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A Review on Barriers in Implementation of Robotics Technology in the Construction Projects

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Abstract: *One of the oldest and most important sectors of a country's economy is the construction sector. Through infrastructure projects, amenities, and real estate development, the Indian construction industry contributes significantly to the country's economic growth and nation-building. India is trailing behind the west in the application of robotics and automation in construction, while the west is seeing a rise in this field. An examination of the particular reasons limiting adoption in Indian building projects is presented in this research. The objective of the review is to identify and categorise the most critical challenges that are limiting the adoption of robotics in construction projects. The information provided will help those working in construction come up with mitigation plans. The results show that, while there is awareness of the benefits of adaptability and the use of robots in construction, there are a number of resistance factors that must be overcome for robotics to be successfully adopted in India. Generally speaking, professionals in the construction industry consider automation and robotics to be synonymous, and they believe that robotics is appropriate for a developing nation like India.*

Keywords: Automation, robotics, modern technology, construction industry, automated construction

I. INTRODUCTION

An in-depth examination of the difficulties in the field of construction robots is required to completely deliver the promise of technological breakthroughs in the construction business. Robotics integration has the potential to improve productivity, safety, and efficiency, but the technology's slow adoption suggests that significant barriers remain. The goal of this research is to thoroughly identify and investigate these limitations, providing insight into specific challenges limiting the widespread deployment of robotics in construction projects. Robotics in building projects shows huge potential for altering traditional construction techniques. In the construction business, the scope of robotics is complex, that extend different applications to improve efficiency, safety, and overall project outcomes. Despite the considerable promise, problems such as economic concerns, integration issues, and legal frameworks must be overcome before robotics in construction can be widely adopted. Robotic bricklaying, masonry, and welding improve precision and uniformity while lowering labor costs and shortening project schedules. Continued research and development in this subject is critical to realizing robotics' full potential, assuring its seamless integration into construction projects, and driving an industry model change.

II. TECHNICAL BARRIERS

Ananya et al. (2017) looks at the future of robots in industrial settings. It delves into issues including item pickup robotics, managing extra-heavy payloads, and sophisticated industrial robots. Robotics development for industrial applications. Robotic object selecting based on 3-D object identification. The future of robotics is in fulfilling the needs of today's production environment. Robot application is critical to the design of an automated system. Rajiv et al. (2019) assessed the awareness of robotics and automation in Indian construction industry. To identify the favourable factors that support 17 acceptances of robotics and automation in Indian construction industry. To identify the factors that resist the adaptation of robotics and automation in Indian construction industry more specifically in the Real Estate and Infrastructure sectors. To determine the views of Indian Construction industry professionals about the suitability of robotics and automation. The Indian construction industry has a low direct source of awareness of robotics and automation in construction (RAC) from the workplace, indicating minimal usage of robots and automation in India. RAC is perceived to be suited for developing countries. The perception and awareness of robotics and automation in the Indian construction industry, but it does not provide detailed insights into the specific challenges and barriers faced in implementing RAC in India. primarily relies on self-reported data, which may be subject to biases and inaccuracies. Smit et al. (2020) explained about excellent work and better production, the construction sector demands automation. The challenges of implementing automation on building sites are explored. Automation is now being used in the construction business. Construction automation technology implementation roadblocks. The high cost of automation in construction, as well as the firm's scale, are important impediments to its deployment. Training programmes and more user-friendly technology can help to reduce obstacles. Automation is now being used in the construction business. Construction automation technology implementation roadblocks. Ahmed et al. (2022) studied into the impact of factors on robotics implementation in developing countries building sectors. Technology, industry, and culture are the drivers, while resources and the environment are the advantages. The study used partial least squares structural equation modeling to assess the relationships between these drivers. According to the findings, robotics drivers have a substantial impact on the Nigerian construction industry, affecting 14.5% of projects. Ishal et al. (2022) examined the improvement methods for these barriers of robotics and automation technologies in the structural and construction industries. Robotics and automation technologies are being used in various areas of construction, including costing and estimation, scheduling and planning, management of projects, and on-site works. The complex execution process, upgradation cost, and re-training of employees are additional challenges for the implementation of these technologies. Major barrier for their execution in construction industries, especially in developing countries like India. Ahsan et al. (2023) examined the primary technical, economic, legal, privacy, and resource obstacles to RPA adoption for tall building safety management. The pilot survey comprised 161 Malaysian tall building specialists, while the full questionnaire poll included 231 experts. Theoretical and empirical breakthroughs in construction safety management and RPA deployment prompted this inquiry. This study illuminates the main obstacles to employing RPA for tall building safety management. Factors such as technology, economics, legislation, privacy, and resources were found to hinder the adoption of RPA for safety management in high-rise structures. valuable insights for businesses considering the use of RPA for safety management in skyscrapers. Implications for further investigation, including the need for research on removing barriers to RPA adoption in the high-rise building sector and exploring the advantages of RPA adoption for safety management in the construction sector.

III. ORGANIZATIONAL BARRIERS

Anirudh et al. (2016) identified the major barriers for the implementation of automation technologies and robotics in Indian construction industry. 19 Establishing an understanding of the principles of automation and to present the latest advancement of the technologies and comparing their efficiency with the traditional methods. A questionnaire was developed and distributed to various construction firms, sub-contractors, specialist contractors, builders, and construction consultants to gather information on automation and robotics technologies. The data analysis from the survey provides insights into the current scenario of automation technology and robotics in the Indian construction industry. The development of training programs and initiatives to address the lack of technical labor skilled in automation technologies. This would help in creating a workforce that is equipped to adopt and utilize modern innovative technologies in construction projects. Shiyao et al. (2019) studied automation and robotics technologies are expected to boost construction productivity, alleviate labor shortages, and eliminate safety risks, especially in high-rise projects. However, there is a scarcity of research on both academic and industrial applications. This research looks at the advancement of academic research as well as the actual use of automation and robotics in high-rise building construction. It highlights four patterns of development: concurrent development headed by the same party, same pace, academic research giving basic technologies, and existing technologies in academic research with no products found. The report proposes closing these gaps and outlining future directions. Pan et al. (2020) investigates stakeholder opinions of future construction robots in Hong Kong, indicating their limited application but critical role in offsite manufacturing and on-site lifting. To comprehend technical systems, stakeholders, and environments, the study use a dialectical system framework. Government assistance, off-site construction, technology adaptability, and integrated

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design are among the recommendations. The findings add to the literature on construction robotics and provide fresh directions for future research. Fopefoluwa (2021) explored and determine the appropriate strategies to further the deployment of RAT in the construction industry by identifying both the positive and negative factors of adopting the technologies based on the viewpoints of prominent construction technology and innovation experts from both industry and academia who are experienced users of these technologies. but there is limited work that simultaneously identifies the positive and negative factors that influence the decision of construction companies to adopt RAT. Cynthia et al. (2022), Based on research and case studies, the report proposes a robot evaluation framework (REF) for construction innovators. To recommend robot adoption, the framework focuses on product, organizational, and process feasibility and analyzes safety, quality, schedule, and cost. The study verifies the REF's effectiveness beyond the initial three scenarios by applying it to ten real-world industry cases. The framework influences results consistency and effort among assessors, and it provides comparative insights for ten robots. Future development will include expanding the sorts of robots and projects to see if the framework need specialization. Amaifeobu et al. (2023) identified different types of robotics available for construction works. To assess the opportunities for adopting robotics in Nigerian construction industry. To assess the barriers for adopting robotics in Nigerian construction industry. Identified and ranked the barriers for adopting robotic technologies in construction, including human-related, site/environment-related, finance-related, technical-related, material/market-related, government/ethicsrelated, and cultural-related barriers. Detailed analysis of the specific types of robots applicable for construction works in the Nigerian construction industry. 21 Potential impact of robotics on issues such as shortage of labor and waste management in the Nigerian construction industry.

IV. OPERATIONAL BARRIERS

Mi Jeong et al. (2015) identified that due to low levels of automation, the construction industry, which accounts for 10% of GDP in industrialized countries and 25% in developing countries, confronts automation issues. With developments in robotic control, sensing, vision, localization, mapping, and planning modules, automation and robotics applications can assist address these difficulties. This special issue focuses on research and case studies demonstrating how automation and robotics technology might be used in the construction of buildings and infrastructure. Following rigorous blind assessments, the publication includes 13 papers. Ammar et al. (2018) studied robotics in construction from a managerial perspective. Since implementation of robotic solutions will require intense information and change management to get the expected benefits out of them, we focus our research on this direction. How could Robotisation improve the construction industry on-site through information and change management. Information management plays a crucial role in employing robotics in construction by providing the necessary data and facilitating automation. Does not explore the potential impact of robotics on the job market or the overall business model of the construction industry. Mohd et al. (2019) investigated the challenges of the implementation of construction robotics technologies in the Malaysian construction industry and the improvement method. The data of the research was achieved through a quantitative method, which questionnaires were distributed to 180 G7 contractors in Kuala Lumpur. Subsequently, 50 valid responses were retrieved, and the 22 collected data were analyzed using Statistical Package for Social Science (SPSS). Challenges of implementing construction robotics technologies in the Malaysian construction industry are the high cost of maintenance and updating processes. G7 contractors should form strategic partnerships with high technology companies that have already implemented construction robotics technologies in their organizations. Focuses on the challenges faced by Malaysian contractors in implementing construction robotics technologies. does not discuss the specific types of construction robotics technologies that were considered in the study. Daniel (2020) identified barriers to the adoption of automation and robotics in the construction industry as perceived by industry experts and answer the research question: What are the barriers to automation and robotics in construction? We gain understanding through exploratory interviews with industry practitioners and automation and robotics researchers. Barriers to the adoption of automation and robotics in construction can be categorized into culture, teams, and technical aspects. The construction industry faces challenges in productivity, safety, quality, and profitability, and automation and robotics have the potential to address these issues. does not consider the potential impact of regulatory and policy factors on the adoption of automation and robotics in the construction industry. Vishal et al. (2022) investigated techniques for improving obstacles. Concentrate on the structural and construction sectors. Construction uses robotics and automation technology in all domains. Implementation is hampered by high costs, a difficult execution method, and personnel retraining. Construction companies are involved in a variety of operations in a variety of industries. Infrastructure, design, pricing, and planning are all examples of activities. Robotics and automation technologies are expensive. Complex execution process, upgrade costs, and employee re-training. Yongki et al. (2023) looks at the deployment of Construction Automation and Robotics in Indonesian construction SOEs, concentrating on real project life cycles, best practices, and prospective applications. Drones, Virtual Reality, and Prefabrication and Modularization are the most prominent technologies used by seven SOEs. However, many implementations are still in the early stages due to a lack of collaboration among contractors, technological firms, and institutions. The report presents an in-depth examination of Indonesia's implementation and compares it to best practices from the United States and China.

V. PERSONAL BARRIERS

Sajjad (2013) studied the increased interest in construction automation and robotics, the article tries to persuade building designers and managers to use robotic systems in current constructions. It investigates modern robot and automation applications in the construction sector, with a focus on the development and implementation processes. The report investigates the interests of stakeholders in research and development and proposes a process for implementation. It concludes that a systematic strategy will improve program success and accelerate the adoption of innovative technology. Paresh et al. (2018) explained Construction automation and robotics improve productivity and safety. Design and maintenance may be automated as well. Rapidly expanding domestic building market. There is a scarcity of reference material available to designers. Wenpan et al. (2019) investigated the traditional construction in Hong Kong faces issues such as declining productivity, inconsistent quality, rising demand, an aging population, and labor market shortages. A systematic approach and detailed roadmap for adopting on-site construction automation and robotic technology is provided to overcome these difficulties. The roadmap assesses 24 short- and medium-term strategies, forecasts a long-term viewpoint, and acts as a guideline for the construction sector to carry out comparable projects in the future. The method used in a consultancy project commissioned by the Construction Industry Council is demonstrated in this article. Vaibhav et al. (2020) explained the implementation of robotics in construction. To identify the feasibility of using robots in construction. Understanding reduction of time and saving cost in construction using automation. Comparison between conventional method and automation. Feasibility of using robots in building construction is determined by comparing robotic performance with manual performance of relevant building tasks.. The paper does not discuss the cost implications of implementing robotics and automation in construction projects. Piyush et al. (2021) documented the barriers to adopting robotics in the US construction industry, which in turn can support a profound understanding of such barriers as well as informing the construction industry and academic researchers about how to look for solutions for these barriers. The potential use of robotics in hazardous construction projects, which could be an important area for further research. Conducted only in South Florida, which may not represent the entire US construction industry. Future studies should consider different regions and cultural factors. Jakela et al. (2022) identified the barriers to the introduction of robots in the existing literature and to supplement them with an empirical study focused on the German construction industry, and subsequently to derive meta-barriers. In addition, a holistic model for overcoming barriers is developed. The model serves as a generic framework for companies to implement robotic systems and considers three different areas of robotics implementation: potentials, enablers, and results for qualitative implementation. Barriers to implementing robotics in the construction industry in Germany and does not consider other industries or countries. And does not provide an in-depth analysis of the technical, economic, and social problems related to construction robotics. Further research activities are needed to explore these areas.

VI. ECONOMIC BARRIERS

Mipan et al. (2018) reported that construction automation and robotics (CAR) is becoming recognized as an important component of the construction industry's future. However, formal advice for the construction industry is lacking. The framework will be translated into an evaluation procedure, which will be checked and validated in real-world scenarios, as part of the research. Mohd et al. (2019) identified that the construction business need innovation and efficient operations to compete worldwide. Automation and robots can boost construction productivity, safety, and quality. Participation of all team members, a professional staff, and engagement with all stakeholders are critical success

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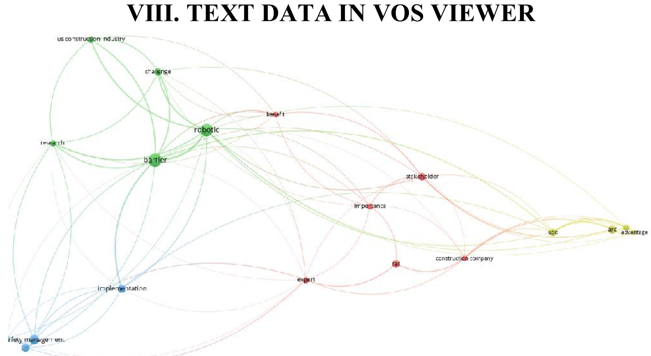
components. In Malaysia, surveys on IBS use were conducted in 2003, 2005, and 2006. CIDB General Manager Issues Press Statement on IBS Use in Public Projects Malaysian building methods and procedures have seen limited modernization. Efforts to promote modern construction techniques and use new technologies. Alberto et al. (2020) investigated robots in the construction business It examines innovative gadgets and exoskeletons for building activities. Construction robots are classified into 18 families. Investigating exoskeletons and their possible dangers. Fully automated building procedures are still a long way off. Many advanced machines are still being tested Ayanda et al. (2022) investigated on robotics to solve challenges such as material waste, injuries, and bad working conditions, the South African construction sector is progressively embracing automation and robotics technologiesThis research emphasizes the significance of comprehending the impact of technology on the building business. Kwok et al. (2022) identified benefits and barriers affecting adoption of CRs in Hong Kong from a multistakeholder perspective. Factors were firstly identified through a systematic literature review in a scientometric approach and validated through a questionnaire survey. Then, the relative importance of these factors was calculated using mean scores ranking, and the stakeholder groups were segmented using k-means algorithm. Does not discuss the specific challenges or limitations faced during the identification and validation of the benefit and barrier factors for CRs adoption in Hong Kong's construction industry. the perspectives of stakeholders in Hong Kong's construction industry, and the findings may not be directly applicable to other regions or industries.

VII. CRITICAL SUCCESS FACTORS

Chun (2021) studied robotic Process Automation (RPA) is gaining traction in the digital transformation community due to its improved productivity and return on investment. However, for some businesses, implementation can be difficult. The purpose of this research is to identify key success factors (CSFs) for RPA adoption in order to increase the likelihood of success and enable enterprises to fully benefit from RPA. A rigorous assessment of the literature and theme analysis of 20 RPA case studies produced 14 CSFs, with 7 fundamental and 7 secondary CSFs identified. This empirical identification contributes to RPA implementation theory and practice. Ralf et al. (2022) identified Critical Success Factors (CSFs) for Robotic Process Automation (RPA). Based on a survey of the literature and expert interviews, we developed a framework containing 32 CSFs. Discusses whether the CSFs identified are unique to RPA or applicable to other process automation technologies. The consequences for theory, practice, and future study are highlighted. CSFs were classified into contextual clusters based on their relevance to RPA implementation. CSFs were also proven to be relevant to various process automation systems. Implications for theory, practice, and future study were addressed. Overestimation of RPA capabilities. These restrictions are not mentioned in peer-reviewed publications. Umar et al. (2020) focused on combining AI and robotics to create intelligent autonomous systems (IASs). A priority hierarchy approach is proposed for developing a sustainable ecology for IASs. IASs can be used to solve societal problems in developing nations like India. Clear restrictions are required for the ecosystem to work properly. In India, eight major criteria have been found for merging AI and robots. Critical success factors (CSFs) for merging AI and robots have been identified. Created a prioritisation hierarchy model for constructing a sustainable environment. EMNEs, governance, utility, people, money, software, data, and hardware were recognised as key elements. A survey of the literature on AI and robotics was conducted, as well as research topics and gaps were found.

VIII. TEXT DATA IN VOS VIEWER



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REFERENCES

[1]. Ananya Banerjee (2017), Robotics in Indian Industry, International Journal of Engineering Research & Technology (IJERT) Vol. 6

[2]. P. Anirudh Akarsh, G.Manikandan (2016), An Investigation On The Existing Barriers And Possible Measures For The Implementation Of Automation Technology In Indian Construction Industry, International Journal of Engineering Research Volume No.5 pp : 396-397

[3]. Alberto Balzan, Claudia Cabrera Aparicio, and Dario Trabucco (2020), Robotics in Construction: State-of-Art of On-site Advanced Devices, International Journal of High-Rise Buildings. https://doi.org/10.21022/1JHRB 2020.9.1.95

[4]. AMMAR BAKIR, ISSA BALCHI (2018), Development and Implementation of Robotics in Construction, Master's Thesis in the Master's Programmes International Project Management & Design and Construction Project Management.

[5]. Abd Rashid, M. N., Abdullah, M. R., & Ismail, D.. (2019). Critical Success Factors CSFs to Automation and Robotics in Industrialized Building System IBS. 8(12). https://doi.org/10.6007/IJARBSS/V8-I12/5432

[6]. Akshatha D ,Vimala M , Sahana S , Manjula M (2017) Robotics in construction technology, International journal of advance research in science and engineering, volume-6

[7]. Amaifeobu, O.C; Iyamu, O.V and Adewunmi, A.C (2023), Opportunities and Barriers for Adopting Robotics in Nigerian Construction Industry, International Journal of Research Publication and Reviews Vol 4

[8]. Bademosi, F., & Issa, R. R. A.. (2021). Factors Influencing Adoption and Integration of Construction Robotics and Automation Technology in the US. 147(8). https://doi.org/10.1061/(ASCE)CO.1943-7862.0002103

[9]. Boya, Ayanda &Akinradewo, Opeoluwa&Aigbavboa, Clinton &Ramabodu, Molusiwa. (2022). Implementation of automation and robotics: Benefits to the construction industry.

[10]. Brosque, C., & Fischer, M. (2022, June). A robot evaluation framework comparing on-site robots with traditional construction methods. Construction Robotics, 6(2), 187–206. https://doi.org/10.1007/s41693-022-00073-4

[11]. Chang, S.. (2022). Factors Influencing Adoption of Construction Robotics in Hong Kong's Industry: A Multistakeholder Perspective. 38(2). https://doi.org/10.1061/(asce)me.1943-5479.0001011

[12]. Chun Pong Lok (2021), Critical Success Factors for Robotic Process Automation Implementation

[13]. Cai, S., Ma, Z., Skibniewski, M. J., & Bao, S. (2019, October). Construction automation and robotics for high-rise buildings over the past decades: A comprehensive review. Advanced Engineering Informatics, 42, 100989. https://doi.org/10.1016/j.aei.2019.100989

[14]. Daniel J. Trujillo M.S. RECM and Eric Holt, Ph.D (2020) Barriers to Automation and Robotics in Construction EPiC Series in Built Environment Volume 1, 2020, Pages 257–265

[15]. Davila Delgado, J. M., Oyedele, L. O., Ajayi, A. O., Akanbi, L., Akinade, O. O., Bilal, M., & Owolabi, H. A.. (2019). Robotics and automated systems in construction: Understanding industry-specific challenges for adoption. 26. https://doi.org/10.1016/J.JOBE.2019.100868

[16]. Gharbia, Marwan. (2021). Developing a prototype for implementing robotic technologies in building construction. 10.13140/RG.2.2.24989.44006.

[17]. Jäkel, J.-I., Rahnama, S., &Klemt-Albert, K.. (2022). Construction Robotics Excellence Model: A framework to overcome existing barriers for the implementation of robotics in the construction industry. https://doi.org/10.22260/isarc2022/0085

[18]. M.J. Kim, H.-L. Chi, X. Wang, L. Ding, Automation and robotics in construction and civil engineering. J. Intell. Robot. Syst. 79, 347 (2015). https://doi.org/10.1007/s10846-015-0252-9

[19]. Kineber, A. F., Oke, A. E., Hamed, M. M., Rached, E. F., Elmansoury, A., &Alyanbaawi, A. (2022, December 29). A Partial Least Squares Structural Equation Modeling of Robotics Implementation for Sustainable Building Projects: A Case in Nigeria. Sustainability, 15(1), 604. https://doi.org/10.3390/su15010604

[20]. Llale, Josephine &Setati, Matleko&Mavunda, Success & Ndlovu, Thando & Root, David &TchumtchaWembe, Paulin. (2020). A Review of the Advantages and Disadvantages of the Use of Automation and Robotics in the Construction Industry. 10.1007/978-3-030-26528-1_20.

[21]. Mir, U. B., Sharma, S., Kar, A. K., & Gupta, M. P.. (2020). Critical success factors for integrating artificial intelligence and robotics. 22(4). https://doi.org/10.1108/DPRG-03-2020-0032

[22]. Olivia Luttinen (2022) Critical success factors in robotic process automation implementation projects, University of jyväskylä faculty of information technology.

[23]. Oke, A. E., Akinradewo, O., Aigbavboa, C., &Akinradewo, O. F.. (2019). Benefits of Construction Automation and Robotics in the South African Construction Industry. 385(1). https://doi.org/10.1088/1755-1315/385/1/012063

[24]. Plattfaut, R., Borghoff, V., Godefroid, M., Koch, J., Trampler, M., & Coners, A.. (2022). The Critical Success Factors for Robotic Process Automation. 138. https://doi.org/10.1016/j.compind.2022.103646

[25]. Pradhananga, P., Elzomor, M., &Kasabdji, G. S.. (2021). Identifying the Challenges to Adopting Robotics in the US Construction Industry. 147(5). https://doi.org/10.1061/(ASCE)CO.1943-7862.0002007

[26]. Paresh S Mistri1 , Hiren. A. Rathod, Remedies over barriers of automation and robotics for construction industry, International journal of advanced research in engineering, science & management

[27]. Pan, Wen & Hu, Rongbo & Linner, Thomas & Bock, Thomas. (2019). Developing a roadmap for implementing on-site construction automation and robotics in Hong Kong.`

[28]. Pan, M., Linner, T., Pan, W., Cheng, H., & Bock, T. (2018, May). A framework of indicators for assessing construction automation and robotics in the sustainability context. Journal of Cleaner Production, 182, 82–95. https://doi.org/10.1016/j.jclepro.2018.02.053

[29]. Pan, M., & Pan, W. (2020, November). Stakeholder Perceptions of the Future Application of Construction Robots for Buildings in a Dialectical System Framework. Journal of Management in Engineering, 36(6). https://doi.org/10.1061/(asce)me.1943-5479.0000846

[30]. Dr. Rajiv Gupta, Jaya Pradeep.S, Chiranjeev Mohota, Mainak Datta, (2019) Preparedness of the Indian Construction Industry to Adapt to Robotics and Automation, IOSR Journal of Business and Management Volume 21.

[31]. Smit Rangani , Jayraj Solanki (2020). Automation in construction industry it's application and barriers to implimentation on construction site, International Research Journal of Engineering and Technology (IRJET) Volume: 07

[32]. Saidi, Kamel & Bock, Thomas & Georgoulas, Christos. (2016). Robotics in Construction. 1493-1520. 10.1007/978-3-319-32552-1_57.

[33]. Sajjad Yaghoubi (2013). Robotics and Automations in Construction:Advanced Construction and FutureTechnology. Vol:13 No:03

[34]. Tanne, Y. A., & Indrayani, N. L. A. (2023, August 17). Review of Construction Automation and Robotics Practices in Indonesian Construction State-Owned Enterprises: Position in Project Life Cycle, Gap to Best Practice and Potential Uses. Architecture, Structures and Construction, 3(3), 373–389. https://doi.org/10.1007/s44150-023-00098-5

[35]. Vishal Chauhan, Swati Dhiman (2022). The challenges to the execution of robotics and automation technologies in construction industries, International Research Journal of Modernization in Engineering Technology and Science. Volume:04

[36]. Ar. vaibhavvishnuwankhede er. Sumesh sawant (2020) Use of robotics and automation in construction industry - case of metro construction, Pune research world an international journal of interdisciplinary studies volume:5

[37]. Waqar, Ahsan & Othman, Idris &Falqi, Ibrahim &Almujibah, Hamad & Alshehri, Abdullah &Alsulamy, Saleh &Benjeddou, Omrane. (2023). Assessment of Barriers to Robotics Process Automation (RPA) Implementation in Safety Management of Tall Buildings. Buildings. 13. 1663. 10.3390/buildings13071663.

[38]. Yahya, M. Y., Hui, Y. L., Yassin, A. M., Omar, R., Robin, R. O. anak ., & Kasim, N.. (2019). The Challenges of the Implementation of Construction Robotics Technologies in the Construction. 266. https://doi.org/10.1051/MATECCONF/201926605012

[39]. Vigneshwar, R. V. K., Shanmugapriya, S., &Vaardini, U. S. (2022, February 9). Analyzing the Driving Factors of BIM Adoption Based on the Perception of the Practitioners in Indian Construction Projects. Iranian Journal of Science and Technology, Transactions of Civil Engineering. https://doi.org/10.1007/s40996-022-00834-9

[40]. Vaardini, Sindhu & Karthiyayini, &Ezhilmathi,. (2016). STUDY ON COST OVERRUNS IN CONSTRUCTION PROJECTS –A REVIEW.