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Benefits and challenges of productivity management systems within the masonry brick production small and medium scale enterprises in Gauteng: A theoretical review of literature

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Abstract

The brick production small and medium scale enterprises SMEs contribute significantly towards the socio and economic development of the Republic of South Africa (RSA). The brick production industry assists in the development of construction and is a source of income for SMEs, as well as creating employment opportunities for the uneducated, unskilled, and semi-skilled human capital. However, there are productivity improvement challenges that negate productivity growth. The methodology proposed for the study is based on reviewing literature whereby the main question is "How do productivity improvement systems influence productivity growth of the brick production SMEs?" The study explores productivity improvement systems that can be utilised to grow and sustain the productivity of brick production SMEs.

Keywords

Productivity, Human Resource Management, Material Resource Planning, Total Quality Management.

1. Introduction

Globally, the brick production industry is perceived as the most unsafe and harmful working environment that migrant workers from surrounding rural areas are drawn to the seasonal work (Maity, Pal amd Dhara 2015; Chakraborty et al.

2017). Chakraborty et al. (2017) further elaborate that the brick production industry is labelled hazardous due to heavy handling of power tools, machinery, exposure to toxic gasses and ergonomic dangers.

The study examines the productivity management systems within the brick production small and medium scale enterprises SMEs in Gauteng. The brick production SMEs are central to global and national economic development (Matsiketa 2018; Mafundu and Mafini 2019; Windapo, Omopariola, Olugboyega and Moghayedi 2021). These SMEs that produce bricks play a vital role in growing the gross domestic product GDP and creating employment opportunities (Clay Brick Association of Southern Africa, 2017. Thus, improving the livelihood of community members (The Construction Industry Development Board 2021).

The economy of South Africa is a mixed economy, emerging market and upper-middle-income economy. South Africa's economy is third highest on the African continent after Nigeria and Egypt who are ranked first and second respectively (Statistics SA, 2017). Galal (2023) Nigeria's GDP amounted to nearly 477.4 billion U.S. dollars in 2022, the highest in Africa. Egypt is ranked second with 475.23 billion U.S. dollars. South Africa's GDP was worth 405.7 billion U.S. dollars and ranked third-highest on the continent.

The South African construction sector contributed approximately 83 billion rand (roughly 5.4 billion U.S. dollars) to the country's GDP in 2020 after two consecutive quarters of growth, South African real gross domestic product (GDP) contracted by 0,2% in the third quarter (July–September) of 2023 (Galal 2021). On the production (supply) side of the economy, five of the ten industries recorded weaker results, with agriculture, manufacturing and construction the biggest drags on growth. The construction industry weakened further, recording a second consecutive quarter of decline. Decreased activities were reported for residential buildings, non-residential buildings and construction works. (Statistics SA 2023). In addition, the GDP from Construction in South Africa decreased to 108601.69 million rand in the third quarter of 2023 from 111673.68 million rand in the second quarter of 2023 (Trading economics 2023).

1.1 Problem Statement

Stemming from the discussion above, even the construction industry has contributed roughly 83 billion rand towards South Africa's GDP, the country's GDP has been sturdily been on a downward trend. The contribution by the construction industry declined from approximately 111673.68 million rand in the second quarter of 2023 to 108601.69 million rand.

1.2 Research aim, objective and question of the study

This research study aims to identify the association of previous literature studies pertaining to their similarities together with the disparities as well as gaps regarding the productivity management systems within the brick production SMEs that operate within the Gauteng region of South Africa.

1.2.1 Research objective:

To explore some of the opportunities and challenges that limit the implementation of identified productivity management systems within the brick making industry in Gauteng, South Africa.

1.2.2 Research question:

What are the some of the challenges that confront the brick production SMEs and what are the benefits of overcoming these organizational barriers?

1.3 The scope of the study

This research study is not limited to South Africa, but also draws focus on Africa and global brick production SMEs. However, more weight is placed on the brick production SMEs that operate within the Gauteng region of South Africa.

1.4 Significance of the study

One of the most important pillars of a country is its economic growth. Developing countries generally implement policies designed to accelerate or enhance their economic growth (Tenza 2020). The brick making industry plays a significant role in the socio-economic development of poor communities in the rural and urban areas across the South Africa, Africa and globally (Sampea and Pakiding 2015; Matsiketa 2018). The study seeks to highlight some the

challenges that negate productivity improvement and benefits of implementing productivity management systems to achieve long-term market related competitiveness and financial feasibility by the brick production SMEs.

2. Literature Review

In a global context, the European Commission (EC) (2022), with a recommendation from May 2003, a more standardised definition of medium-scale enterprise SME is an establishment that employs fewer than 250 employees and whose annual turnover or annual balance sheet total does not exceed 50 million euros. Small-scale enterprise SME employ less than 50 workers with a projected profit that does not exceed 10 million euros. Micro-scale enterprise SME have less than 10 personnel with an estimated profit that does not go above 2 million euros as cross tabulated in **table 1. below**.

Table 1. Quantitative interpretation of small and medium scale enterprises SMEs by European Commission

Company category	**Employee headcount**	**Turnover Less than**
Medium	Less than 250	Approximately 50 million euros
Small	Less than 50	Approximately 10 million euros
Micro	Less than 10	Approximately 2 million euros

Source: European Commission (2022:14)

The National Small Enterprise Act, 1996 (Act No. 102 of 1996) explain the small and medium scale enterprises SMEs as a category that involve a separate and distinct business entity and any of its subsidiaries or branches, as well as cooperative enterprises managed by one owner or carried on in any sector or subsector of the national economy.

Table 2. Interpretation of SMEs within the brick construction industry in South Africa

Construction size/class of enterprise	**Total full time equivalent of paid employees**	**Turnover Less than**
Micro	0-10	Approximately R10.00 million
Small	11-50	Approximately R75.00 million
Medium	51-250	Approximately R170.00 million

Source: National Small Enterprise Act (2019:2)

According to the National Small Enterprise Act, 1996 (Act No. 102 of 1996) (2019) micro enterprises employ roughly 0 to 10, small enterprises employ 11 to 50 and medium enterprises employ at least 51 to 250 employees with profit margins of roughly R10 million, R75 million and R170 million respectively (see **table 2** above). This is how small, micro and medium scale enterprises (SMMES) are defined in South Africa. From a global perspective, 63 percent of personnel are employed by SMEs (Pula 2015).

2.2 The concept of Productivity

Practitioners and scholars often use productivity and performance interchangeably. However, the distinction between both concepts differ in their respective right. Performance focusses on how efficient an employee executes a prescribed task that relates to their work description (Rusinovci 2015:104). Greasley (2010:511) communicates the concept of productivity is a result of increasing levels of output without a proportionate increase in human capital and physical resources, or a reduction in human capital and physical resources without a proportionate reduction in levels of output. Productivity in the brick production SMEs is defined as the resources involving clay/sand, water and cement divided by the bricks generated (Islam, Nazifa, Yuniarto, Uddin, Salmiati and Shahid 2019). The resources used within the construction environment divided by the generated product is regarded as productivity (Ebikeseye and Puyate 2022; Del Rio and Sovacool 2023). As stated by (Moswane, Aigbavboa and Mewomo 2018; Zhan and Pan 2020), productivity is an operational concept that is measured as “the ratio of output to input”.

2.3 The Brick Production Process in the Brick Production SMEs

Masonry block making is one of many small and medium scale artisanal industries that have been around for a long time (Saediman, Noraduola and Nafiu, 2014). Sampe and Pakiding (2015) brick creation contributes to the development and growth of the building and construction industry. In the construction of various civil engineering structures, brick is one of the most sought-after materials (Murmu and Patel 2019). Shakir and Muhammed (2018) a brick is one of the most common building materials used to construct houses. A brick is a versatile and ubiquitous material that can be used to construct buildings, walls, and decorative installations. In addition to being strong and heat-conserving, bricks are also resistant to fire and corrosion.

The brick production process has not changed since its inception dating as back as 7000 BC when these manufactured bricks were used in the construction of building structures such as the Taj Mahal in India, the Chrysler Building in New York etc., (Fiala, Mikolas and Krejsova 2019; Sayyed et al. 2021). According to Sholanke (2015) brick are masonry block units made of cement, sand, and water. In construction of shelters and other infrastructure, they are mainly utilised as walling materials. The brick production process (see **figure 1** below) begins by excavation and processing of clay sand, brick formation, drying, burning/firing and cooling (Aneke & Shabangu 2021; Ridwan et al. 2021; Suhariyanto et al. 2022).

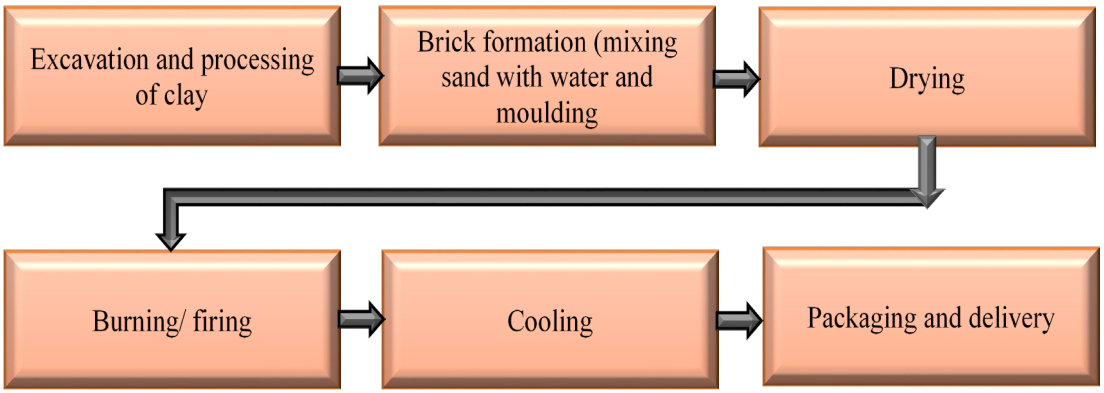

Figure 1. The brick production process for small and medium scale enterprises SMEs

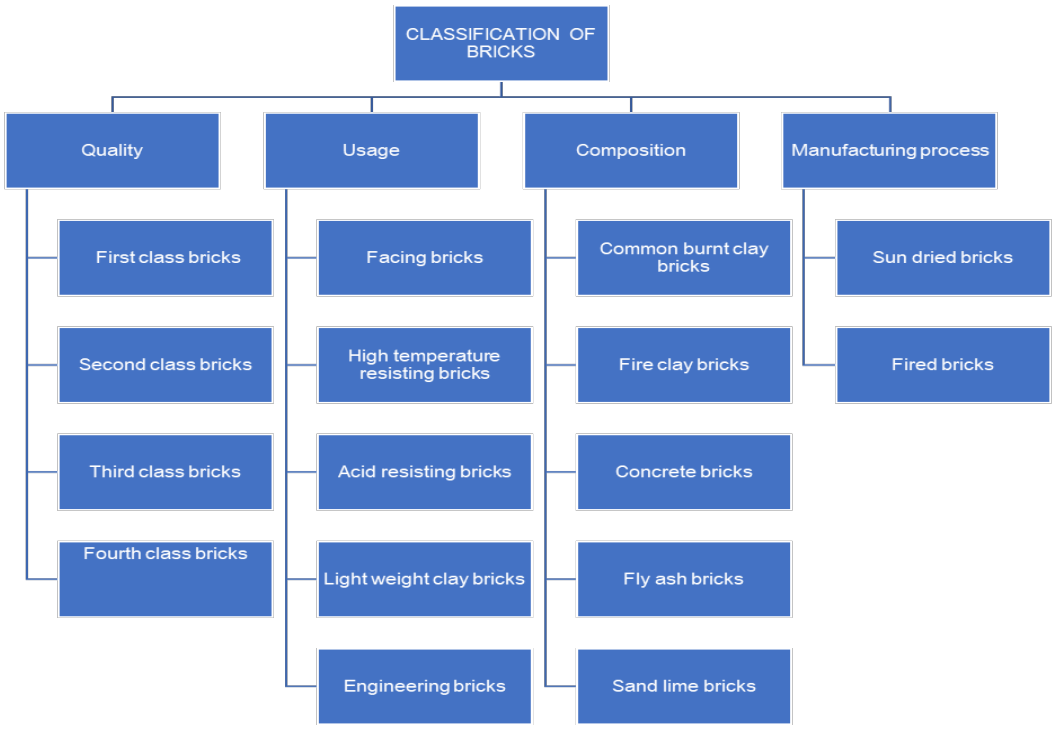

Figure 2. Illustrate the classification of bricks by the small and medium scale enterprises SMEs

The standard brick size that is used in South Africa is 222mm long x 106mm wide x 73mm with a mass of between 3kg and 3.5kg (Nithiya et al. 2016). Aniyikaiye et al. (2021) in South Africa, the type of combustion Kilns used is clamp and scove, the type of fuel used for firing/baking bricks is fly ash or coal, wood and farm waste (macadamia husks), the fired brick dimension is 220mm long × 150mm wide × 75mm high. The bricks in South Africa are mostly produced in this format. Arevalo-Barrera et al. (2019) how relatively strong (compressive strength) a masonry brick manufacturing is, depends upon SMEs considering the following challenges: namely:

- water and cement should weigh the same during the mixing process;
- bricks should be aged appropriately;
- proper material usage and brick density should be maintained; and
- it should be ensured that the density of the cement and water is as dense as possible during the mixing process.

The use of coal and wood for firing/baking masonry bricks during the production process by SMEs is a major contributor to global warming as it emits carbon emissions into the atmosphere (Bajracharya et al. 2022). The main problem detected within the brick SME is the high level of waste in its production process, which directly affects productivity and efficiency.

2.3 Background of Productivity Management Functions

The brick production SMEs use productivity management systems to transform their operational process in order to transform inputs into value-added outputs. Thus, attaining long-term market related competitiveness and financial feasibility (Gavrila and Lucas Ancillo 2021). Productivity management functions involve adopting organizational systems, integrating them with new technologies and personnel to completely overhaul and improve the brick production SMEs operational process (Kyakulumbye and Pather 2022).

The following productivity management functions are presented according to numerous literature review studied. These various productivity management functions involve human resource development (HRD), material resource planning (MRP) and total quality management (TQM).

2.4 Definition of productivity management functions - Human resource development (HRD), material resource planning (MRP) and total quality management (TQM)

Human resource development comprises of managing labour and designing jobs so that employees are used efficiently and effectively for organizational success (Heizer, Render and Munson 2017). Human resource development focusses on developing innate abilities such skills, knowledge, experiences etc., employed to drive workforce productivity aligned with organizational strategies (Kucharˇcíková, Miˇciak, and Hitka 2018).

People articulate the concept of quality in multiple ways. For some people, the distinction is based on high quality, meaning better product, performance, and enhanced features (De Feo 2015, Sinaga 2017). Depending on their role within the production-marketing value chain, some people view quality subjectively and according to different criteria (Evans & Lindsay 2017). Heizer et al. (2017), a total quality management program emphasizes quality throughout the entire organization, including suppliers and customers. Sunaryo et al. (2019) described quality product and service as a total quality management (TQM) system that SMEs use to identify and satisfy customer needs through provision of excellent quality of clay bricks and in store customer service. The concept of total quality management (TQM) suggests that the entire personnel involving management and employees' continuously strive to work towards enhancing their operations (Kumar and Raut 2021).

Material resource planning (MRP) is a function designed for brick production processes that are difficult to plan and to assist the brick production SMEs achieve the target market strategy and financial feasibility through integration of forecasting, basic production planning, procurement and shop control (Juraev et al. 2020). Material requirement planning (MRP) as a dependent demand – meaning the demand for one item is related to the demand for another item, is a system that is used to manage logistics through production planning and inventory management (Najy 2020). Siregar (2022) described the system of material requirement planning (MRP) is a scheduling and inventory method of controlling the availability of raw material used to produce the bricks and masonry blocks by SMEs to ensure that finished products are manufactured successfully and importantly on time scheduled.

2.5 Productivity improvement systems challenges - Human resource development (HRD), material resource planning (MRP) and total quality management (TQM)

2.5.1 Human resource development (HRD) challenges in the Brick Production SMEs

The brick SMEs are operated by owners and managers who are capable but lack the necessary experience to grow and sustain their productivity (Evans and Lindsay 2017). According to literature explored, The brick production SMEs do not have the necessary funding to continuously educate and train their employees to improve their productivity. The development of brick artisan's using education (knowledge) and training (skill development) to grow productivity of the brick production SMEs is negated by a lack of investment or funding from the government and shortage of skill (Kolodziejek & Tey 2016; Singh et al. 2019; Aka et al. 2020; Pham et al. 2020).

2.5.2 Material Resource Planning (MRP) challenges in the Brick Production SMEs

Shortage of raw material results in work stoppage, production processes being halt, and not meeting customer demands. Conversely, too much inventory of material will result in an increase in costs. Dependent demand techniques such as material requirement planning (MRP) system that is applicable in all spheres of production (Najy 2020). The belief of Mezgebe et al. (2023) regarding the existing industrial challenges in the construction industries is that there is lack of information dissemination involving artificial intelligence (AI) applications involving human automation interaction whereby in the industries of such nature are faced with bottlenecks due to poor material resource planning (MRP).

2.5.3 Total Quality Management (TQM) challenges in the Brick Production SMEs

Literature review mentions that lack of knowledgeable personnel, low mindset, lack of effective communication, extra cost and time consuming and lack of top management support as challenges that influence implementation of total quality management (TQM) by the brick production SMEs (Tey and Ooi 2014; Kolodziejek and Tey 2016;). A lack of top soil (clay) contributes to poor brick quality for SMEs because of land degradation (Das 2015:288). Evans & Lindsay (2017) state that, other challenges that influence TQM include digging tools that are eroded/ damaged, over time, changes in the settings of machines and power due to vibrations and physical inspection by humans and measuring instruments used by brick production SMEs may not be uniform.

2.6 Application of Productivity Systems - Ergonomics, Human Resource Management and Business Process Re-Engineering

2.6.1 Human Resource Management (HRM) on the Productivity Improvement

Adu et al. (2019:31) state that brick production SMEs must possess the necessary skills to successfully manufacture their products. Adu et al. (2019:31) further add that education is part of a social infrastructure that involves accumulation of knowledge and development of skill over a given period through various educational systems that are designed to increase the likelihood of population employability. Human resource management (HRM) needs to ensure that employees are properly trained and that the quality of training is maintained (Heo, Han, Shin & Na 2021).

2.6.2 Material Resource Planning (MRP) on the Productivity Improvement

Sadeghi, Makui and Heydari (2014) to determine how soon a planned order can be released, two parameters are used for material requirement planning (MRP) – Lot size and planned lead-time (PLT). Lot size refers to the number of products or commodities ordered for delivery while planned lead-time looks at the estimated completion dates for the production order and release date for the scheduled order (Heizer et al. 2017). An effective use of material requirement planning (MRP) system enables businesses to gain market related competitiveness and efficiency. Thus, improving customer satisfaction (Hasanati et al. 2018). A successfully implementation of material requirement plaining (MRP) also leads to an efficient planning of production processes and cutting production time (Najy 2020).

2.6.3 Business Process Reengineering (BPR) on the Productivity Improvement

The brick production SMEs all over world are constantly striving to attain market related excellence that gives them a superior edge over their competitors (Singh et al. 2022). A radical redesign of brick production processes by SMEs can lead to an achievement in higher levels of productivity (Pakhomova, Dubrakova and Aseev 2021).

3. Research Methodology

It important was important that the study explored various literature, past and present in order to comprehend some of the benefits and challenges that confront brick production SMEs. This aided the study to answer the main research question. "*What are the some of the challenges that confront the brick production SMEs and what are the benefits of overcoming these organizational barriers*?". Thus, a qualitative theoretical approach (which is subjective) was implemented through the review of literature involving articles, journal publications, books and government documents that related to the research topic "*benefits and challenges of productivity management systems within the masonry brick production small and medium scale enterprises in Gauteng: A theoretical review of literature*". The study used accredited research platforms such as Google scholar, Elsevier, MDPI, Emerald publications etc. to broaden the scope.

5. Results and Discussion

The explored literature demonstrated how instrumental identified productivity improvement systems (human resource management, material resource planning (MRP) and business process re-engineering) are in driving productivity within the masonry brick construction SMEs. In accordance to the review of applied literature, productivity improvement systems are lean manufacturing mechanisms that coherently contribute significantly towards the productivity growth and efficacy of the brick production SMEs.

Author(s)	Title	Findings
Singh et al. 2019	*Factors affecting the labour productivity of brickwork and analyzing them using RII method*	As indicated in their findings, brick companies that train their employees regularly and are well experienced, affects their productivity positivilty.
Valdes et al. 2020	*Artisan Brick Kilns: State-of-the-Art and Future Trends*	Brick production enterprises should incorporate automatic control of process variables and computer simulations of phenomenological processes. Thus, allowing more thermally efficient design of kilns, which will emit less hazardous greenhouse gases and atmospheric pollutants.
Mohiuddin, Al-Aminb, 2022	*Green Management in SMEs of Bangladesh: Present Scenario, Implementation Obstacles and Policy Options*	In their study, found that preservation of raw-material involving clay/sand excavated from the earth's surface, protecting employee from injuries as a result operational or product process and looking after the users of the end-product are key productivity contributors. Thus resulting in brick companies attaining market and economic gain.
Adu, Oladele and Lashinde, 2019	*The Masonry Block Industry in Akwa Ibom State: Challenges and Prospects of Entrepreneurial Development*	The results reveal that amongst other factors including readily available material onsite, employment opportunities, government funding and enabling business environment results in improved productivity of the brick companies.
KARMAOUI et al. 2022	*IoT-Based Architecture to Improve Workflow in Bricks Manufacturing*	The integration of internet-of-things (IoT) with operational brick process to improve workflow thus mitigating brick production stoppages.

However, literature read also highlighted key challenges involving lack of funding, shortage of material resources, poor quality of material involving clay/sand and less or too much inventory that negate productivity growth of brick production SMEs. Thus, undermining the significant impact that these productivity improvement systems have on achieving productivity. Contrary to these latent challenges, brick production companies SMEs can use productivity management systems including human resource management, material resource planning and business process re-engineering to overcome the said above barriers to attain long-term productivity growth and economic feasibility.

6. Future Research

The study explored research constructs using a qualitative methodology through reviewing accredited journals, articles, government documents etc. Thus, empirical findings could not be drawn. Furthermore, this research work is part of an ongoing Doctor of Philosophy (PhD) study. The research study does not account for all productivity improvement systems that seem to undermine the significant impact that management systems have on productivity growth. In addition, the study only employed a qualitative review of the literature. This limited the study's generalizability to other brick construction SMEs in South Africa, Africa and globally. Thus, opening up other future research prospects. Research in the future should focus on quantitatively or using a mixed-method (a combination of both qualitative and quantitative research) to assess the impact of productivity improvement systems on productivity growth of the brick production SMEs.

6. References

Adu, E.T., Oladele, M.A.O. and Lashinde, A.T., The Masonry Block Industry in Akwa Ibom State: Challenges and Prospects of Entrepreneurial Development, 2019.

Almssad, A., Almusaed, A. and Homod, R.Z., Masonry in the Context of Sustainable Buildings: A Review of the Brick Role in Architecture. *Sustainability*, vol. 14, no. 22, pp.1-28, 2022.

Aniyikaiye, T.E., Edokpayi, J.N., Odiyo, J.O. and Piketh, S.J., Traditional Brick Making, Environmental and Socio-Economic Impacts: A Case Study of Vhembe District, South Africa. *Sustainability*, vol. 13, no. 19, pp.1-24, 2021.

Banstola, S., Acharya, S.R. and Shin, Y.C., Health problems among child labour in the brick industries of Nepal. *Austin J Public Health Epidemiology*, vol. 6, no. 1, pp.1-7, 2019.

Berisha, G. and Pula, J.S., Defining Small and Medium Enterprises: a critical review. *Academic Journal of Business, Administration, Law and Social Sciences*, vol. 1, no. 1, pp.17-28, 2015.

Calzavara, M., Battini, D., Bogataj, D., Sgarbossa, F. and Zennaro, I., Ageing workforce management in manufacturing systems: state of the art and future research agenda. *International Journal of Production Research*, 58(3), pp.729-747, 2020.

Chakraborty, T., Das, S.K., Pathak, V. and Mukhopadhyay, S., Occupational stress, musculoskeletal disorders and other factors affecting the quality of life in Indian construction workers. *International Journal of Construction Management*, vol. 18, no. 2, pp.144-150, 2018.

European Commission (2022). Entrepreneurship and small and medium-sized enterprises (SMEs). Available from: https://www.eusmecentre.org.cn/wp-content/uploads/2022/12/SME-Definition.pdf.

Evans, J.R., and Lindsay, W.M., Managing for Quality and Performance. Tenth Ed: United States of America: Cengage Learning, 2017.

Fiala, J., Mikolas, M. and Krejsova, K., Full brick, history and future. *In IOP conference series: earth and environmental science*, vol. 221, no. 1, pp.1-6. IOP Publishing, 2019.

Galal, S., Value added to gross domestic product (GDP) by the construction industry in South Africa from 2014 to 2020. Available: https://www.statista.com/statistics/1121217/construction-sector-value-added-to-gdp-in-south-africa/, 2017.

Gavrila, S.G. and de Lucas Ancillo, A., Spanish SMEs' digitalization enablers: E-Receipt applications to the offline retail market. *Technological Forecasting and Social Change*, no. 162, pp.1-13, 2021.

Hashem, G., Organizational enablers of business process reengineering implementation: An empirical study on the service sector. *International Journal of Productivity and Performance Management*, vol. 69, no. 2, pp.321-343, 2020.

Heizer, J.H. and Render, B., Principles of operations management. Tenth Edition. New York: Pearson Educación, 2017.

Heo, S., Han, S., Shin, Y. and Na, S., Challenges of Data Refining Process during the Artificial Intelligence Development Projects in the Architecture, Engineering and Construction Industry. *Applied Sciences*, vol. 11, no. 22, pp.1-14, 2021.

Islam, R., Nazifa, T.H., Yuniarto, A., Uddin, A.S., Salmiati, S. and Shahid, S., An empirical study of construction and demolition waste generation and implication of recycling. *Waste Management*, vol. 95, pp.10-21, 2019.

Khouja, A., Lehoux, N. and Cimon, Y., A fuzzy-based competitiveness assessment tool for construction SMEs. Benchmarking: *An International Journal*, vol. 30, no. 3, pp.868-898, 2022.

Kolodziejek, N. and Tey, L.S., Characteristics and Challenges of Brick Making Industry in Central Aceh, Silih Nara, Indonesia. *Journal of Advanced Research Design*, vol. 18, no. 1, pp.20-34, 2016.

Kyakulumbye, S. and Pather, S., Understanding ICT adoption amongst SMEs in Uganda: Towards a participatory design model to enhance technology diffusion. *African Journal of Science, Technology, Innovation and Development*, vol. 14, no. 1, pp.49-60, 2022.

Lawaju, N., Parajuli, N. and Shrestha, S.K., Analysis of Labor Productivity of Brick Masonry Work in Building Construction in Kathmandu Valley. *Journal of Advanced College of Engineering and Management*, vol. 6, pp.159-175, 2021.

Mafundu, R.H. and Mafini, C., Internal constraints to business performance in black-owned small to medium enterprises in the construction industry. *The Southern African Journal of Entrepreneurship and Small Business Management*, vol. 11, no. 1, pp.1-10, 2019.

Matsiketa, K.E., Development of product quality management guidelines for informal small-scale brick manufacturing enterprises in Dididi, Limpopo Province, South Africa (Doctoral dissertation), 2018.

Moswane, D., Aigbavboa, C. and Mewomo, M., An Investigation into the Labour Productivity Trends in the North-West Province of South Africa. *In Proceedings of the World Congress on Engineering*, vol. 2, pp. 4-6, 2018.

Murmu, A.L. and Patel, A., Towards sustainable bricks production: An overview. Construction and building materials, vol. 165, pp.112-125, 2018.

Pakhomova, E.G., Dubrakova, K.O. and Aseev, V.Y., The influence of the coefficient of variation on the process reliability of brick production. Journal of Applied Engineering Science, vol. 19, no. 2, pp.533-536, 2021.

Pengoriya, V., Comparative Evaluation of Energy Efficiency of Brick Kilns and Energy Study of Natural Gas Based Brick Kiln for Small Scale Production in India. Available: https://shodhgangotri.inflibnet.ac.in/bitstream/123456789/4575/1/synopsis.pdf, 2016.

Rauch, E., Linder, C. and Dallasega, P., Anthropocentric perspective of production before and within Industry 4.0. *Computers and Industrial Engineering*, vol. 139, pp.1-15, 2020.

Sayyed, N., Singh, S., Lakha, N., Bageshwar, S., Mandlik, A., Kohare, N. and Nirmohi, U., Manufacturing of Sand Bricks using Mahurzari Village Lake Sand. *International Journal Of Multidisciplinary Research In Science, Engineering and Technology* (IJMRSET), vol. 4, no. 4, pp. 523-526, 2021.

SEDA., The Small, Medium and Micro Enterprise Sector of South Africa. Bureau for Economic Research. Available: http://www.seda.org.za, 2012.

SEDA., SMME quarterly update 1st quarter 2020. Available: http://www.seda.org.za/Publications/Publications/SMME%20Quarterly%202020%20Q1.pdf, 2020.

SEDA., SMME quarterly update 1st quarter 2021. Available: http://www.seda.org.za/Publications/Publications/SMME%20Quarterly%202021%20Q1%20September.pdf**,** 2021.

Shahul Hameed, N.S., Salamzadeh, Y., Abdul Rahim, N.F. and Salamzadeh, A., The impact of business process reengineering on organizational performance during the coronavirus pandemic: moderating role of strategic thinking, vol. 24, no. 5, pp.637-655, 2022.

Singh, A., Kumar, V., Verma, P. and Kandasamy, J., Identification and severity assessment of challenges in the adoption of industry 4.0 in Indian construction industry. Asia Pacific Management Review, 2022.

Statistics SA., A tale of three economies in Africa. Statistical Release, February 2017. Reports. Available: https://www.statssa.gov.za/?p=9583, 2017.

Statistics SA., GDP weakens in the third quarter . Statistical Release, December 2023. Reports. Available https://www.statssa.gov.za/?p=16870, 2023.

Statista., African countries with the highest Gross Domestic Product (GDP) in 2022. Statistical Release, April 2023. Reports. Available: https://www.statista.com/statistics/1120999/gdp-of-african-countries-by-country/2023, 2022

Tey, L.S. and Ooi, T.L., Exploring the barriers and the level of TQM implementation in Malaysian construction industry. Research Journal of Applied Sciences, Engineering and Technology, 7(16), pp.3419-3424, 2014.

The National Small Enterprise Act., Available: https://www.gov.za/documents/national-small-business-act, 1996.

Clay Brick Association of Southern Africa, Available: https://www.claybrick.org/cba-2017-sustainability-report, 2017.

Trading Economics., South Africa GDP Growth Rate Available: https://tradingeconomics.com/south-africa/gdp-growth, 2021.

Trading Economics., South Africa GDP from Construction. Available: https://tradingeconomics.com/south-africa/gdp-from-construction, 2021.

Trading Economic., South Africa GDP from Construction. Available Statistical Release, September 2023. Reports. , 2023.

Windapo, A., Omopariola, E.D., Olugboyega, O. and Moghayedi, A., Use and performance of conventional and sustainable building technologies in low-income housing. Sustainable Cities and Society, vol. 65, pp.102606, 2021.

Biography / Biographies

Lucky Boy Tebogo Makhubedu is a lecturer in the Faculty of Science, Department of Statistics and a doctoral student in the Faculty of Engineering and Build Environment (FEBE) at the University of Johannesburg, South Africa. His research interests are in continuous productivity improvement in the fields of mining, brick construction and manufacturing operations, operational research and the application of productivity improvement systems and value-adding drivers and has published 5 academic papers.

Professor Charles Mbohwa is a Pro-Vice Chancellor Strategic Partnerships and Industrialisation at University of Zimbabwe and an affiliated Professor in the Faculty of Engineering and the Built Environment. He is an established researcher and professor in the field of sustainability engineering and energy. He was the Chairman and Head of Department of Mechanical Engineering at the University of Zimbabwe from 1994 to 1997 and was Vice-Dean of Postgraduate Studies Research and Innovation in the Faculty of Engineering and the Built Environment at the University of Johannesburg from 2014 to 2017. He has published more than 350 papers in peer-reviewed journals and conferences, 10 book chapters and three books. He has a Scopus h-index of 11 and Google Scholar h-index of 14. Upon graduating with his BSc Honours in Mechanical Engineering from the University of Zimbabwe in 1986, he was employed as a mechanical engineer by the National Railways of Zimbabwe. He holds a Masters in Operations Management and Manufacturing Systems from University of Nottingham and completed his doctoral studies at Tokyo Metropolitan Institute of Technology in Japan. He was a Fulbright Scholar visiting the Supply Chain and Logistics Institute at the School of Industrial and Systems Engineering, Georgia Institute of Technology, a Japan Foundation Fellow, is a Fellow of the Zimbabwean Institution of Engineers and is a registered mechanical engineer with the Engineering Council of Zimbabwe. He has been a collaborator in projects of the United Nations Environment Programme. He has also visited many countries on research and training engagements including the United Kingdom, Japan, German, France, the USA, Brazil, Sweden, Ghana, Nigeria, Kenya, Tanzania, Malawi, Mauritius, Austria, the Netherlands, Uganda, Namibia and Australia. He has had several awards including British Council Scholarship, Japanese Foundation Fellowship, Kubota Foundation Fellowship; Fulbright Fellowship.

Dr Nelson Sizwe Madonsela holds a doctoral degree (Ph.D. in Engineering Management) from UJ and obtained his Master of Technology degree in Operations Management from UJ. He received a Bachelor of Technology degree in Quality from the University of South Africa (UNISA) and a National Diploma in Information Technology (Software Development) from Tshwane University of Technology (TUT). His research focuses on Business Artificial Intelligence and operation management, focusing on operational excellence. He also focuses on areas such as quality management systems, digital transformation, and project management. He has presented at local and international conferences and authored book chapters. Dr. Madonsela has helped provide high-level strategic and technical guidance in quality management and advanced project management to upskill the workforce among industries within South Africa. Additionally, he serves as a National Advisor on curriculum development, teaching and learning methods, and best practices in quality and operations management in several South African universities.