Principles of Lean Manufacturing Techniques to Bring Continuous Improvement in the Plastic Industry

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Abstract

This article aims to study the constraints faced by the plastic industry. The main objective of the study was the implementation of various principles of lean manufacturing techniques to bring continuous improvement in the plastic industry. The researcher collected data from respondents who are employees of the plastic manufacturing industry. The statistical analysis was conducted using SPSS, demographic analysis, descriptive analysis, frequency, correlation, and regression. A correlation table is interpreted based on the Pearson correlation value and the significance value. The independent variables are quality improvement, product improvement, customer satisfaction, employee satisfaction, and supplier whereas, the dependent variable is the Kaizen method. The Pearson correlation of KM with quality improvement is 85.3% with a 0.000 significance value which shows a high correlation, the Pearson correlation of KM with product improvement is 88.3% with a 0.000 significance value which shows a high correlation, Pearson correlation of KM with customer satisfaction is 12.9% with -0.057 significance value which shows that one variable increases so the other decreases, Pearson correlation of KM with employee satisfaction is 15.5% with -0.023 significance value which shows that low correlation and finally, Pearson correlation of KM with Supplier is 40% and significance value which is 0.000 which shows high correlation.

Keywords
Lean Techniques, Plastic Manufacturing, continuous improvement, Kaizen Method

1. Introduction
The lean manufacturing demand for plastic originated in South Africa when the price and competition increased globally. The plastic industry of South Africa is facing some major constraints; the pricing of raw materials, lack of advanced machinery, import prices, and limited investments. This research focused on lean manufacturing techniques which include plastic recycling, local production of materials, and packaging of medical devices. The employees should be aware of lean practices, their implementation, and working towards achieving competitive advantage (Berhe, 2022). According to research by (Adeniran & Shakantu, 2022), plastics are one of the most used materials in every field of life. As China is producing a large number of plastic products in bulk that are sold at a relatively cheaper price, it has shown an adverse impact on other local plastic industries.

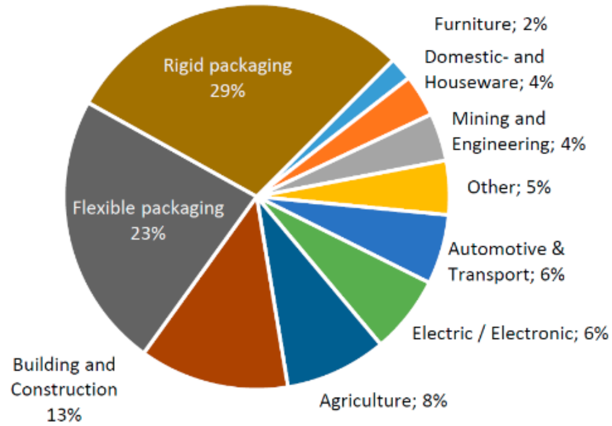

Figure 1. Plastic division of sectors
Source: (DTIC, 2023)

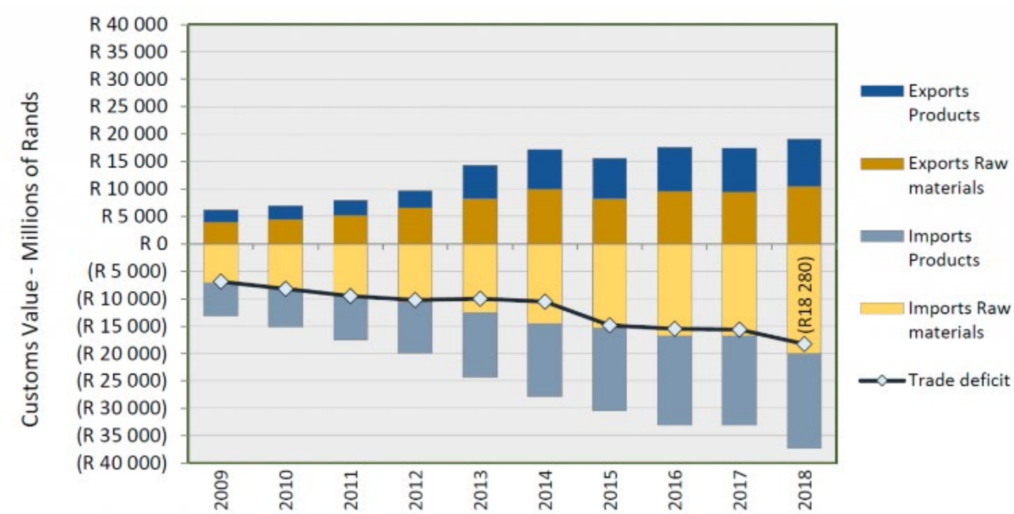

Figure 2. Plastic Distribution
Source: (DTIC, 2023)

As Figures 1 and 2 above show the plastic industry is dominated by flexible and rigid packaging (52%), and the remaining is consumed by other sectors. However, the plastics industry is currently facing some challenges due to the global change in demand and inflation [4]. The rising issue of plastic waste has grabbed quite some attention at global levels (Chen et al., 2021). Another study conducted in a similar domain revealed that the plastic industry is undergoing some trends that are shaping the South African plastic market as well (Rossi et al., 2022).

1.1 Lean Manufacturing Techniques

Lean manufacturing is a systematic approach to decrease waste and raise the value of plastic manufacturing processes (Ncube et al., 2021). It emphasizes the opinion that any activity that does not facilitate the additional value to the final product is considered waste, therefore, the waste can include overproduction, waiting for processing, inventory, and others. The lean manufacturing approach consists of several principles that include constant improvement, timely production, waste minimization, and respect for people. Some of the basic tools associated with the Lean philosophy include Kanban, Kaizen, Jidoka, and others (Vinodh, 2020).

1.2 Challenges of The Lean Manufacturing Techniques

Although lean manufacturing provides high-quality products and eliminates waste production its implementation faces a lot of challenges. These challenges include a lack of management support (Ismyrlis, 2021), and resistance to change because people often do not accept changes in their working practices (Castillo, 2022). Implementation of the Lean manufacturing system can be successful with adequate employee involvement and training Lack of expertise, poor planning, lack of commitment from the management to the employees, and lack of strategic approaches account for the managerial and technical barriers in implementing the Lean manufacturing approach reluctant Employees can pose a challenge to training them on new procedures (Elkhairi et al., 2019).

2. Literature Review

The following are key principles and methodologies associated with Kaizen:

2.1 PDCA (Plan-Do-Check-Act) Cycle

A common problem-solving strategy in Kaizen is the PDCA cycle. There are four stages to it: plan, do, check, and act (Minh & Quyen, 2022). The problem is recognised, information is gathered, and viable solutions are produced during the planning stage. The selected solution is put into practice on a limited scale during the doing phase (Minh & Quyen, 2022). The results are assessed and contrasted with the anticipated outcomes during the checking phase. The better process is standardised, corrections are made, and lessons are learned in the action phase.

2.2 Gemba (The Real Place)

Gemba is a Japanese term that describes the real workspace where value is produced, such as a factory floor, office, or assembly line. Going to the gemba is crucial for Kaizen because it allows you to cooperate with front-line employees and watch processes, find waste, acquire insights, and observe processes. Practitioners of Kaizen can have a greater awareness of the difficulties and opportunities for improvement by being actively involved in the workplace.

2.3 The Kaizen Events

Kaizen events, often called blitzes or workshops, are intense and targeted improvement initiatives. In order to solve particular issues or possibilities, cross-functional teams commonly collaborate during these events for a brief time, typically a few days (World Bank, 2015). Kaizen activities encourage teamwork, knowledge exchange, and quick progress.

2.4 5S Methodology

A collection of workplace standardisation and organisation strategies called the 5S methodology are applied in Kaizen. The five S's are Shine, Standardise, Set in Order, and Sustain. By removing clutter, designating spaces for everything, assuring cleanliness, putting in place standardised procedures, and maintaining the changes over time, the technique seeks to create an organised, effective, and visually controlled workplace.

2.5 Kaizen Methods and Tools

In order to support efforts to solve problems, reduce waste, and enhance processes generally, the kaizen philosophy of continuous improvement makes use of a variety of tools and strategies. The following list of tools and strategies for Kaizen is typical:

2.6 Value Stream Mapping (VSM)

A visual representation of the whole process flow, from the supplier to the client, is called a value stream map. It aids in the detection and elimination of wasteful activities and optimises the entire value chain. Organisations can use VSM to comprehend the current condition of their processes, see chances for change, and create procedures for the future.

2.7 5S Techniques

The 5S methodology emphasises standardisation and workplace organisation. Sort, Set in Order, Shine, Standardise, and Sustain are the five S's (Duckworth, 2016). By putting 5S into practise, businesses increase productivity, save waste, and establish a secure and orderly workplace (Duckworth, 2016). It entails purging and maintaining the workspace (Shine), organising important objects logically and efficiently (Set in Order), standardising work procedures (Standardise), and preserving these advancements throughout time (Sustain).

2.8 Poka-Yoke
Poka-Yoke, sometimes referred to as error-proofing, tries to stop mistakes and faults from happening or find them early in the process. It entails putting in place tools to direct workers and stop errors, like physical or visual cues. Poka-Yoke procedures promote efficiency and customer happiness by reducing rework, faults, and quality problems.

2.9 The Kaizen Newspaper
The Kaizen Newspaper is a visual communication tool that documents ideas for improvement, developments, and outcomes. Employees can check the status of ongoing projects and exchange suggestions for improvements thanks to their frequent display in common places (Jin, 2022). The Kaizen Newspaper fosters a culture of continuous improvement by encouraging transparency, cooperation, and involvement.

2.10 A3 Problem-Solving
A3 Problem-Solving is a methodical strategy for resolving issues and implementing changes. The problem-solving procedure, which includes problem description, root cause analysis, action plans, and follow-up, is guided by an A3-sized piece of paper. A3 Problem-Solving encourages critical thinking, data-driven decision-making, and cross-team and cross-department problem-solving.

Standard Work entails recording the most effective technique for carrying out a particular operation or process. It creates a distinct and consistent strategy, minimising variety, mistakes, and waste. Standard Work enables organisations to develop standardised and effective processes by serving as a baseline for ongoing improvement initiatives.

2.11 Kaizen Events
Also known as Kaizen blitzes or Kaizen workshops, Kaizen Events are concentrated improvement efforts carried out over a brief period of time, usually a few days. In order to address specific issues or possibilities discovered through data analysis or employee proposals, these events bring together cross-functional teams. Kaizen Events promotes knowledge exchange, collaboration, and quick improvements.

2.12 Kanban
A Kanban board is used to visualise workflow, WIP limits are used to limit the number of jobs that can be completed at once, and a pull mechanism is used to start work depending on demand. By minimising multitasking and locating workflow bottlenecks, it promotes a culture of continuous improvement and increases productivity. Kanban is frequently utilised in a variety of industries to boost overall productivity and streamline procedures.

2.13 Root Cause Analysis
The goal of Root Cause Analysis (RCA), a methodical approach to problem-solving, is to find and deal with an issue's root causes rather than only treating its symptoms. Organisations can put into place efficient solutions to stop the issue from happening again in the future by investigating and comprehending the core reasons. To identify the root causes of the issue and provide more lasting remedies, RCA entails a methodical investigation, data collecting, and analysis (Kautz et al., 2014).

2.14 JIT
Just-in-Time A production and inventory management technique called just-in-time (JIT) strives to supply goods or services at the appropriate time, in the appropriate quantity, and with the least amount of waste possible (Arntz, Gregory, & Zierahn, 2016). It places a focus on using a pull system, encouraging continuous flow in the production process, and producing in response to genuine client demand. JIT helps reduce inventory costs, improve efficiency, and enhance customer responsiveness (Arntz, Gregory, & Zierahn, 2016).

These tools and techniques empower organizations to identify and address inefficiencies, eliminate waste, and drive continuous improvement. By leveraging these Kaizen tools, organizations can enhance productivity, quality, and customer satisfaction while creating a culture of engagement and improvement at all levels (Zvidzayi, 2021).

3. Methods
In this research, it has widely been discussed that lean manufacturing is the philosophy that, when adopted completely creates a culture of continuous improvement where employees at all levels work together to acquire regular improvements to manufacturing procedures. The research emphasizes the choice of an effective technique for the research that can provide proper guidance and insight to get the research managed effectively and efficiently till the end (Pandey et al, 2021). This research has utilized deductive theory (Okoli, 2021) and it assists in testing hypotheses, building the relationships among variables, and then producing proven results scenically and the defined results.

3.1 Model of Research Honeycomb
The model of honeycomb research assists in describing six significant research methodology components that include strategy, design, analysis, collection, philosophy, and approach (Willie, 2021). The model helps in giving an in-depth understanding and knowledge of the research methodology that is used in specific research. In the current research, the honeycomb model has been applied to accomplish the needs of the research methodology (Figure 3).

Figure 3. Research Model of Honeycomb (Self-made)

3.2 Research Philosophy
The philosophy of research is mainly based on the options through which the information has been collected, utilized, and analyzed in the research. Several authors have discussed various types of philosophy; although three types are major that is interpretivism, positivism, and pragmatism (McChesney and Aldridge, 2019).

4. Data Collection
To achieve the stated aims, the researcher collected data. These are the employees who work in the plastic manufacturing industry and use the lean team approach. The statistical analysis was conducted using SPSS and the tests applied for analysis were demographic analysis, descriptive analysis, frequency, correlation, and regression. Based on the collected data through the survey method, the results are analyzed below:

5. Results and Discussion
5.1 Frequency Analysis
The analysis below is the responses obtained from participants. These are based on what the participants think about the Kaizen method approach.

5.1.1 Working in muti-functional teams improves process quality

Table 1: Responses of Participants

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly agree	22	10.1	10.1	10.1
	Agree	63	29.0	29.0	39.2
	Neutral	81	37.3	37.3	76.5
	Disagree	42	19.4	19.4	95.9
	Strongly disagree	9	4.1	4.1	100.0
	Total	217	100.0	100.0	

This simply means that to improve the process quality in any plastic manufacturing firm, it is fruitful to work in multi-functional teams (Table 1).

5.1.2 Waste should be eliminated during all phases.

Table 2: Responses of Participants

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly agree	73	33.6	33.6	33.6
	Agree	79	36.4	36.4	70.0
	Neutral	48	22.1	22.1	92.2
	Disagree	17	7.8	7.8	100.0
	Total	217	100.0	100.0	

This means that the majority agreed that waste should be eliminated during all phases because the main idea or purpose of using such methods is to reduce the waste from the materials as well as from the processes (Table 2).

5.1.3 Implementation of a lean manufacturing system can be successful with adequate employee involvement

Table 3: Responses of Participants

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly agree	54	24.9	24.9	24.9
	Agree	71	32.7	32.7	57.6
	Neutral	63	29.0	29.0	86.6
	Disagree	25	11.5	11.5	98.2
	Strongly disagree	4	1.8	1.8	100.0
	Total	217	100.0	100.0	

The lean manufacturing system is a useful system that can help organisations to grow. The usefulness of employee involvement for an organisation is immense but at the same time, a lean manufacturing system can help to reduce wastage and maximize productivity. Employees expect the organisation to adopt lean methods because it not only reduces waste but also increase efficiency (Table 3).

5.1.4 Plastic manufacturing involves releasing waste that causes pollution

Table 4: Responses of Participants

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly agree	43	19.8	19.8	19.8
	Agree	74	34.1	34.1	53.9
	Neutral	72	33.2	33.2	87.1
	Disagree	25	11.5	11.5	98.6
	Strongly disagree	3	1.4	1.4	100.0
	Total	217	100.0	100.0	

The majority of respondents believed that in plastic manufacturing firms, the waste is released into the environment which causes pollution (Table 4). There are a limited number of firms that use the right methods and procedures for reducing wastage yet there are several other firms that release the waste directly into the air. A clean and green environment is essential and the plastic industry needs to understand this.

5.1.5 The lean manufacturing process helps in waste management

Table 5: Responses of Participants

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly agree	26	12.0	12.0	12.0
	Agree	74	34.1	34.1	46.1
	Neutral	74	34.1	34.1	80.2
	Disagree	35	16.1	16.1	96.3
	Strongly disagree	8	3.7	3.7	100.0
	Total	217	100.0	100.0	

This means that employees are aware of the benefits of lean management and its effectiveness in waste management. The lean manufacturing process is useful for managing waste in organizations because it includes different methods of waste management that can reduce the emission of harmful gases as well as the use of pollutants (Table 5).

5.1.6 Quality is compromised if there are few wastages

Table 6: Response of Participants

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly agree	46	21.2	21.2	21.2
	Agree	68	31.3	31.3	52.5
	Neutral	62	28.6	28.6	81.1
	Disagree	34	15.7	15.7	96.8
	Strongly disagree	7	3.2	3.2	100.0
	Total	217	100.0	100.0	

The response obtained from the employees has revealed that product quality is affected if there is more wastage. Once the firms do not start working on the wastage aspect, so there are chances of more errors in producing quality products. As firms concentrate more on quantity rather than the quality of the product (Table 6).

5.1.7 Lean manufacturing can reduce defects

Table 7: Response of Participants

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly agree	47	21.7	21.7	21.7
	Agree	68	31.3	31.3	53.0
	Neutral	67	30.9	30.9	83.9
	Disagree	29	13.4	13.4	97.2
	Strongly disagree	6	2.8	2.8	100.0
	Total	217	100.0	100.0	

This means that defects from the products can be reduced if lean manufacturing methods are applied (Table 7).

5.1.8 Product improvement requires resources and lean practices

Table 8: Response of Participants

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly agree	35	16.1	16.1	16.1
	Agree	71	32.7	32.7	48.8
	Neutral	79	36.4	36.4	85.3
	Disagree	27	12.4	12.4	97.7
	Strongly disagree	5	2.3	2.3	100.0
	Total	217	100.0	100.0	

This means that product improvement requires the availability of some resources and lean practices for supply chain managers or the manufacturing department to apply (Table 8).

5.1.9 Customer satisfaction is increased when continuous improvements are made to products

Table 9: Response of Participants

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly agree	48	22.1	22.1	22.1
	Agree	71	32.7	32.7	54.8
	Neutral	71	32.7	32.7	87.6
	Disagree	21	9.7	9.7	97.2
	Strongly disagree	6	2.8	2.8	100.0
	Total	217	100.0	100.0	

This means that customer satisfaction is increased when manufacturing firms continuously make amendments and use new processes to improve the quality of the products (Table 9).

5.1.10 Employees find teamwork more effective for applying lean principles

Table 10: Response of Participants

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly agree	38	17.5	17.5	17.5
	Agree	103	47.5	47.5	65.0
	Neutral	54	24.9	24.9	89.9
	Disagree	17	7.8	7.8	97.7
	Strongly disagree	5	2.3	2.3	100.0
	Total	217	100.0	100.0	

Based on the results obtained, it is evident that employees find it very useful to use teamwork and lean principles because it improves process efficiency. Most of the employees believe that if plastic manufacturing starts applying lean principles it will lead to better results (Table 10).

5.1.11 Employees achieve their goals through teamwork

Table 11: Response of Participants

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly agree	39	18.0	18.0	18.0
	Agree	66	30.4	30.4	48.4
	Neutral	68	31.3	31.3	79.7
	Disagree	36	16.6	16.6	96.3
	Strongly disagree	8	3.7	3.7	100.0
	Total	217	100.0	100.0	

The overall response of the employees has revealed that when employees work together in teamwork, they achieve their organisational goals and the rate of problem-solving is also high. This is because, with shared vision and ideas, the teams can work according to their needs (Table 11).

5.1.12 Strong relationship with suppliers provides good quality of raw material

Table 12: Response of Participants

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly agree	28	12.9	12.9	12.9
	Agree	77	35.5	35.5	48.4
	Neutral	77	35.5	35.5	83.9
	Disagree	28	12.9	12.9	96.8
	Strongly disagree	7	3.2	3.2	100.0
	Total	217	100.0	100.0	

The results indicate that when companies form strong relationships with suppliers, it provides them with good-quality raw materials. The manufacturing sector is responsible for maintaining healthy relationships with the suppliers but at the same time, it is also important for them to ensure that the suppliers deliver the right products (Table 12).

5.2 Correlation Analysis

Table 13: Correlation

		Kaizen Method	Quality Improvement	Product Improvement	Customer Satisfaction	Employee Satisfaction	Supplier
Kaizen Method	Pearson Correlation	1	.853**	.883**	.129	.155*	.400**
	Sig. (2-tailed)		.000	.000	.057	.023	.000
	N	217	217	217	217	217	217
Quality Improvement	Pearson Correlation	.853**	1	.954**	.087	.097	.361**
	Sig. (2-tailed)	.000		.000	.199	.155	.000
	N	217	217	217	217	217	217
Product Improvement	Pearson Correlation	.883**	.954**	1	.081	.110	.398**
	Sig. (2-tailed)	.000	.000		.235	.107	.000
	N	217	217	217	217	217	217
Customer Satisfaction	Pearson Correlation	.129	.087	.081	1	.892**	.806**
	Sig. (2-tailed)	.057	.199	.235		.000	.000
	N	217	217	217	217	217	217
Employee Satisfaction	Pearson Correlation	.155*	.097	.110	.892**	1	.934**
	Sig. (2-tailed)	.023	.155	.107	.000		.000
	N	217	217	217	217	217	217
Supplier	Pearson Correlation	.400**	.361**	.398**	.806**	.934**	1
	Sig. (2-tailed)	.000	.000	.000	.000	.000	
	N	217	217	217	217	217	217

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

As shown above, the correlation table is interpreted based on the Pearson correlation value and the significance value. The independent variables are quality improvement, product improvement, customer satisfaction, employee satisfaction, and supplier whereas, the dependent variable is the Kaizen method (Table 13).

6. Conclusion

The implementation of lean manufacturing helps in the development of a continuous environment of culture that reduces the waste of the industry. The researcher has set several different objectives and questions that have to be answered later in the study. In this study, the researcher has achieved different terminologies that explain the role of managers in this industry and the way they treat their employees more appropriately and positively. Due to these improvements in the case of costs, the quality of the product and performance involves the assuring of the climate. The researcher also concluded that educating and creating awareness among firms and plastic manufacturers is essential for the manufacturers who know how to benefit lean manufacturing to achieve the goals of an organisation. Effective lean manufacturing techniques can be implemented to achieve quality products (Ferreira et al., 2017), improved environment (Santos et al., 2016), safety (Bastos et al., 2014), and social responsibility (Santos et al., 2018).

References

Adeniran, A.A. and Shakantu, W., The health and environmental impact of plastic waste disposal in South African Townships: A review. International Journal of Environmental Research and Public Health, 19(2), p.779, 2022.

Arntz, Melanie, Terry Gregory, and Ulrich Zierahn. The Risk of Automation for Jobs in OECD Countries: A Comparative Analysis. OECD Social, Employment and Migration Working Papers No. 189. Paris: OECD, 2016.

Bastos, A., Sá, J., Silva, O. and Fernandes, M.C., A study on the reality of Portuguese companies about work health and safety. Occupational Safety and Hygiene II, 1, pp.687-691, 2014.

Berhe, H.H., Application of Kaizen philosophy for enhancing manufacturing industries' performance: an exploratory study of Ethiopian chemical industries. International Journal of Quality & Reliability Management, 39(1), pp.204-235, 2022.

Castillo, C., The workers' perspective: emotional consequences during a lean manufacturing change based on VSM analysis. Journal of Manufacturing Technology Management, 33(9), pp.19-39, 2022.

Chen, H. L., Nath, T. K., Chong, S., Foo, V., Gibbins, C., and Lechner, A. M. , The plastic waste problem in Malaysia: management, recycling, and disposal of local and global plastic waste. SN Applied Sciences, 3, 1-15, 2021.

DTIC, South Africa plastic industry, 2023. [Online]. Available at: http://www.thedtic.gov.za/sectors-and-services-2/industrial-development/plastics/ [Accessed 8.3.2023].

Duckworth, Angela., GRIT: The Power of Passion and Perseverance. New York: Scribner, 2016.

Elkhairi, A., Fedouaki, F. and El Alami, S., Barriers and critical success factors for implementing lean manufacturing in SMEs. IFAC-PapersOnLine, 52(13), pp.565-570, 2019.

Ferreira Rebelo, M., Silva, R. and Santos, G., The integration of standardized management systems: managing business risk. International Journal of Quality & Reliability Management, 34(3), pp.395-405, 2017.

Ismyrlis, V., Lean and Kaizen: the past and the future of the methodologies. In Lean Manufacturing. IntechOpen.

Jin, K. & Ohno, I., Promoting Quality And Productivity Improvement/ Kaizen in Africa Research Project - Japanese Experiences Of Industrial Development And Development Cooperation: Analysis Of Translative Adaptation Processes [VOL.2], 2022. [online] Available at: https://www.jica.go.jp/jica-ri/publication/booksandreports/uc7fig000000278y-att/Kaizen_20220304.pdf.

Kautz, Tim, James J. Heckman, Ron Diris, Bas ter Weel, and Lex Borghans. "Fostering and Measuring Skills: Improving Cognitive and Non-cognitive Skills to Promote Lifetime Success." OECD Education Working Papers 110. Paris: OECD Publishing, 2014.

McChesney, K. and Aldridge, J., Weaving an interpretive stance throughout mixed methods research. International journal of research & method in education, 42(3), pp.225-238, 2019.

Minh, N.D. & Quyen, N.T.H., Human resources quality improvement from the perspective of Kaizen practices. *Management*, *26*(1), 144-163, 2022.

Mordor Intelligence, Plastic industry of South Africa, 2023. [Online]. Available at: https://www.mordorintelligence.com/industry-reports/south-africa-plastic-packaging-market [Accessed 8.3.2023].

Ncube, L.K., Ude, A.U., Ogunmuyiwa, E.N., Zulkifli, R. and Beas, I.N., An overview of plastic waste generation and management in food packaging industries. Recycling, 6(1), p.12, 2021.

Okoli, C., Inductive, Abductive, and Deductive Theorizing. Available at SSRN 3774317, 2021.

Pandey, P. and Pandey, M.M., Research methodology tools and techniques. Bridge Center, 2021.

Rossi, A.H.G., Marcondes, G.B., Pontes, J., Leitão, P., Treinta, F.T., De Resende, L.M.M., Mosconi, E. and Yoshino, R.T., Lean Tools in the Context of Industry 4.0: Literature Review, Implementation, and Trends. Sustainability, 14(19), p.12295, 2022.

Santos, G., Murmura, F. and Bravi, L., SA 8000 as a Tool for a Sustainable Development Strategy. Corporate Social Responsibility and Environmental Management, 25(1), pp.95-105, 2018.

Santos, G., Rebelo, M., Lopes, N., Alves, M.R. and Silva, R., Implementing and certifying ISO 14001 in Portugal: motives, difficulties, and benefits after ISO 9001 certification. Total Quality Management & Business Excellence, 27(11-12), pp.1211-1223, 2016.

Vinodh, S., TISM for analysis of barriers affecting the adoption of lean concepts to electronics component manufacture. International Journal of Lean Six Sigma, 2020.

World Bank. World Development Report. 2015: Mind, Society, and Behavior. Washington, DC: World Bank. –. 2019. World Development Report 2019: The Changing Nature of Work. Washington, DC: World Bank, 2015.

Willie, L., Measuring success of information systems in small and medium enterprises in Gauteng (Doctoral dissertation, Vaal University of Technology), 2021.

Yadav, G., Luthra, S., Huisingh, D., Mangla, S.K., Narkhede, B.E. and Liu, Y., Development of a lean manufacturing framework to enhance its adoption within manufacturing companies in developing economies. Journal of Cleaner Production, 245, p.118726, 2020.

Zvidzayi, J., The impact of 5s kaizen in the implementation of lean manufacturing in South Africa (SA). In Proc. Int. Conf. Ind. Eng. Oper. Manag (pp. 6492-6501), 2021.

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