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The Impact of Industry 4.0 on Productivity Growth of the Brick Construction Industry in South Africa

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Abstract

The South African brick construction small and medium scale enterprise (SMEs) industry operates on the premise of optimising profitability and realising market-related competitiveness. However, there are numerous challenges affecting the integration of industry 4.0 by the masonry brick construction (SMEs) to improve operational processes negating growth in productivity. The study explores the technological concepts that improve operational processes and how they stimulate the productivity growth of masonry brick construction SMEs. Using a qualitative (inductive/subjective) research approach, this study commenced by listing and identifying relevant research publications. This was followed by a comprehensive literature review of the impact of industry 4.0 on productivity growth within a domain of the brick construction industry in South Africa. Furthermore, this study provides results, conclusions and recommendations emanating from the literature review.

Keywords
Industry 4.0, Productivity, Construction

1. Introduction

According to Sacasas (2017), the term “technology” is commonly used loosely in society and in most cases, as a short and artless way of defining an instrument such a device/gadget – telephone, laptop, etc. Carroll (2017) explain the concept of technology as the science of craftsmanship. Lawaju, Parajuli and Shrestha (2021), the term "productivity" in construction is often used in conjunction with performance factor, productioFn rate and unit person-hour rate. Further literature read report that productivity in SMEs scale brick industries refers to the quantitative relationship between bricks generated and resources used that involves coal, clay or sand, water and pipes to utilize water, energy (coal, wood and electricity) (Islam et al. 2019)

The construction small and medium scale SMEs is the most recognised sector in various countries such as Bangladesh, Ghana, India and South Africa. Republic (Aniyikaiye et al. 2021). The Construction Industry Development Board (CIDB) (2021) stated that the industry plays a significant role in improving the socio-economic development of rural and urban communities. The report further mentioned that the construction industry contributes to the creation of jobs and measure of the South African Gross Domestic Product (GDP).

According to Mafundu and Mafini (2019) the South African GDP, perceived by many to be the strongest on the continent of Africa, the second quarter 2021 revenue was approximately R1.131 billion, increasing by 1.2% in the second quarter of 2021 (April–June). Conversely, a 1.5% decrease in South Africa’s GDP was seen in the three months to September 2021 compared to the previous quarter. Furthermore, the construction SMEs GDP declined by R110

760 million rand in the third quarter of 2021 from R111 306.36 million rand in the second quarter of 2021. According to Statistics SA (2021) the brick construction industry's total value decreased from 3.6% in 2017 to 2.7% in 2021. Based on the total value and GDP reports, it is anticipated that the production value is decreasing, which is a challenge for construction industries within the brick construction environment in South Africa.

Matsiketa (2018); Nepal et al. (2019) even though the masonry brick industry continues to negatively impact the environment due to the amount of carbon emissions that get released during the processes of firing, there are other barriers that negate productivity growth. Literature read reveal that the productivity growth of the brick construction industry in South Africa is low due to SMEs underperforming (Das and Landani 2021; Justino, Tengeh and Twum-Darko 2022). This challenge results to poor GDP (Solgi, Gitinavard and Tavakkoli-Moghaddam 2021). Bajrachary et al. (2022) argued in their study that masonry brick industries do not invest in technology in order to improve their operations. This is due to lack of funding from the government (SADC, 2016:4). Koumas et al. (2021) other constraints involve growing fears that technology leads to job-cuts, it is expensive and the level of education of brick artisans. Lack of adoption of automation/ robotics and lack of financial support from the government (Delgado 2019). Studies by (Valdes et al. 2020; Koumas et al. 2021) have shown that there is a lack of acceptance and adjustment to technology by conventional masonry brick employees', thus it becomes difficult to train brick artisans in alignment to technological requirements.

1.1 Problem statement

Based on the backdrop, Statistics SA report that production output decreased from 3.9% in 2017 to 2.7 in 2021 and that the GDP declining by 0.7% because of low construction productivity. Mafundu and Mafini (2019) mention that, even though GDP 1.2% in the second quarter of 2021, the industry still experienced a decline of 1.5% in the same year. According to projections, which is a worrying factor, the brick production has been on a downward trajectory over the past years, which is reflected in the production value decrease stated above. Furthermore, there is a lack of readiness to industry 4.0 shown by masonry brick SMEs. Arguably, most of these brick construction SMEs were not even ready for industry 3.0 as they lack technological systems such as automation/robotics to improve operational processes.

1.2 The research objective and aim of the study

Preceding the discussion from the problem statement above, the research objective addressed:

"how industry 4.0 affects productivity growth of the masonry brick construction industry in South Africa?"

This study aims to explore the coherence between identified technological concepts that can assist masonry brick SMEs enhance their brick operational process thus attaining market and financial feasibility.

1.3 Research scope

Technology plays a vital role in improving operational process of any organisation. The aim of the study is to examine the effect of technological concepts on productivity growth of the masonry brick construction SMEs in South Africa.

1.4 Importance of the study

This study will bring to light the importance of using technology (industry 4.0) to advance operational processes in order to improve productivity within the brick manufacturing SMEs industry, thus attaining market and financial feasibility. Highlighting key barriers that negate adoption of industry 4.0 by brick artisans and brick construction SMEs. In addition, this study will help demystify the ideology that industry 4.0 leads to technological job losses.

2. Literature Review

2.1 Brick construction process

A process of masonry brick manufacturing (see figure 1 below): starts by extracting sand using digging, sand is then placed on a roller using a metal grid to remove unwanted particles, sand is then mixed with water, moulded to the correct specification, goes through the firing/burning process, drying, packaging and delivery to potential customer (Suryakanta 2014; Pengoriya 2016).

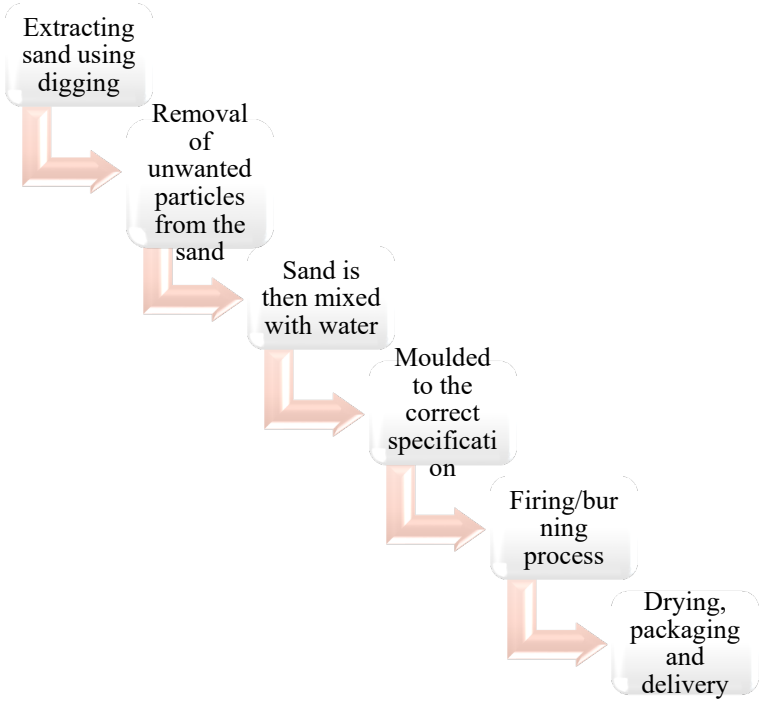

Figure 1. Masonry brick manufacturing process, **Source**: Suryakanta 2014; Pengoriya 2016)

2.2 Brief historical view of technology in South Africa

It was not until 1994 that the chains of an apartheid regime were finally broken. Mandela, at the time, president of the African National Congress (ANC), considered to be the most popular political party among black people (Makhubedu et al. 2017:2), became the first black president of the Republic of South Africa. These changes in supremacy were a manifestation of changing political power that was overwhelmingly pro-white (Marais and Pienaar 2010). It was not until 1971 that the South African Broadcasting Commission (SABC) offered television services. Due to the rapid advancement of technology, it was alarming that television did not make its debut to the South African public until more than 40 years after its invention as noted in an article by the history of television in South Africa (2014:2). When Neil Armstrong and Buzz Aldrin landed the Apollo 11 lunar module on the moon, South Africans missed a significant moment in history, according to Nixon (1999). The little box was associated with atomic bombs and poison gas by Prime Minister Hendrik Verwoerd. The ruling party, at the time, sought to keep black role models such as Nelson Mandela and others off public television (South African Press Association 1996). The apartheid regime used this strategy as a political tactic to keep information from reaching international communities, as they were trying to avoid foreign sanctions.

2.3 Evolution of technology

An announcement that industry 4.0 was upon us by Klaus Schwab and the World Economic Forum (WEF) sparked debates pertaining to technological disruptions and potential technological unemployment that come with it (Lee et al. 2018). A wave-like of industry 4.0 is currently sweeping across South Africa and with it, comes uncertainty. Prevalent problems such as unemployment and disparities in income continue to haunt African nations and their industries (Maku, Ajike and Chinedu 2019). South Africa is no exception as the country faces a number of internal and external operational challenges that impede market related competitiveness (Neingo and Tholana 2016).

To get an extensive comprehension of industry 4.0, it is imperative that the study examines prior industrial revolutions and their significant impacts (Suri 2018). According to Yun et al. (2018) there is no clear-cut explanation of what industrial revolution is. The first Industrial Revolution or technological transformation, from a historical global economic perspective, began in Great Britain, in 1760 and 1840, known as the British Industrial Revolution (De Vries 1994). However, according to O'Brien (2017:3), there are convincing arguments acknowledging Netherlands as the

"1st Modern Economy". Having said that, the world saw Great Britain as a benchmark for progress (Allen and Weisdorf 2010).

This was a time that saw prominent men of science such as Sir Isaac Newton and Robert Boyle make significant technological transitions about universal gravitation and motion of gases. This was an unprecedented moment in history, which revolutionized and galvanized how the modern world has come to view and comprehend the economic landscape. A time of inventions – machine tools, steam power, iron making, and textiles. In 1870 and 1914, the world was morphed by the second industrial age, also known as the technological revolution (Vyas 2018). An era of telephones, automobiles and airplanes. Then came the third industrial age in 1969 – 2000. This revolution witnessed the manufacturing sector going digital. According to the World Economic Forum (2017:3), technology integration – artificial intelligence systems, advanced robotics, wearables and additive manufacturing, the internet, virtual and augmented reality are breakthrough technologies of the 4IR. However, it is important to highlight that only people with financial capabilities have a pass to enter the digital world (Schwab 2016:4). This further limits third world countries and disadvantaged communities.

2.4 Technological capital challenges in the brick manufacturing sector

As a means of improving efficiency of operational process through using technological systems, brick construction SME companies have to embrace industry 4.0. However, there are challenges that prevent brick construction SMEs from a smooth integration of technology into their operations (Koumas, Dossou and Didier 2021).

Table 1. Challenges that impact on brick construction SMEs

Author(s)	Challenges
Adu et al. (2019)	There are only a small number of brick construction SMEs that use technology
Valdes et al. (2020)	Loss of jobs due to adoption of technology
Koumas et al. (2021)	Lack of financial assistance from government
Vrontis et al. 2022	Uncertain on how to integrate technology within the industry

These identified technological capital shortcomings have positioned the brick construction SMEs at a disadvantage. In addition, these drawbacks hinder efficiency and productivity growth of brick construction SME companies.

2.5 Technology in the brick manufacturing sector

The brick construction industry can improve their operational process productivity and attain market feasibility by integrating technological innovation involving automation (robotic flexible machinery) and human robotic (material handling) (Grube et al. 2017; Ghafoorpoor et al. 2018). The brick construction SME companies can enhance their operational process by integrating smart manufacturing (Akinshipe and Kornelius 2017).

This can be achieved by applying for government funding (SADC 2016; Koumas et al. (2021). In addition, brick construction SMEs can educate and train brick artisans in alignment to technological requirements, thus improving operational process (Saunders 2018). employing technological systems such as human robotics and automation even though the systems are less used by brick masonry production SMEs (Akinshipe and Kornelius 2017).

According to Karmaoui et al. (2022), the masonry brick construction SMEs can integrate technological systems such as the Internet of Things (Iot) to their brick production process to overcome non-value adding factors through gathering real time data and transmitting that information to the structures that deal with making decisions in order to monitor operational processes, energy control and maintenance. Utilising Rapid Upper Limb Assessment (RULA) in CATIA V5R20 software to introduce ergonomic interventions. The software helps minimise awkward working postures involving manual lifting and moving of heavy material to the brick manufacturing site and constant bending for long periods (Hussain et al. 2019). A conducive working environment and investment in smart manufacturing have the capability of influencing the productivity of brick manufacturing SMEs (Bajrachary et al. 2022).

2.6 The effect of industry 4.0 on human capital

According to Yamoah (2014), the concept of human capital (HC) can be articulated as any form of knowledge or skill – inborn or external, acquired over a given period of time through some form of schooling that individuals in a

population possess and their contribution towards productivity (Navruz-Zoda and Shomiev 2017). Makhubedu et al. (2017), the concept of human capital refers to the collection of distinct human resources we possess as a society, such as work experience, skill sets, a combination of intangible qualities – self-confidence, responsibility and motivation (Shomos 2010:1).

A company's first instinct is to discover innovative ways of surviving this, conceivably unpredictable and aggressive global economic environment that is constantly changing (Dobre 2013). Investment through HC – education (Knowlegde) and training (skills development) is a managerial concept that can be used to promote industry 4.0 awareness and ensure that workers are trained in alignment to technological requirements. History has shown that machines have contributed towards improvement in production output while decreasing costs in production. History has also shown that technology has created more jobs (Saunders 2018). This is despite growing concerns that technology could lead to people losing their jobs at an alarming rate.

This is according to Kelly's citation of the World Economic Forum (2020), approximately 60 million jobs were lost due to covid-19 and now employees have to worry about losing more jobs because of organisations pushing the use of technology within their working environment. As described in their report, WEF concluded that, "a new generation of smart machines, fueled by rapid advances in artificial intelligence (AI) and robotics, could potentially replace a large proportion of existing human jobs."

However, some research findings suggest otherwise, see table 2 below:

Table 2. Research findings regarding the nexus between technology and unemployment/ job cuts

Author(s)	Findings
Matuzeviciute, Butkus and Karaliute (2017)	The results revealed that there was no correlation between technological innovation and unemployment.
Fiorelli (2018)	According to the results, digital technology does not directly cause unemployment since the balance between jobs destroyed and created has historically been positive.
Kapeliushnikov (2019)	Results suggested that in the long run, reduction in labour demand under the impact of new technologies is merely a theoretical possibility that has never before been realised in practice.

3. Research methodology

The study applied the qualitative (subjective) research approach (non-numeric) in its data collection methodology. The method focused on trying to gain insight on the general perception (inductive reasoning) of the worldview on the influence of industry 4.0 on productivity growth of the brick construction SMEs industry in South Africa derived from literature reviewed (Creswell 2014). Academic research requires a thorough review of past and current literature as it plays an important role in future research and development. To explore the impact of industry 4.0 on productivity growth of the brick construction industry in South Africa, the study listed, reviewed and identified research publications, books and government documents that related to the research topic. Some of the documents after being reviewed, the researcher decided to exclude them from the study as they had similarities.

4. Results, discussion and conclusion

The literature explored emphasized the importance of industry 4.0 in influencing productivity growth of brick construction SME companies. However, literature read also highlighted a number of technological challenges that continue to hinder the integration and application of technological systems in the brick construction SMEs industry. Through smart manufacturing, SMEs can enhance the efficiency of operational processes through automation, human robotics and the internet of things (IoT). The South African government should start assisting brick construction SMEs with financial support so that companies can equip brick makers with the knowledge and skills that are aligned with technological requirements. Furthermore, these companies can use the same funding/subsidy to participate in activities of industry 4.0. This will result in productivity growth, market and financial feasibility, improvement in the rate of gross domestic product (GDP), economic growth of South Africa. In conclusion, the world is not the same as it was in the 1800s. International and national companies have to embrace industry 4.0 – technological advancements that

render old technology obsolete even though this might be disruptive in nature. This requires brick manufacturing SMEs to evolve by adjusting to innovative technologies by altering their business models and operational processes. Thus, improving service delivery and customer-waiting time. This study recommends that the analysis of the impact of industry 4.0 using quantitative research methods be used for future research, considering that this research used a qualitative research approach.

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6. Biography

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