensure that skills gap is efficiently bridged, making it possible for all employees to develop the necessary competencies. Furthermore, incentivizing lifelong learning through rewards or career advancement opportunities can motivate employees to continuously upskill, ensuring that the workforce remains adaptable and prepared for ongoing technological advancements.

Focusing on Human Resource Development
Human resource development plays a key role in building a workforce that is resilient and adaptable to Industry 4.0 technologies.

Implementing mentoring and coaching programs can help employees navigate the challenges of digital transformation and equip them with the soft skills necessary to thrive in a rapidly evolving work environment. Aligning performance management systems with Industry 4.0 goals is also crucial, as it ensures that employees' personal objectives are in line with organizational objectives [25]. This alignment can foster a culture of continuous improvement and motivation. Additionally, creating structured career progression plans will not only help retain skilled talent but also foster engagement by providing clear pathways for professional growth. By focusing on employee development, organizations can build a stable and capable workforce that is prepared for the future of work.

5. Conclusions

The study highlights several key determinants of workforce readiness for Industry 4.0 technologies in Sri Lanka's industrial and service sector. The workforce is generally well-qualified, with a significant proportion holding diplomas or higher qualifications and extensive work experience in the field of engineering. However, workforce readiness remains dependent on specific factors, including organizational leadership, government involvement, education and training programs, and addressing skills gap.

The research underscores the critical role of organizational contribution, with proactive leadership and strategic investment in technology fostering a more adaptable workforce. Government policies and incentives are crucial, though bureaucratic challenges may hinder their effectiveness. The study emphasizes that education and training programs tailored to Industry 4.0 technologies are the most influential enabler of workforce readiness. However, skills gap remains a significant barrier, indicating the need for structured interventions. Human resource development initiatives, particularly those focusing on career progression and employee engagement, also contribute positively to readiness. Additionally, age is found to be a moderating factor, with younger employees showing greater adaptability to technological advancements.

While the study centers on Sri Lanka's industrial and service sectors, its findings hold valuable insights for other developing and transitional economies undergoing similar shifts toward Industry 4.0. The determinants of workforce readiness identified - such as the role of leadership, education, policy support, and targeted human resource development - are universally relevant and can inform broader strategies across regions facing comparable challenges.

To address these challenges, the study recommends strengthening education and training programs, enhancing government involvement, addressing skills gap through targeted interventions, and focusing on human resource development. By implementing these strategies, Sri Lanka's manufacturing sector can better prepare its workforce including engineers for the demands of Industry 4.0 and ensure a successful digital transformation.

This study lays the foundation for future research on workforce readiness for Industry 4.0, offering several key directions for further exploration. It suggests examining sector specific challenges by evaluating workforce preparedness across industries like healthcare, agriculture and finance. Longitudinal studies are recommended to understand the long-term effects of interventions and track changes in readiness over time. Research should also investigate the impact of organizational and national culture, particularly in diverse work environments. Additionally, the role of emerging technologies, such as blockchain and quantum computing, in workforce readiness warrants further attention.

The study emphasizes the need to assess the readiness of disadvantaged groups, including women and differently-abled individuals, and to evaluate the effectiveness of government policies in promoting workforce readiness. Future research should focus on developing inclusive strategies for technology adoption and addressing workforce gaps.

References

1. Dalenogare, L. S., Benitez, G. B., Ayala, N. F., and Frank, A. G., "The Expected Contribution of Industry 4.0 Technologies for Industrial Performance," *Int. J. Prod. Econ.*, Vol. 204, No.4, August, pp. 383–394, 2018, doi: 10.1016/j.ijpe.2018.08.019.

2. Samaranayake, W. M. S. K., P, Nakandala, D., Lau, H., and Malaarachchi, D. N., "Barriers to the Adoption of Digital Servitization: A Case of the Sri Lankan Manufacturing Sector," *Int. J. Emerg. Mark.*, No.7, December, 2022, doi: 10.1108/IJOEM-01-2022-0011.

3. De Bustis, A. Ganesan, V., and Herath, G. "Unlocking Sri Lanka's Digital Opportunity," 2018, [Online]. Available: https://www.mckinsey.com/business-functions/mckinsey-digital/our insights/unlocking-sri-lankas-digital-opportunity#.

4. Hidayatno, A., Rahman,I., and Irminanda, K. R., "A Conceptualization of Industry 4.0 Adoption on Textile and Clothing Sector in Indonesia," *ACM Int. Conf. Proceeding Ser.*, pp. 339–343, 2019, doi: 10.1145/3364335.3364351.

5. Schumacher, A., Erol, S., and Sihn, W., "A Maturity Model for Assessing Industry 4.0 Readiness and Maturity of Manufacturing Enterprises," *Procedia CIRP*, Vol. 52, pp. 161–166, 2016, doi: 10.1016/j.procir.2016.07.040.

6. Lakmali, G. D. E., Vidanagamachchi, K. , and Nanayakkara, L. D. J. F., "Readiness Assessment for Industry 4.0 in Sri Lankan Apparel Industry," *Proc. Int. Conf. Ind. Eng. Oper. Manag.*, Vol. 0, No.5, March, pp. 1076–1088, 2020.

7. Jayatilake, A. S., and Withanaarachchi, H.S.B., "Industry 4.0 in the Apparel-Manufacturing Sector: Opportunities for Sri Lanka," *1st Interdiscip. Conf. Manag. Res. Sabaragamuwa Univ. Sri Lanka*, No.2 December, pp. 0–9, 2013.

8. Kovačević, M., Pantelić, V., and Smiljković, M., "Labour Force as A Component of the Economy," *Ekon. Preduz.*, Vol. 71, No. 5–6, pp. 243–259, 2023, doi: 10.5937/ekopre2306243k.

9. Moraes E. C., and Lepikson, H. A., "Industry 4.0 and Its Impacts on Society," *Proc. Int. Conf. Ind. Eng. Oper. Manag.*, Vol. 2017, No.4 OCT, pp. 729–735, 2017.

10. Ghobakhloo, M., "The Future of Manufacturing Industry: A Strategic Roadmap Toward Industry 4.0," *J. Manuf. Technol. Manag.*, Vol. 29, No. 6, pp. 910–936, 2018, doi: 10.1108/JMTM-02-2018-0057.

11. Bigdeli, A.Z, Kapoor, K., Schroeder, A., and Omidvar, O., "Exploring the Root Causes of Servitization Challenges: An Organisational Boundary Perspective," *Int. J. Oper. Prod. Manag.*, Vol. 41, No. 5, pp. 547–573, 2021, doi: 10.1108/IJOPM-08-2020-0507.

12. Baines,T., and Lightfoot, H.W., "Servitization of the Manufacturing Firm: Exploring the Operations Practices and Technologies that Deliver Advanced Services," *Int. J. Oper. Prod. Manag.*, Vol. 34, No. 1, pp. 2–35, 2014, doi: 10.1108/IJOPM-02-2012-0086.

13. Manoharan, K., Dissanayake, P., Pathirana, C., Deegahawature, D., and Silva, R., "A Competency-based Training Guide Model for Labourers in Construction," *International Journal of Construction Management*, Vol. 23, No. 8, pp. 3-5, 2021, doi.org/10.1080/15623599.2021.1969622.

14. Iliyasu R., and Etikan, I., "Comparison of Quota Sampling and Stratified Random Sampling," *Biometrics Biostat. Int. J.*, Vol. 10, No. 1, pp. 24–27, 2021, doi: 10.15406/bbij.2021.10.00326.

15. Howell, C. R. Su,W., Nassel, A. F., Agne, A. A,. and Cherrington, A. L., "Area Based Stratified Random Sampling using Geospatial Technology in A Community-Based Survey," *BMC Public Health*, Vol. 20, No. 1, pp. 1–9, 2020, doi: 10.1186/s12889-020-09793-0.

16. Sun, Z., "A Study on the Educational use of Statistical Package for the Social Sciences," *Int. J. Front. Eng. Technol.*, Vol. 1, No. 1, pp. 20–29, 2020, doi: 10.25236/IJFET.2019.010102.

17. Gogtay N. J., and Thatte, U. M., "Principles of Correlation Analysis," *J. Assoc. Physicians India*, Vol. 65, No. MARCH, pp. 78–81, 2017.

18. Shaw, R. G., and Mitchell-Olds, T., "ANOVA for Unbalanced Data: An Overview," *Ecology*, Vol. 74, No. 6, pp. 1638–1645, 1993, doi: 10.2307/1939922.

19. Feldkamp, M. L., Carey, J. C., and Sadler, T. W. (2007). "Development of Gastroschisis: Review of Hypotheses, A Novel Hypothesis, and Implications for Research," *American Journal of Medical Genetics,* Part A, 143A(7), 639–652. https://doi.org/10.1002/ajmg.a.31578

20. Ahmad, H., and Halim, H., "Determining Sample Size for Research Activities: The Case of Organizational Research," *Bus. Rev.*, Vol. 2, No.2.

21. Ling, Li., "Reskilling and Upskilling the Future-Ready Workforce for Industry 4.0 and Beyond," *Inf. Syst. Front.*, Vol. 26, No. 5, pp. 1697–1712, 2022, doi: 10.1007/s10796-022-10308-y.

22. Saumyadi, H. A. D. and Jayawardane, V. P. T., "The Workplace Support Received by Young Women Engineers in Sri Lanka," *Eng. J. Inst. Eng. Sri Lanka*, Vol. 55, No. 3, pp. 113–122, 2022, doi: 10.4038/engineer.v55i3.7526.

23. Hamada, T., "Determinants of Decision-Makers ' Attitudes toward," *Soc. Sci.*, 2019.

24. Wijesinghe, D. P. S., . Saumyadi , H. A. D., and Jayawardane,V.P.T., "Improving Engineering Ethics of Professional Engineers in Sri Lanka – Perspectives of Young Engineers," *Eng. J. Inst. Eng. Sri Lanka*, Vol. 54, No. 3, p. 77, 2021, doi: 10.4038/engineer.v54i3.7461.

25. Babeiya, E. E. and Masabo, C. J. "The Role of ICTs in Enhancing Citizens ' Involvement in Decision-Making in Local Governments in Tanzania," *Int. J. Technol. Manag.*, Vol. II, No. II, pp. 1–13, 2017.