

PROCEEDINGS OF THE WABER SuDBE CONFERENCE 2024

30 – 31 July 2024

University of the Witwatersrand

Johannesburg, South Africa

EDITORS

Prof. Samuel Laryea, University of the Witwatersrand, South Africa

Prof. Baizhan Li, Chongqing University, China

A/Prof. Emmanuel Adu Essah, University of Reading, United Kingdom

A/Prof. Sarfo Mensah, Kumasi Technical University, Ghana

Prof. Hong Liu, Chongqing University, China

Prof. Runming Yao, University of Reading, UK/Chongqing University, China

ISBN: 978-0-7961-6032-4



In collaboration with:



Proceedings of the WABER SuDBE 2024 Conference

30th – 31st July 2024

University of the Witwatersrand, Johannesburg, South Africa

© Copyright

The copyright for papers in this publication belongs to the authors of the papers.

ISBN: 978-0-7961-6032-4 (e-book)

The ISBN for this publication was provided by the National Library of South Africa. Legal deposits of the publication have been supplied to the National Library of South Africa, Library of Parliament, and other places of Legal Deposit.

First published in July 2024

Published by:

WABER SuDBE Conference 2024

C/o Professor Samuel Laryea, Conference chair

School of Construction Economics and Management

University of the Witwatersrand, Johannesburg, South Africa

Email: info@wabersudbeconference.com / samuel.laryea@wits.ac.za

Website: www.wabersudbeconference.com

Editors

Prof Samuel Laryea, University of the Witwatersrand, South Africa

Prof Baizhan Li, Chongqing University, China

A/Prof Emmanuel Adu Essah, University of Reading, United Kingdom

A/Prof Sarfo Mensah, Kumasi Technical University, Ghana

Prof Hong Liu, Chongqing University, China

Prof Runming Yao, University of Reading, UK / Chongqing University, China

Declaration

All papers in this publication have been through a review process involving a review of abstracts, peer review of full papers by at least two referees, reporting of comments to authors, revision of papers by authors and re-evaluation of the revised papers to ensure quality of content.

BARRIERS TO DIGITALIZATION OF PROCUREMENT – A REVIEW

Elizabeth Ojo-Fafore¹ and Samuel Laryea²

^{1,2} School of Construction Economics and Management, University of the Witwatersrand, South Africa

The concept of digital technology is making waves in the construction industry in developed countries; however, it is not the same story in other nations as there are several barriers militating the progress of adoption of the new concept. This study aims to investigate the barriers militating digitalization of procurement in Construction, to proffer solutions. This study investigated possible barriers affecting the implementation of digitalization of procurement using a descriptive literature review. Several past works were reviewed to fill the gaps and apply new methods that will enable the digitalization of procurement. The study discovered several barriers restraining the digitalization of Procurement, but there are three common barriers to the literature reviewed; insecurity, cost, and Lack of skilled expertise. This industry will bring overall improvements in project time, quality, cost, and safety standards as well as client requirements and satisfaction. This research paper is of the view that digitalization will increase productivity and the competitive advantage in the Construction industry. In conclusion, there is a need to prioritize investment in digital tools and technology to have ease of adoption of procurement digitalization.

Keywords: construction industry, digitalization, procurement, South Africa

INTRODUCTION

There is no doubt that we are in the era of digital and all industries of the economy need to be compliant to stay relevant and be sustainable and competitive. Digitalization is rapidly spreading to all aspects of the economy and in terms of the level of digitization among industries, construction industries are far behind (Schnell et al., 2023).

This revolution resulted in innovative technologies like artificial intelligence, more advanced robotics, wearable, and digital fabrication as known as additive manufacturing such as 3D printing, smart devices such as processors and other smart hardware to collect, send, and analyze data, virtual and augmented reality, changing the process of production and prototypes of businesses across different industries. Transformation; intelligent sensors, automations, robotics, the internet, and the like (Adekunle et al., 2021). In developed countries, the notion of digital technology is spreading within the industry; however, it is opposite in the developing countries as there are several barriers affecting the progress of adoption of the new concept (Aighimien et al., 2019). While other industries such as those in the field of banking, manufacturing, and retail have started adopting technological innovation, it is slow within the construction industries impacting their comparative advantage compared to other industries (Castagina et al., 2016, Osunsanmi et al., 2018). Construction is known to be sluggish in

¹ Elizabeth.ojo-fafore@wits.ac.za

² Samuel-Laryea@wits.ac.za

adopting technology (Aliyu and Oke 2023). Previous studies by scholars reveal that there are chances for the construction industry to be transformed and become more productive through digital environments (Windapo, 2021), Oke and Arowoiya, 2022 noted several barriers to adopting digital technology. Ifije and Aigbavboa, 2020 research also supported this assertion. There is a need to digitalize companies in developing countries.

There are several studies on electronic procurement, but few on the Digitalization of procurement. Digitalization goes beyond e-procurement. Digitalization occurs when digital tools are actively used throughout the entire procurement. This paper will investigate the factors affecting the digitalization of procurement in the construction. The specific objectives below guided the research.

- (i) To outline the barriers restraining the adoption of digitalization of procurement - Construction Industry.
- (ii) To state the benefits as it offers solutions to these barriers

RESEARCH METHOD

This study examines the barriers impacting the digitalization of procurement in the construction industry. A qualitative approach was utilized using a literature review. This study adopted a descriptive review, which is to examine the opinion of the research topic as it discloses any comprehensible pattern on trend concerning pre-existing recommendations (King and He, 2005, Pare et al., 2015). Recent publications also provide a better discourse on the research topic, to check its relevancy to pinpoint future research needs (Graulich et al., 2021). Engine Scopus and ResearchGate were used to gather relevant research articles, as they are credible search tools. At first, was getting more e-procurement which dates way back to 2015. Finally, digitalization from 2020, emerged after the Covid-19 pandemic. The barriers analysed in this paper range from the year 2020 till date. A descriptive review thinks that the findings represent the state of the art in the area of study (King and He 2005)

Article Selection (Data Sources)

Engine Scopus and ResearchGate were used to gather relevant research articles, as they are credible search tools. Earlier searches were getting more of e-procurement which dates way back to 2015. Finally got digitalization in 2020, which emerged after the COVID-19 pandemic. Researchers like Hallinger and Kovacevic (2019); and Mongeon and Paul-Hus (2016), Empirical research indicate that Scopus provides a broader range of sources compared to the Web of Science, particularly in fields beyond medicine and the physical sciences. The analysis comprises various document formats. The lack of a specified start date for the search allows the engine to retrieve the oldest literature publications. Relevant terms and combinations of terms were used in the search. Only Twenty-Four (24) papers are not relevant to the scope of the study. An advanced investigation was performed on ResearchGate in the study and a total of eleven (11) papers on Barriers to the Digitalization of procurement in the Construction Industry were identified. Other papers on mainstream Procurement were reviewed to get a view of Digitalization in Procurement and its barriers. A total of forty-three (43) studies from Scopus and Research Gate were reviewed for this paper.

Data analysis

According to Allen and Reser (1990), subject investigation has been used prolifically in a range of research applications in information and library science (ILS). The subject investigation was undertaken to review the selected papers to identify the general view of procurement,

Procurement in the Construction Industry, Digitalization of Procurement, and Barriers affecting the Digitalization of Procurement in the Construction Industry.

Procurement

Procurement is defined in so many ways depending on the authors' perspective. According to Schwalbe, 2013, Procurement is a procedure of acquiring goods and services from outside the organization. It is an institutional structure approved by the client for the application and occasionally subsequent operation of a project (Odhigu et al., 2012). It is a requisite through which the clients generate the requirement for the achievement of project-specific objectives (Rooke et al., 2023). Organizations involved in procurement in the industry are constantly looking for ways of improvement (Ibem and Laryea, 2015).

In Construction Procurement is the client's effort to purchase construction products and services (Charvat, 2000). Procurement is the procedure of finding, picking, and confirmation of the contributions required for the execution stages of the project (Building, 2011). The procurement method means the various awarding of risk and responsibility to attain the project's goals. To choose the appropriate method for the project procurement process, it should consider the characteristics of the project, and the project and client requirements.

Procurement strategy involves three major key factors which can be seen in Figure 1 and are major determinants of a successful project (Construction Excellence, 2015)

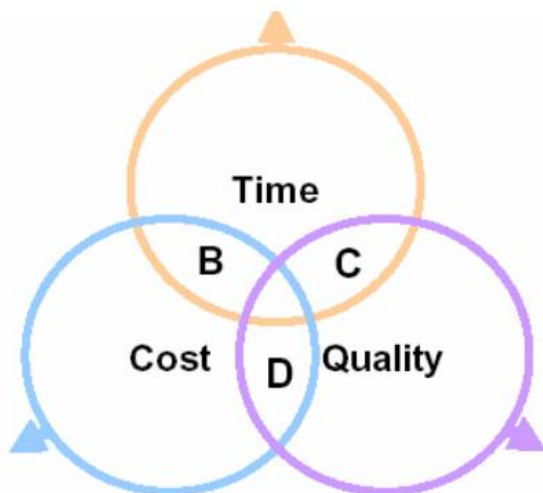


Figure 1: Procurement Strategy (Source: constructingexcellence.org.uk, 2015)

Digitalization and procurement

The construction industry has a role in the socio-economic development of a country and is thus regarded as an agent of growth (Gounden, 2000). Procurement is used to advance efficiencies within the construction industry or to advance socio-economic objectives (Watermeyer and Band, 1994). Utilizing procurement policy, the government aims to improve efficiencies and promote specific socio-economic objectives in the construction sector, with a focus on developing countries (Aziz and Ofori (1996), Abeysekera and Dezylva, (1997). In the Public sector, procurement has been utilized to improve economic activities (Govender and Watermeyer 2001). Digital Technologies are demonstrated to give a competitive edge concerning productivity, communication, and efficiency from the sectors that have endorsed the concept

RESULTS

Benefits of procurement digitalization

- Digital Procurement plays is vital to the construction
- Improves productivity and sustainability (Barbini, et al., 2020)
- Enhances the quality and operation performance (Alaloul et al., 2020).
- Efficiencies of tasks, simplify decision making and assist strategic activities (Bienhaus and Haddud 2018).
- Process efficiency and effectiveness, Competitiveness, and cost reduction (Motaung and Sifolo 2023)

Barriers to Digitalization of Procurement - Construction Industry

Twelve (12) papers were reviewed, and the findings are enumerated in Table 1 below.

Table 1: Barriers affecting digitalization of procurement

S/N	Barriers	Study area	Ref
1	(i)Lack of confidence (ii) absence of belief (iii) inadequate data resources (iv) Expensive and intricate nature (v) Non-standardized data (vi) poor grasp of blockchain technology (vii)low support from high-level management (viii) low awareness of related legal issues	Blockchain Technology Adoption in Construction	(Otasowie et al., 2023)
2	Talent incapability, Insecurity, Immature Processes, Cost, and Resistance to change.	Benefits & Barriers of Digital Procurement: Lessons from an Airport Company.	(Motaung and Sifolo, 2023)
3	(i) Insufficient Management policy and commitment (ii) Inadequate teamwork (iii) Lack of legislation (iv) Absence of incentives (v) Insufficient training (vi) Inadequate enforcement.	Barriers to achieving sustainable construction Project procurement in the private sector	(Ershadi et al., 2021)
4	(i)Data (ii) Lack of Core Technology (iii) inadequate Digital Infrastructure Allocation (iv) shortage of Technical Personnel (v) Shortage of Technical Standards."	Digital Transformation in the Chinese Construction	(Zhang <i>et al.</i> , 2023)
5	(i) Market-based risk (ii) High cost of maintaining sustainability (iii) Usage in the underground economy	Investigating barriers to blockchain adoption in Construction supply chain management:	Singh et al., 2023
6	(i)organizational management (ii) technical (iii) regulatory (iv) economic barriers	Barriers to the adoption of digital technologies for sustainable construction	Oke et al., 2023
7	(i)Status Quo Industry standards (ii) Lack of client interest (iii) Lack of financial needs and drive for using DTs	Regression analysis of barriers to digital in the construction industry.	Chen et al. (2023)
8	(i) Lack of data & Information sharing (ii) lack of regulatory compliance (iii) lack of data ownership	Smart Technologies in the Construction Industry:	Hwang et al. (2022)
9	(i)Lack of Acceptance (ii) Lack of Control (iii) Competence barriers	Implementation of Digital Technologies in Construction	Schnell et al. (2022)

10	(i)technological immaturity (ii)infrastructure decisions (iii)lack of professional expertise (iv) lack of cultural adaptation (v) stakeholder compliance	Realizing the need for the digital transformation of stakeholders' management	Prebanic and Vukomanovic (2021)
11	(i)Resistance by the consultant team (ii) lack of training and skills required (iii) costs involved when adopting innovative technologies on projects (iv) current legislation (v) clients' lack of knowledge.	The construction industry transformation and the digital divide	Windapo (2021)
12	(i) Budget (ii) Fear of innovation (iii) Fear of unknown (iv) Security issues (v) System Development.	Top 5 Barriers to Procurement Digitalization & How to overcome them	Anne (2020)

DISCUSSION

Benefits of procurement digitalization

The benefits are the advantages of digitalizing Procurement. According to the Igros et al. (2022) study, digital procurement is essential to the construction industry since it synchronizes the building schedule with inventories.

According to Barbini et al. 2020, computerized evaluations at the procurement stage utilizing BIM demonstrated an increase in productivity and sustainability. Hallikas, Immonen, and Brax (2021) found that digital procurement skills improve supply chain performance. It emphasizes the need to acquire data through a digitalized process and how data utilization improves an organization's operational effectiveness.

The system integrator may quickly detect project characteristics, and project implementers can see and use the frequency findings (Choi et al., 2021). Building information management, cloud-based computing, and augmented and virtual reality technologies are being used to modernize and affect the building industry's stability (Alaloul et al., 2020). Bienhaus and Haddud's (2018) conclusions on the benefits of digitalizing procurement processes include the following: (1) Improved efficiency in everyday administrative operations; (2) Simplified the complex decision-making process; and (3) Assisting in shifting procurement's focus to strategic activities. Motaung and Sifolo's (2023)

Barriers to digitalization of procurement

The barriers to the digitalization of procurement refer to factors that affect the easy implementation of digital technology use in the goods and services of construction processes. Past literature on the barriers to digitalization will be reviewed in this section.

Motaung and Sifolo (2023), found the following barriers in their study; Benefits and barriers of Digital Procurement: Lessons from an airport Company (i) Lack of Talent Capabilities (ii) insecurity (iii) Immature Processes (iv) Cost (VI) Resistance to change.

Ershadi et al. (2021) study on barriers to attaining sustainable construction project procurement in the private sector found the following as a barrier to sustainable procurement in the construction Industry. (i) Insufficient Management policy and commitment (ii) Inadequate teamwork (iii) Lack of legislation (iv) Absence of incentives (v) Insufficient training (vi) Inadequate enforcement.

Dineo et al. (2023), study provided important perceptions into factors that influence e-procurement preparedness in South African government departments. Technology, legal

framework, organization's finance, procurement structure, leadership, and procurement policy are some of these factors.

Anne (2020), a business strategist stated that there are five major barriers affecting the digitalization of procurement. The barriers are (i) Budget (ii) Fear of innovation (iii) Fear of the unknown (iv) Security issues (v) System Development.

Windapo (2021), analysis of the transformation and digital divide in the construction industry argued that obstacles to using innovative technologies in construction such as hostility by the consultant team, the necessary training and skills, the cost implications when adopting innovative technologies on projects, current legislation and lack of knowledge by clients.

Zhang (2023), in his study, discovered that barriers are impactin the digitalization of procurement in the Chinese construction industry

Singh et al. (2022), found Barriers to include contractor hesitancy, inefficiency, delays, and budget overruns, hindering the sector's adoption of modern tools for improved performance.

Prebanic and Vukomanovic (2021), study shows that barriers to digitalizing procurement in construction include technological maturity, infrastructure decisions, professional expertise, cultural adaptation, and stakeholder compliance, as highlighted in the paper.

Schnell et al. (2022), found barriers such as Acceptance, Control, and Competence hinder the digitalization of procurement in the construction industry, as identified in the paper's holistic digital-technology-implementation process.

Chen et al. (2023), identified barriers for construction organizations to adopt digital technologies as demonstrated relationships between organizational characteristics and the perceived DTs adoption barriers by using an explanatory sequential design by combining the advantages of quantitative and qualitative data.

The results of the literature review show some common barriers highlighted in the studies. The three major common barriers are Security, Cost, and Lack of Technology Expert

Insecurity: Data security and privacy hinder the use of Digital technology (Goyal et al., 2019). Also, some policies restrict workers from being tagged to track location and movements (Edirisingle, 2019). The study of Handan Kunkacu et al. (2023), relates their concerns on the security of confidential data in smart contacts.

Cost: This is the most significant impediment to the adoption of innovative construction safety solutions. The initial investment, operational costs, and maintenance costs all have an impact on the economic and financial risks that an organization faces. (Bademosi and Issa, 2021).

Lack of Technology experts: According to Pradhanga et al. (2021), the shortage of professionals is a major technical obstacle that is preventing their widespread application in buildings. Nnaji et al. (2020) define new technology as requiring features, support, training, durability, technology, efficacy, reliability, and versatility.

CONCLUSION AND RECOMMENDATION

The paper looked at what Digital Technology is all about to the concept of Procurement and was narrowed down to Procurement as South Africa's construction industry is moving towards digitalization

This paper revealed that there are few works on the Digitalization of Procurement in this industry as evident in a Scopus search for papers specifically on Digital Procurement. From the literature, it was evident that Digitalization of Procurement has a great impact on the South African Construction industry. Digitalization will maximize a competitive advantage which will increase effectiveness and reduce construction costs. It will improve the operational performance of an organization.

Despite the inherent benefits of digital procurement, various limitations prevented the technology from being widely implemented in the South African construction industry. Three major common factors were ascertained to be Security, cost, and lack of technology experts. To combat these barriers, the Issue of Security is of great concern to any industry. The implementation of overhaul security protocols and ensuring compliance with industry standards and regulations are the foundations of protecting data.

The industry needs to prioritize investment in digital tools and technologies that will have a great impact on their operations and deliver the most value. Also, there is a need to provide training and education programs to develop the necessary digital skills.

This study is limited as there is not much empirical study done in assessing the digitalization of Procurement, specifically for the study area. With this gap, it will be recommended to have a further empirical investigation of the benefits and barriers to the digitalization of Procurement. This study is a preamble for the main investigation of the adoption of Digital procurement and its impact on the Industry. Also, to synchronize the words e-procurement and Digital Procurement, as was revealed during the data sourcing for this paper. Most papers before 2020 were e-procurement, while the advent of the COVID-19 pandemic brought about Digital procurement.

ACKNOWLEDGMENT

This research is supported by the WITS CIDB Centre of Excellence

REFERENCES

- Abeysekera, and De Zylva, E. (1997). Development of Domestic Construction Contractors in Sri Lanka Proceedings First International Conference on Construction Industry Development, School of Building and Real Estate, National University of Singapore
- Abioye, S.O.; Oyedele, L.O.; Akanbi, L.; Ajayi, A.; Delgado, J.M.D.; Bilal, M.; Akinade, O.O.; Ahmed, A. Artificial intelligence in the construction industry: A review of present status, opportunities, and future challenges. *J. Build. Eng.* 2021, *44*, 103299.
- Adekunle, S.A. *et al.* (2021) 'Key constraints to optimal BIM penetration among Nigerian Quantity surveyors', in *Construction Management 50th Anniversary Conference*. No publisher name. Available at: <https://research.manchester.ac.uk/en/publications/key-constraints-to-optimal-bim-penetration-among-nigerian-quantit> (Accessed: 3 April 2024).
- Adeniran, A. A., and Shakantu, W. (2022, June). Digitalization of the South African Construction Industry: A Potential for Further Future Research. In *Construction in 5D: Deconstruction, Digitalization, Disruption, Disaster, Development: Proceedings of the 15th Built Environment Conference* (pp. 17-27). Cham: Springer International Publishing.
- Allen, B., and Reser, D. (1990). Content analysis in library and information science research. *Library and information science research*, *12*(3), 251-62.

- Aliu, J. and Oke, A.E. (2023), "Construction in the digital age: exploring the benefits of digital technologies", *Built Environment Project and Asset Management*, Vol. 13 No. 3, pp. 412-429. <https://doi.org/10.1108/BEPAM-11-2022-0186>.
- Alaloul, W. S., Liew, M. S., Zawawi, N. A. W. A., and Kennedy, I. B. (2020). Industrial Revolution 4.0 in the construction industry: Challenges and opportunities for stakeholders. *Ain Shams Engineering Journal*, 11(1), 225–23
- Anne R.(2020) Top 5 Barriers to Procurement Digitalization and How to Overcome them. (5) Top 5 Barriers to Procurement Digitalization and How to Overcome Them | LinkedIn
- Aziz, A and Ofori, G. (1996). Developing World Beating Contractors through Procurement Policies: The Case of Malaysia. CIB W92 proceedings.
- Bademosi, F., & Issa, R. R. A. (2021). Factors influencing adoption and integration of construction robotics and automation technology in the US. *Journal of Construction Engineering and Management*, 147(8), 04021075.
- Baglou, M., Ghoddousi, P. and Saeedi, M. (2017) ‘Evaluation of Building Materials Based on Sustainable Development Indicators’, *Journal of Sustainable Development*, 10(4), p. 143. Available at: <https://doi.org/10.5539/jsd.v10n4p143>.
- Barbini, A., Malacarne, G., Romagnoli, K., Massari, G. A., and Matt, D. T. (2020). Integration of life cycle data in a BIM object library to support green and digital public procurements. *International Journal of Sustainable Development and Planning*, 15(7), 983–990. <https://doi.org/10.18280/IJSDP.150702>
- Castagnino, Santiago, Christoph Rothballer, and Philipp Gerbert. (2016). “What’s the Future of the Construction Industry? | World Economic Forum.” Retrieved June 5, 2019 (<https://www.weforum.org/agenda/2016/04/building-in-the-fourth-industrial-revolution>
- Charvat, W. C., (2000), Construction Procurement: Excerpt from The Architect’s Handbook of Professional Practice, 13th Ed
- constructingexcellence.org.uk, (2015) Published by Constructing Excellence. Procurement 15/03/04
- Edirisinghe, R. (2019). Digital skin of the construction site: Smart sensor technologies towards the future smart construction site. *Engineering, Construction and Architectural Management*, 26(2), 184–223. <https://doi.org/10.1108/ECAM-04-2017-0066>.
- Ershadi, Marcus Jefferies, Peter Davis, Mohammad Mojtahedi (2021) Achieving Sustainable Procurement in Construction Projects. The Pivotal Role of a Project Management Office . Available from: https://www.researchgate.net/publication/350055567_Achieving_Sustainable_Procurement_in_Construction_Projects_The_Pivotal_Role_of_a_Project_Management_Office#fullTextFileContent [accessed Jun 17 2024].
- Graulich,N., Lewis,S.E., Kahveci ,A., Nyachwaya,J.M., Lawrie,G.A.(2021). Writing a review article: what to do with my literature review. Royal Society of Chemistry. <https://pubs.rsc.org/en/content/articlehtml/2021/rp/d1rp90006d>
- Gounden SM. (2000). The Impact of the National Department of Public Works’ Affirmative Procurement Policy on the Participation and Growth of Affirmable Business Enterprises in the South African Construction Sector. Unpublished Phd Thesis, University of Natal.
- Goyal, P., Sahoo, A. K., and Sharma, T. K. (2019). Internet of things: Architecture and enabling technologies. *Materials Today: Proceedings*, 34(3), 719–735. <https://doi.org/10.1016/j.matpr.2020.04.678>.
- Habibi, M., Kermanshachi, S. and Rouhanizadeh, B. (2019) ‘Identifying and Measuring Engineering, Procurement, and Construction (EPC) Key Performance Indicators and Management Strategies’, *Infrastructures*, 4(2), p. 14. Available at: <https://doi.org/10.3390/infrastructures4020014>.

- Hallikas, J., Immonen, M. and Brax, S. (2021) ‘Digitalizing procurement: the impact of data analytics on supply chain performance’, *Supply Chain Management: An International Journal*, 26(5), pp. 629–646. Available at: <https://doi.org/10.1108/SCM-05-2020-0201>.
- Ibem, E.O. and Laryea, S. (2015). EProcurement use in the South African construction Industry. *Journal of Information Technology in Construction (ITCon)* 20:364- 384
- Ifije, O. and Aigbavboa, C. (2020) ‘Identifying Barriers of Sustainable Construction: A Nigerian Case Study’, *MATEC Web of Conferences*, 312, p. 04004. Available at: <https://doi.org/10.1051/mateconf/202031204004>.
- Igros, C. J. E., Mariñas, K. A. A., Young, M. N., Tri, Y., Jou, Y. T., & Nadlifatin, R. (2022) Implementing Digital Procurement in Construction Industry.
- King, W. R. and He, J. (2005). Understanding the role and methods of meta-analysis in IS research. *Communications of the Association for Information Systems*, 16 (1), 665–686.
- Lok, K.L. *et al.* (2023) ‘Sustainable digitalisation and implementation of ISO standards for facilities management’, *Facilities*, 41(5/6), pp. 434–453. Available at: <https://doi.org/10.1108/F-03-2022-0038>.
- Maepa, D.N., Mpwanya, M.F. and Phume, T.B. (no date) ‘Readiness factors affecting e-procurement in South African government departments’, *Journal of Transport and Supply Chain Management*, 17(1), p. 874. Available at: <https://doi.org/10.4102/jtscm.v17i0.874>.
- Malik, H. and Sharma, P. (2022) ‘Inventory Management in Construction Industry’, *IOSR Journal of Engineering*, 12, pp. 2278–8719.
- Masiyiwa, ST. (1994). The African Experience, Zimbabwe. Proceedings BEAM Conference, Durban. Implementing the RDP and Affirmative Action in the Construction Industry
- Motaung, J.R. and Sifolo, P.P.S. (2023) ‘Benefits and Barriers of Digital Procurement: Lessons from an Airport Company’, *Sustainability*, 15(5), p. 4610. Available at: <https://doi.org/10.3390/su15054610>.
- Nnaji, C., & Karakhan, A. A. (2020). Technologies for safety and health management in construction: Current use, implementation benefits and limitations, and adoption barriers. *Journal of Building Engineering*, 29, 101212.
- Odhigu, F.O. *et al.* (2012) ‘Investigation into the impacts of procurement systems on the performance of construction projects in East Malaysia’, *International Journal of Productivity and Quality Management*, 9(1), pp. 103–135. Available at: <https://doi.org/10.1504/IJPQM.2012.044014>.
- Oke, A.E. and Arowoia, V.A. (2022), “Critical barriers to augmented reality technology adoption in developing countries: a case study of Nigeria”, *Journal of Engineering, Design, and Technology*, Vol. 20 No. 5, pp. 1320-1333, doi: 10.1108/JEDT-12-2020-0519.
- Osunsanmi, TO, AE Oke, and CO Aigbavboa. 2018. “Fusing RFID with Mobile Technology for Enhanced Safety of Construction Project Team Members.” in *Proceedings of the International Conference on Industrial Engineering and Operations Management*.
- Otasowie, K., Aigbavboa, C., Oke, A., Adekunle, P., and Zanele, B. (2023, October). Blockchain Technology Adoption in Construction Projects Logistics in South Africa: Militating Factors. In *Proceedings of the Future Technologies Conference* (pp. 341-354). Cham: Springer Nature Switzerland.
- Pagani, M. and Pardo, C. (2017)The impact of digital technology on relationships in a business network. *Ind. Mark. Manag.* 2017, 67,185–192.
- Paré, G. , Trudel, M. C. , Jaana, M. , and Kitsiou, S. (2015). Synthesizing information systems knowledge: A typology of literature reviews. *Information & Management*, 52 (2), 183–199.10.1016/j.im.2014.08.008

- Pradhananga, P., ElZomor, M., and Santi Kasabdj, G. (2021). Identifying the challenges to adopting robotics in the US construction industry. *Journal of Construction Engineering and Management*, 147(5), 05021003.
- Prebanić Kristijan Robers and Vukomanović Mladen, (2021). "Realizing the Need for Digital Transformation of Stakeholder Management: A Systematic Review in the Construction Industry," *Sustainability*, MDPI, vol. 13(22), pages 1-27, November.
- Rooke, J. *et al.* (2023) 'Researching decision support: what do we need to know?'
- Schnell, P.; Haag, P.; Jünger, H.C. (2023) Implementation of Digital Technologies in Construction Companies: Establishing a Holistic Process which Addresses Current Barriers. *Businesses* 2023, 3, 1–18. <https://doi.org/10.3390/businesses 3010001>
- Singh AK, Kumar VP, Dehdasht G, Mohandes SR, Manu P, Rahimian FP. (2023) Investigating the barriers to the adoption of blockchain technology in sustainable construction projects. *J Clean Prod* 2023;136840. <https://doi.org/10.1016/j.jclepro.2023.136840>
- Wang Xuetong, Liu Lingyi, Liu Jingkuang and Huan Xiaojun (2022), Understanding the determinants of Blockchain Technology Adoption in the Construction Industry. *Buildings* 2022, 12, 1709 <https://doi.org/10.3390/buildings12101709>
- Windapo, A.O. (2021) 'The construction industry transformation and the digital divide: Bridging the gap', *South African Journal of Science*, 117(7–8), pp. 1–4. Available at: <https://doi.org/10.17159/sajs.2021/10990>.
- Watermeyer R.B and Band NG. (1994) The Development of Small Scale Enterprises, Skills, Entrepreneurship and Employment Opportunities through the provision of Housing. National Housing Forum. Nov.
- Zhang, N. *et al.* (2023) 'Digital Transformation in the Chinese Construction Industry: Status, Barriers, and Impact', *Buildings*, 13(4), p. 1092. Available at: <https://doi.org/10.3390/buildings13041092>.



UNIVERSITY OF THE
WITWATERSRAND,
JOHANNESBURG

100¹⁹²²₂₀₂₂