

# An Analysis of Enablers and Barriers of Sustainable Manufacturing in Southern Africa

Michael Mutingi, *Member, IAENG*, Harmony Musiyarira, Charles Mbohwa, Venkata P. Kommula

**Abstract**—In today's competitive manufacturing environment, pressures continue to mount over sustainability issues in terms of economic, environmental and social performance in manufacturing. As a result, sustainable manufacturing has gained recognition across the world. However, maintaining the momentum of sustainable manufacturing activities in Southern Africa is a challenge. Learning from our preliminary studies in the literature, we highlight the key enablers and barriers behind implementation of sustainable in the region. A survey of the key enablers and barriers is then presented. Views and opinions from expert researchers and practitioners in region are collated and analyzed in order to draw useful strategies for effective implementation of sustainable manufacturing. The research is a knowledge resource for decision makers concerned with sustainability decisions in the manufacturing sector in the Southern African region.

**Index Terms**—Sustainable manufacturing, sustainability, enablers, barriers, Southern Africa

## I. INTRODUCTION

THE current manufacturing industry environment has become extremely competitive in the global market [1][2]. To stay afloat in the global business environment, organizations have to ensure high-level performance by adopting modern manufacturing strategies. Nowadays, most stakeholders in various societies consistently put pressure on manufacturers to take a spirited shift towards environmental and social responsibility. Therefore, in addition to the objective of creating sustained profit margin, organizations have to consider sustainability based on the triple bottom line concept, which incorporates three dimensions, namely, economic, environmental and social performance [3][4]. Sustainable manufacturing is one of the most popular

manufacturing initiatives that can be used as a platform to achieve the triple bottom line objectives [5]. This initiative is increasingly gaining momentum as many organizations continue to depend on the use of natural resources and emit wastes which result in environmental damage [1][2][3].

Sustainable manufacturing can be viewed as the creation of products using non-polluting, economically viable processes that conserve energy and natural resources, and are safe and sound for employees, consumers and the society at large [5]. However, as manufacturing activities continue to increase, specifically in Southern Africa, higher levels of waste and pollution are inevitable, which may not be sustainable in the long run. As a result, there is a strong motivation for organizations to adopt manufacturing technologies that maximize economic and social benefits, while minimizing environmental damage [1][2][3]. However, in most countries in the region, developments towards sustainability are not much emphasized. Though a few large capital-intensive industries have so far continued to perform well, most manufacturing industries have grappled to keep abreast with global developments [6]. Research on sustainable manufacturing is limited in the Africa, and particularly Southern Africa. Existing literature on manufacturing does not adequately cover important aspects of sustainability such as circular economy, sustainable business models, cleaner production, and related concepts [7]. To date, most of the countries have manufacturing-based economies, as evidenced by significant growth in several manufacturing value chains such as textiles, metal processing, leather, and agro-processing. As such, so much attention is given to building the manufacturing industry [7]. Given that the manufacturing sector has always been a significant contributor to harmful carbon emissions, resource depletion, and environmental damage, sustainable manufacturing becomes crucial to these manufacturing developments in the region. African countries have been signatories to a number of global environmental and welfare treaties, such as the 2015 Paris COP 21, the United Nation's SDGs, and the International Labor Organization conventions [7]. Therefore, manufacturing developments in the region are expected to be compliant with these agreements.

Related studies have investigated the enablers and barriers of sustainable manufacturing initiatives from a global context [5], and in Malaysian automotive industries [8], Sri Lankan manufacturing sector [9], Spanish companies [10], Indian and German industry [11], and Malaysian manufacturing firms [12]. The main question arising from

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M. Mutingi a Senior Lecturer with the Faculty of Engineering, Namibia University of Science and Technology, Namibia. He is also a Visiting Senior Research Fellow with the Department of Quality and Operations Management, Faculty of Engineering and the Built environment, University of Johannesburg, South Africa. (phone: 264-61 207 2569; fax: 264-61 207 9569; e-mail: [mmutingi@nust.na](mailto:mmutingi@nust.na)).

H. Musiyarira is an Associate Professor with the Namibia University of Science and Technology, Faculty of Engineering, Namibia (email: [hmutiyarira@nust.na](mailto:hmutiyarira@nust.na))

C. Mbohwa is an established Researcher and Professor with the Department of Quality and Operations Management, Faculty of Engineering and the Built environment, University of Johannesburg, South Africa. (email: [cmbohwa@uj.ac.za](mailto:cmbohwa@uj.ac.za)).

V. P. Kommula is an Associate Professor with the Department of Mechanical Engineering, Faculty of Engineering and Technology, University of Botswana, Botswana. (email: [kommula@mopipi.ub.bw](mailto:kommula@mopipi.ub.bw)).

this study is: What are the major enablers and barriers of sustainable manufacturing in Southern Africa? How would researchers and practitioners collaborate together to strengthen and take advantage of the enablers and to mitigate barriers?

The rest of the paper is organized as follows. The next section presents the research methodology followed in this study. Literature search findings are presented in Section 3. Section 4 presents results and discussions. Section 5 highlights the main managerial implications of the study. Concluding remarks are presented in Section 6.

## II. RESEARCH METHODOLOGY

This research utilizes primary and secondary data in its approach. Primary data was obtained through survey research, involving experts in the field, while secondary data was gathered from literature sources on barriers and enablers of sustainable manufacturing. First, literature search was conducted to find relevant literature on enablers of and barriers to sustainable manufacturing. The key words that were used in this search were basically two: “sustainable manufacturing” and “green manufacturing”. These two key words were used in combination with related descriptive words, that is, “barriers”, “inhibitors”, “enablers”, “drivers”, “determinants”, and “factors”. This highlighted the possible range of enablers and barriers of sustainable manufacturing. Second, a questionnaire was designed based on close-ended questions rated on a scale of 1 to 5, where, 1 = very low influence, and 5 = very high influence. Selected academic and professional experts in the field were asked to review the questionnaire before administering the questionnaire to participants. Third, we collated expert views and opinions from leading academics, consultants and practitioners from the region. The participants were selected based on their experience and expertise in the field. Participants were contacted through an online questionnaire tool, allowing them to give independent views on the enablers and barriers associated with the application of sustainable manufacturing practices.

Respondents were encouraged to share their knowledge and experiences in the transformation of manufacturing systems to high-performing systems in terms of economic, environmental, and social performance. Findings on literature search survey of key enablers and barriers are presented in the next section.

## III. LITERATURE SEARCH FINDINGS

The outcome of the literature search survey yielded several barriers to and enablers of sustainable manufacturing. However, some of the factors used different wording yet referred to the same meaning. A closer look at the content of these factors helped to rationalize these factors into 7 enablers of and 7 barriers to effective implementation of sustainable manufacturing practices. Table 1 lists and briefly describes the 7 enablers of sustainable manufacturing, beginning from market pressure, government support and regulations, down to infrastructure and facilities.

TABLE I  
ENABLERS OF SUSTAINABLE MANUFACTURING

No.	Enabler	Brief Description	References
1	Market pressure	Customer expectations, Industry best practices	[1] [4] [12]
2	Government support and legislation	Environmental regulations, law enforcement, participation	[1] [5]
3	Economic benefit	Reduced costs, efficient processes, financial gain	[2] [3] [5] [9] [12]
4	Investment	Investment in technology and innovation	[1] [3] [5]
5	Quality improvement	Quality in production process and products	[4] [5]
6	Education and training	Workers’ training and education in technology	[11] [4] [7] [9]
7	Infrastructure and facilities	Adequate access to transport facilities	[6] [7] [9]

Related enablers include stakeholder pressure, company image, public concern, and perceived benefits [5] [9] [10]. The literature sources from which each of these enablers were found is also presented along with the respective enablers.

## IV. UNITS

Table 2 presents a list of barriers to sustainable manufacturing, beginning from lack of awareness and inadequate funding, down to implementation and operational challenges. Other related barriers synonymous to the above include lack of pressure from suppliers, the community, shareholders and investors, and lack of best practices from other firms who have implemented sustainable manufacturing practices [9] [12].

TABLE II  
BARRIERS TO SUSTAINABLE MANUFACTURING

No.	Barrier	Brief Description	References
1	Lack of awareness	Limited information on sustainability concepts and market trends	[1] [2] [5] [7] [9]
2	Inadequate funding	Insufficient financial support, limited access to credit facilities	[5] [6] [8] [7] [9] [10]
3	Lack of standards and benchmarks	Absence of best practices, standards and guidelines	[5] [6] [7] [9]
4	Lack of management support	Neglect of senior leaders or management	[5] [9]
5	Employee resistance	Negative reactions towards new concepts on sustainability	[9] [12]
6	High costs	High initial costs of implementing sustainability technologies	[5] [7] [8] [9]
7	Implementation and operational challenges	Difficulties in implementing and operating sustainability technologies	[7] [9]

A number of past studies on sustainable manufacturing concentrated on developing countries while very limited studies were in developing countries, let alone in the African continent [7] [12], and particularly in the Southern African

region [6]. The next section presents the descriptive statistics of the results, along with the relevant discussions.

### V. RESULTS AND DISCUSSIONS

Leading academics, researchers, consultants and practitioners were searched using online databases. Academics and researchers in the field were searched by visiting websites of universities and research institutions. Some of the consultants were searched by way of personal visits and referrals from known identified practitioners. Altogether, 47 potential participants were contacted through online questionnaires and personal visits. Out of the 47 participants, a total of 28 responses were obtained. However, a total of 23 useful and reasonable responses were obtained, which yields a response rate of 48.9%.

The importance or influence of each of the identified enablers and barriers was evaluated based on their respective mean values, where lower-than-average values would imply that the factor under consideration has insignificant influence on the adoption of sustainable manufacturing practices, and vice versa. To evaluate the central tendency of the data, standard deviation values were determined.

TABLE III

DESCRIPTIVE STATISTICS OF ENABLERS OF SUSTAINABLE MANUFACTURING

No.	Enabler	Mean	Std. Dev.
1	Market pressure	3.55	0.96
2	Government support and legislation	2.78	1.01
3	Economic benefit	3.98	0.82
4	Investment	3.76	0.81
5	Quality improvement	3.88	0.90
6	Education and training	3.58	0.88
7	Infrastructure and facilities	3.26	0.96

TABLE IV

DESCRIPTIVE STATISTICS OF BARRIERS TO SUSTAINABLE MANUFACTURING

No.	Barriers	Mean	Std. Dev.
1	Lack of awareness	3.94	0.98
2	Inadequate funding	4.02	1.01
3	Lack of standards and benchmarks	3.28	1.10
4	Lack of management support	3.22	0.98
5	Employee resistance	2.84	1.02
6	High costs	4.18	0.89
7	Implementation and operational challenges	3.44	0.78

Table III presents the statistics of the identified enablers. It can be seen that the mean values of all the enablers are above 2.5 measured on a scale of 1 to 5. This implies that all the enablers have important influence on sustainable manufacturing, as was discovered in [5] and [12]. A further look at the mean values shows suggests that economic benefit (with mean 3.98), quality improvement (with mean 3.88), and investment (with mean 3.76) are the most influential enablers. Government support and legislation is the least of them all, yet with the highest standard deviation.

Table IV lists the statistics of the identified barriers to sustainable manufacturing. It can be seen that the mean values of all the barriers are more than 3.22 on a scale of 1 to 5. This finding highlights the fact that all the barriers are highly influential. The finding is similar to the results obtained in [5] and [12]. Further analysis suggests that high costs (with mean 4.18) are the greatest inhibitor to sustainable manufacturing practices. This is followed by

inadequate funding (with mean 4.02) and lack of awareness (with mean 3.94). On the contrary, employee resistance is the least influential barrier. The minimum standard deviation for these barriers is 0.78 for implementation and operational challenges while the highest is 1.10 for lack of standards and benchmarks.

The next section discusses the managerial implications associated with the findings from this research.

### VI. MANAGERIAL IMPLICATIONS

Useful and interesting managerial implications can be derived from the results of this research. Priority areas were identified. The first notable lesson is to work towards the reduction of costs incurred in the implementation of sustainable manufacturing technologies and practices. Efficient and cost-effective management of manufacturing processes is important to ensure that the overall costs are low. This can also be enhanced through the application manufacturing philosophies such lean management techniques. Achieving high quality with minimal costs will be made possible and easier. Secondly, improving access to funding and attracting investments in innovation and sustainable technologies will mitigate the barrier of inadequate funding. Along with this, senior management in organizations in collaboration with institutions of higher learning and consultancy firms should devise ways of improving the awareness of the potential economic benefits of implementing sustainable manufacturing practices. Awareness on sustainability concepts and their benefits should be spread throughout the manufacturing sector.

### VII. CONCLUSIONS

Given the intense competition in the global market, the manufacturing sector in the Southern African region, which is the most thriving industry sector, needs to put in place sustainable manufacturing practices in order to survive the competition. The purpose of this research was to investigate the barriers and enablers of sustainable manufacturing in the Southern African region. Responses (views and opinions) from academicians, consultants and industry experts in the field were collected using a questionnaire survey. Strategic implications were derived from statistical analysis of the responses. This research is a knowledge resource for decision makers concerned with sustainability decisions in the manufacturing sector in the region. The research and the lessons derived from this study can be extended further to other regions in the continent. Furthermore, it may be useful to identify and study the causal relationships in each of the enablers and barriers.

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