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STRENGTHENING MANUFACTURING COMPETITIVENESS THROUGH SUSTAINABLE MANUFACTURING AMONG INDUSTRIAL ESTATE IN WEST JAVA, INDONESIA

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Abstract: Sustainable manufacturing utilizes environmentally friendly resources and minimizes waste. It prioritizes efficiency in production. This study investigated the economic, environmental, social, science and technology factors to create sustainable manufacturing in an industrial estate, as well as to determine the impact on strengthening manufacturing competitiveness. A survey was conducted on 175 managers in the manufacturing industry at an industrial estate in West Java, Indonesia. Data analyzed through Structural Equation Modelling found that economic, environmental, social, science and technology factors have a significant effect on sustainable manufacturing and on manufacturing competitiveness. Costs, level of pollution, number of customers, research and development are some important indicators in strengthening sustainable manufacturing, and economic factors are the most significant in affecting the development of sustainable manufacturing. To increase manufacturing competitiveness, it is necessary to have sustainable manufacturing through optimizing economic, environmental, social, science and technology factors. This study recommends that to manufacturing industry stakeholders pay attention to principles of sustainable manufacturing through several variables that encourage the creations of superior manufacturing competitiveness.

Keywords: Competitive strategy, sustainable manufacturing, manufacturing competitiveness, industrial estate.

Introduction

The Indonesian government's target to improve the country's global competitiveness rankings in 2019 was not achieved, as the country slid from the previous ranking of 45 to 50, as recorded in the 2019 Global Competitiveness Index published by the World Economic Forum. While Indonesia's ranking in Ease of Doing Business (EODB) is at 73 out of 190 countries, this ranking is below Vietnam and Malaysia (World-Bank, 2020). The government's optimism to improve the EODB rank to below 60, as presented the at Indonesia Economic and Investment Outlook 2020 event, will face considerable obstacles due to the global economic recession caused by the COVID-19 pandemic. In addition, CEIC data published by ISI Emerging Markets Group, showed that that Indonesia experienced a significant decline in its industrial production index from October 2019 (6,736) to January 2020 (-0,813). Growth with a negative value in early 2020 implies that industrial production in Indonesia is in an unhealthy state and experienced various problems that must be addressed.

One important component in national economic development is the contribution of the manufacturing sector because it can make the greatest contribution to Gross Domestic Product (GDP). The importance of the manufacturing industry sector can be tracked by several indicators that monitor its contribution to GDP, including production, number of workers, and productivity. To increase economic growth, Indonesia must strengthen its business competitiveness, including through the development of the manufacturing industry. Although the government has a policy of developing industrial estates across various regions (Kandiawan *et al*., 2017), this policy has not been able to significantly increase industrial production. For this reason, an effective strategy is needed to increase the contribution of the manufacturing industry to GDP. Business success and long-term sustainability depend on continuous transformation and maintaining competitiveness through building special capabilities (Hussain & Jahanzaib, 2018). Indonesian manufacturers do not adhere to the economic, social, and environmental goals of sustainable development (Azapagic & Perdan, 2000).

Competitiveness is generally developed through strategic management (Chikán *et al*., 2022). The essence of strategic management is to make companies more competitive in the market by improving and sustaining market positions (Oral & Reisman, 1988). To improve global competitiveness, several countries in the region establish a domestic economic integration (Fafurida *et al*., 2016). One of the biggest challenges to industry today is finding ways to improve competitiveness so that business continues to grow (Ocampo *et al*., 2017). Manufacturing strategy determines the deployment of various resources to build capabilities in creating products, and maintaining costs and advantages to sustain a high level of profitability and a strong market position (Soosay *et al*., 2016). Competitiveness is one of the main goals of developing countries because it is considered an index to measure economic progress (Alomari, 2019). It is also a key strategy to business survival and a core benchmark for ensuring a firm remains a going concern in a modern business environment (Uchehara, 2019). Competitiveness is an important starting point because the investments it attracts contributes to higher living standards and generates the resources needed for wider societal goals (Schwab, 2018).

Manufacturing sustainability is important to strengthen business performance in the manufacturing industry (S. Sarjana *et al*., 2020). The development of sustainable manufacturing is a big challenge for Indonesian SMEs (Fatimah *et al*., 2013). Implementing sustainable manufacturing initiatives can save a company money and increase revenue (Carley *et al*., 2014). A comprehensive system approach to sustainable manufacturing needs to be done through a Life Cycle Assessment (LCA) approach because of the environmental impacts from manufacturing to the life cycle phase, such as raw material acquisition, material production, and end of life (Westkamper *et al*., 2000). Sustainable manufacturing issues emphasize the need for a systems approach that can synthesize the triple bottom line, life cycle views, and information systems (Rachuri *et al*., 2010). Sustainability has been found to be a driver of innovation (Jawahir *et al*., 2013). Manufacturing has faced many challenges to become sustainable while maintaining competitiveness (Hussain & Jahanzaib, 2018).

A manufacturing strategy must allow a company to provide savings in terms of production even though its effectiveness depends on the volume and profile of product demand (Kaku, 2017). The manufacturing industry is seeking an open, inclusive, and neutral set of indicators to measure sustainability of manufactured products and manufacturing processes (Joung *et al*., 2012). Sustainable manufacturing recommends that companies implement new design and analyse procedures, energy reduction methods, material reduction efforts, and better material handling practices so as to minimize environmental impacts throughout the product life cycle (Rachuri *et al*., 2010). The benefits of sustainable manufacturing include economic gains, social commitment, meeting regulatory requirements, and using less resources, fulfilling consumer expectations, appreciation, and media attention, and earning benefits (Carley *et al*., 2014). Innovative sustainable manufacturing can be an engine for sustainable growth by not only promoting economic expansion, but also enabling social welfare and environmentally sound practices (Jawahir *et al*., 2013). The manufacturing industry development function is directed towards business sustainability (Sarjana & Widokarti, 2020).

Manufacturing industries need to develop compliance strategies, be environmentally responsible and be able to collaborate in considering economic, environmental, and social objectives (Ahmadi-Gh & Bello-Pintado, 2022). The manufacturing industry is the main part of the national real economy, and many developed and developing countries attach great significance to it (Liu *et al*., 2017). Manufacturing companies can add services, combine them with goods or tie in services to sales to differentiate their products and make them more attractive to customers in a highly competitive environment (Avendano *et al*., 2019). The industrial sector is one of the most highlighted sectors in discussions about the environment, adding to the market challenges of the sector as consumers increasingly consider the environmental footprint of the products they purchase (Djajadiningrat & Famiola, 2004). Industrial estates so far are collections of unrelated industries, especially in environmental management (Djajadiningrat & Famiola, 2004). New geographic drivers of manufacturing include changes in factor inputs, transformations in manufacturing technology, and service integration with manufacturers to create new hybrid production systems and hybrid products (Bryson *et al*., 2013).

This study aims to determine the effect of economic, environmental, social, science and technology factors on sustainable manufacturing and their impact on manufacturing competitiveness, especially for manufacturers in industrial estates. The development of industrial estates was meant to encourage growth that is more directed, integrated, and provides optimal results through efficiency, spatial planning, and environment. For this reason, industrial estate development must use sustainable development practices by paying attention to economic, social, environmental functions, and obeying regulations.

Literature Review

Manufacturing Competitiveness

Competitiveness is perceived as the ability to sell products that meet the requirements of demand and at the same time ensure profits over time that allow the company to grow (Uchehara, 2019). Efforts to create superior value correlates with superior financial performance or higher profitability than the industry average (Porter, 1998). It is important to create strategies to increase competitiveness (Fafurida *et al*., 2016). Manufacturing competitiveness uses comparative performance to meet certain objectives (Ocampo *et al*., 2017), which are important for job creation and economic growth (Gates, 2018). Competitiveness is vital for companies competing in the global market, where products, services, people, and innovations move freely despite geographical boundaries (Chao-Hung & Li-Chang, 2010). Investing in science and innovation indicate that a country encourages producers to increasingly use advanced technology to enhance manufacturing competitiveness (Giffi *et al*., 2016).

It is important to achieve competitiveness and sustainability simultaneously in the manufacturing industry while balancing between complexity, resilience, and efficiency (Byrne & Monostori, 2021). Infrastructure, macroeconomics, health and basic education, higher education and training, efficiency of the goods market, technological readiness, business sophistication, and innovation are great contributors to competitiveness (Alomari, 2019). Productivity is one of the fundamental pillars for increasing competitiveness through technology adoption, adequate production scale, and increased efficiency (Beber *et al*., 2019).

Sustainable Manufacturing

Sustainable manufacturing is to intelligently use natural resources to create products, use new technologies, foster social cohesion, meet economic, environmental and social goals, and preserving the environment while continuing to improve the quality of human life (Garetti & Taish, 2011). New ways of doing business and creating value by engaging in initiatives and innovations that help develop a healthier environment, increase competitiveness, reduce risk, build trust, encourage investment, attract customers, and generate profits (OECD, 2011) are gaining attention because of the rapid improvement in alleviating environmental degradation (Chowdhury & Yasmin, 2018). A systems approach to the creation and distribution of innovative products and services, minimizing resources, eliminating toxic substances, and producing zero waste (Rachuri *et al*., 2010) is a comprehensive strategy to reduce environmental impacts and improve the economic performance of the manufacturing industry (Yuan *et al*., 2012). Sustainable manufacturing is the integration of activities carried out by the company covering the environmental, social, and economic fields (Patalas-Maliszewska *et al*., 2022). The four main sustainable manufacturing activities involve reducing energy use, water use, emissions from the manufacturing process, and physical waste (Carley *et al*., 2014). Sustainable manufacturing practices refer to energy, material and waste management, as well as increased energy efficiency that results in economic savings, increased competitiveness and higher productivity (Alayón, 2016).

Three pillars of sustainable development include economic sustainability, sustainable manufacturing, and social sustainability (Florescu & Barabas, 2018). Sustainability is an important part of manufacturing strategy (Kaku, 2017). It has become a core component of business for long-term success, but the average producer often targets short-term economic benefits (Hussain & Jahanzaib, 2018). Sustainable manufacturing is an effective solution to support the growth of the industry (Yuan *et al*., 2012). It combines lean manufacturing ideas, green manufacturing, total quality management, and corporate social responsibility and processes that reduce waste, while staying focused on ethical obligations to the community (Carley *et al*., 2014). Energy conservation and waste management are found to be the most popular sustainability practices (Alayón, 2016).

Sustainable manufacturing aims to reduce resource consumption through increasing efficiency in the manufacturing process, eliminating unnecessary use of resources, and reducing the amount of waste and emissions (Carley *et al*., 2014). Sustainability sees developing and improving human life over time through the optimization of production and consumption by making efficiencies in material and energy consumption, focusing on reducing poverty and preserving resources (Azapagic & Perdan, 2000). Using environmentally friendly methods for the recovery of useful resources is a vital issue for governments and industry globally (Chowdhury & Yasmin, 2018). Such methods offer a new way to produce superior, integrated products that enable sustainable value creation for all stakeholders (Jawahir *et al*., 2013). It is a comprehensive strategy to improve a company's economic, social, and environmental performance (Hussain & Jahanzaib, 2018). Sustainable development in manufacturing goes beyond environmental preservation to protect the environment and its resources and satisfy human needs and drive progress (Kaku, 2017).

Sustainable manufacturing practices are carried out with various actions, initiatives, and techniques that positively influence the environmental, social, or economic performance of manufacturing companies, and control or reduce the impact of company operations on the triple bottom line (Alayón, 2016). They seek to optimize production efficiency while minimizing environmental impacts and maintaining social justice (Nambiar, 2010). Effective solutions are needed to support the growth and expansion of the sustainable manufacturing industry (Yuan *et al*., 2012).

Sustainable manufacturing uses less energy and resources to produce products that are just as effective and at least of the same quality as products made using current methods (Carley *et al*., 2014). New integration concepts for the development of sustainable manufacturing aims to link core production targets, such as reducing costs and production time, and reduce manufacturing waste that affects the environment (Florescu & Barabas, 2018). Sustainable manufacturing systems must be designed and managed as integrated socio-techno environmental systems from a total life cycle perspective by considering interactions between different sub-systems (Jawahir *et al*., 2013). They are all about minimizing the diverse business risks inherent in manufacturing operations while maximizing new opportunities that arise from improved processes and products (OECD, 2011).

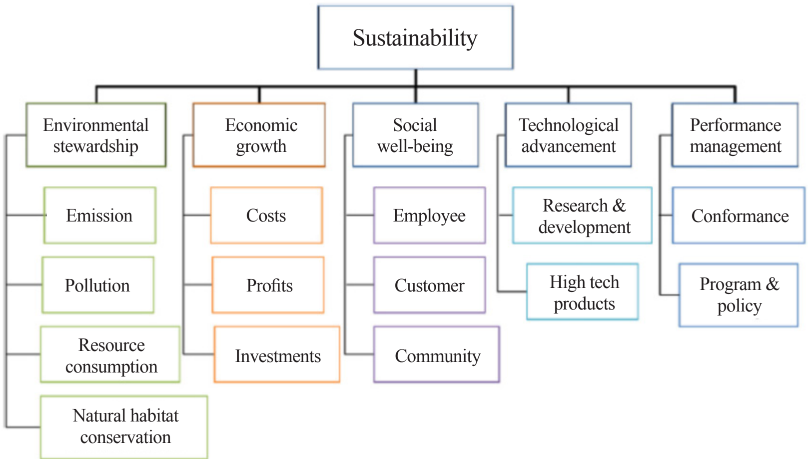

Figure 1: Sustainability indicator (Joung *et al*., 2012)

Figure 1 shows the the basis of determining several independent variables, including economic, environmental, social, and technology factors, as described by Joung *et al*. (2012) so that the concepts and theories used are similar and correlated and can be applied in different locations. The indicators highlighted by Joung *et al*. (2012) include emissions, consumption, resources consumption (environmental stewardship), costs, profits, investments (economic growth), employees, customers, and community (social well-being). Business competition in industrial estates needs to involve social activities, increasing internal capabilities and management compliance (Sarjana *et al*., 2018).

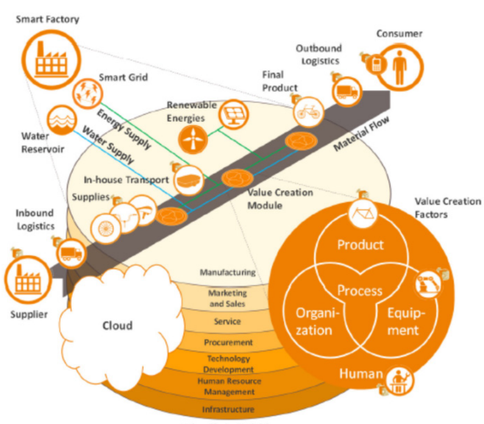

Figure 2: Variable description of sustainable manufacturing (Stock & Seliger, 2016)

Sustainable manufacturing variables were described by Stock and Seliger (2016) (Figure 2) who researched industry 4.0 from a macro perspective by revealing several dimensions, including human, process, product, organization, and equipment. Industrial value creation that focuses on industry 4.0, prioritizes sustainable manufacturing with various dimensions are used as indicators in this study.

Hypothesis Development

The research hypothesis formulated from the literature review are as follows:

H_1: Economic factors have significant effect on sustainable manufacturing

H_2: Environment factors have significant effect on sustainable manufacturing

H_3: Social factors have significant effect on sustainable manufacturing

H_4: Science and technology factors have significant effect on sustainable manufacturing

H_5: Sustainable manufacturing has significant effect on manufacturing competitiveness

Materials and Methods

Empirical investigation presented in this study examines the important roles of economic, environmental, social, science and technology factors in order to create sustainable manufacturing in industrial estates, as well as to determine their impact on strengthening manufacturing competitiveness. Quantitative research is applied in this study by surveying manufacturing industries in an industrial area located in West Java, Indonesia which has the largest number of industrial areas in Indonesia. The selection of 175 manufacturing company managers was done through random sampling. The research questionnaire was in the form of a list of statements that referred to indicators in order to establish the completeness of research variables being tested.

Construct reliability and variance extracted are implemented to analyze confirmatory factors to obtain valid and reliable data through questionnaire verification. The analysis of survey data was done using Structural Equation Modelling (SEM) with the Lisrel 8.8 software. The advantage of using SEM analysis is its ability to analyze various data with complex levels of difficulty. SEM is able to solve complex models with strong theoretical support and aims to confirm the suitability of the theoretical model based on in-depth theory study (Figure 3).

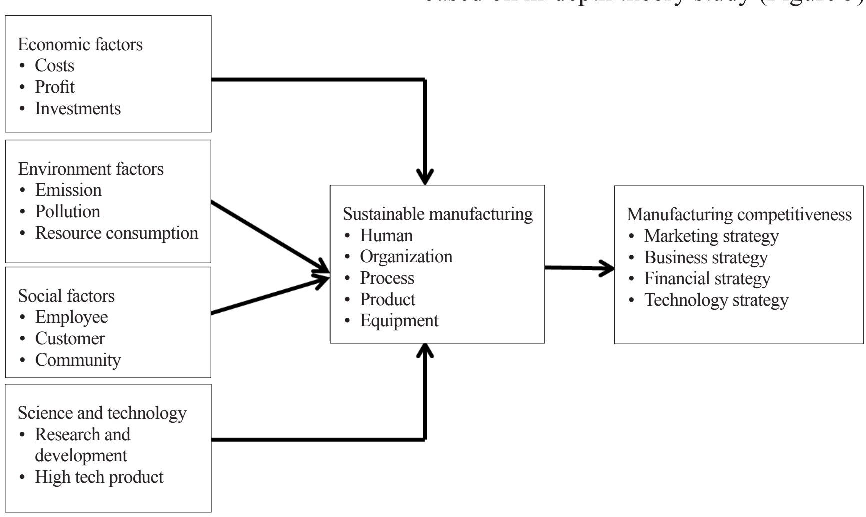

Figure 3: Research framework

Results and Discussion

Analysis developed in this study utilizes structural equation modelling as part of multivariate statistical calculations. Some of the variables used in forming the model have complexity so the SEM test is an appropriate analysis. Lisrel 8.8 calculates SEM to answer the hypothesis. Data sample of 175 respondents is sourced from company managers in manufacturing industry located in industrial estates. Completeness of data is obtained from questionnaires distributed to respondents in industrial estates in West Java.

Table 1: Characteristics of respondents

Profile of Respondents	Characteristics	Total	Percentages (%)
Gender	Male	147	84
	Female	28	16
Age	< 30	7	4
	30 - 40	17	9.7
	40 - 50	95	54.3
	50 >	56	32.0
Education	High school	4	2.3
	Diploma	19	10.9
	Bachelor's degree	113	64.6
	Master's degree	39	22.3
Line of business	Automotive	74	42.3
	Electronic	39	22.3
	Food & beverage	23	13.1
	Pharmaceutical	13	7.4
	Logistic	11	6.3
	Others	15	8.6

Respondents were classified into four categories: Gender, age, education level, and line of business (Table 1). Most of the respondents were males at 84% compared to female respondents at 16%. Respondents aged 40-50 years old make up 54.3%, and 64.6% of respondents have a Bachelor's degree education, which is considered essential to developing thinking skills to achieve company goals. The manufacturing businesses in West Java are quite diverse, but most are engaged in automotive or automotive components, at 42.3%. The automotive industry is felt to be more stable in responding to latest developing situations and conditions so that despite turmoil, it can still survive and grow again.

Structural equation modelling is used to calculate the size of Construct Reliability (CR) and Variance Extracted (VE). Good model fit in calculations using path coefficients is significantly acceptable by having construct reliability values above 0.7 for each construct tested (Gefen *et al*., 2000), and the construct has good validity if the average VE is greater than 0.5 (Hair *et al*., 2005). Minimum value for measuring CR must be greater than 0.7, while minimum value for measuring VE must be greater than 0.5. Economic, environmental, social, and science and technology factors, sustainable manufacturing and manufacturing competitiveness, CR and VE calculations are performed to determine the results of the modelling.

Table 2: The results of construct reliability and variance extracted

Variable	Dimension	Standardized Loading (l)	t-value	Error Variance	Construct Reliability (CR)	Variance Extracted (VE)	Remark
Economic factors	eco1 = Cost	0.91	15.09	0.18	0.995	0.793	Valid & reliable
	eco2 = Profit	0.90	15.04	0.18			
	eco3 = Investments	0.86	13.85	0.26			
Environment factors	env1 = Emissions	0.72	10.14	0.48	0.975	0.621	Valid & reliable
	env2 = Pollutions	0.82	11.77	0.33			
	env3 = Resource consumption	0.82	11.88	0.32			
Social factors	soc1 = Employee	0.65	6.81	0.57	0.945	0.508	Valid & reliable
	soc2 = Customer	0.69	6.74	0.58			
	soc3 = Community	0.79	5.64	0.74			
Science & technology	sci1 = Research and development	1.15	5.47	-0.33	0.962	0.886	Valid & reliable
	sci2 = High technology product	0.67	4.89	0.55			
Sustainable manufacturing	sm1 = Human	0.72	0.00	0.82	0.970	0.520	Valid & reliable
	sm2 = Organization	0.69	4.85	0.52			
	sm3 = Process	0.78	4.99	0.40			
	sm4 = Product	0.74	4.38	0.71			
	sm5 = Equipment	0.67	4.49	0.68			
Manufacturing competitiveness	mc1 = Marketing strategy	0.98	0.00	0.03	0.953	0.593	Valid & reliable
	mc2 = Business strategy	0.63	10.36	0.61			
	mc3 = Financial strategy	0.47	6.98	0.78			
	mc4 = Technology strategy	0.89	23.18	0.21			

The value of construct reliability comes from the square of total standard loading value divided by the square of total standard loading value plus the total error value, where the standard loading value comes from the standardized loading value for each indicator, and the error value comes from the measurement error of each indicator. While the variance extracted value comes from the total value of square for standard loading divided by the total value of square for the standard loading plus the total value of error. The variance extracted value obtained shows the amount of variance from indicators extracted by the latent construct is more than error variance. The results shown in Table 2 show that economic factors consist of various dimensions so reliability calculations obtained a CR value of 0.995 and the variance calculation obtained VE value of 0.793. Measurement for other variables are environmental factors, CR (0.975) and VE (0.621); social factors, CR (0.945) and VE (0.508); science and technology, CR (0.962) and VE (0.886); sustainable manufacturing, CR (0.970) and VE (0.520); and manufacturing competitiveness, CR (0.953) and VE (0.593). Overall CR and VE results produce values above the threshold of construct reliability and variance extracted that can be accepted.

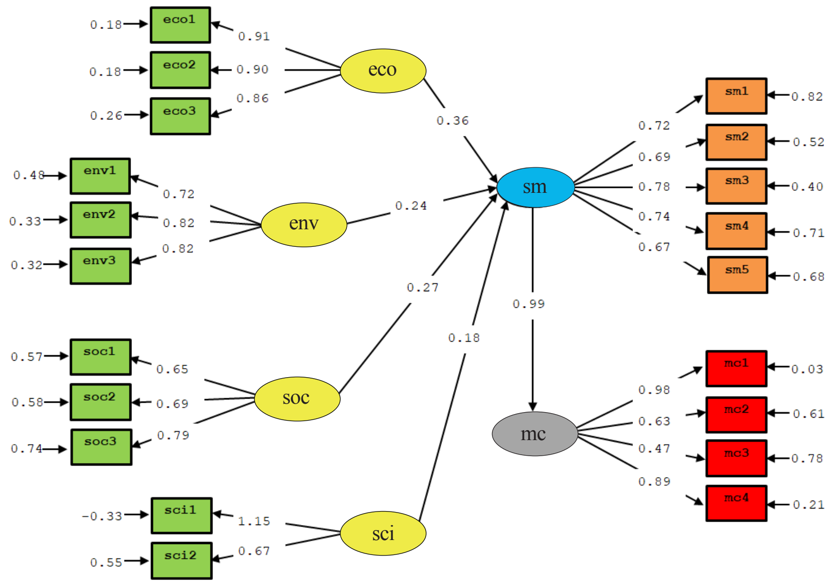

Figure 4: Equation modelling structural analysis results

The level of influence of economic, environmental, social, and science and technology factors on sustainable manufacturing are measured, which can have impact on manufacturing competitiveness through structural equation modelling tests that take place at manufacturing industry in various industrial estates. The results of analysis through various calculations in the study reveal the influence between tested variables which is formed through combination of several indicators that support it. In this case it is devoted to developing business in manufacturing industry. Results of the calculation (Figure 4) reveal that the value of effect economic factors on sustainable manufacturing is $\Upsilon_{11} = 0.36$, This shows that the magnitude of influence on economic factors is obtained from three indicators: t costs, profit, and investment. Costs have the highest influence compared to other indicators. The contribution of economic factors obtained through the development of the three indicators show that it can influence sustainable manufacturing by 36%, while 64% was influenced by other factors. The influence of environmental factors on sustainable manufacturing has effect value of $\Upsilon_{21} = 0.24$. The result indicates that environmental factors can affect sustainable manufacturing with effect value of 24%, and 85% are influenced by other factors. The influence of social factors on sustainable manufacturing has effect value of Υ_{31}=0.27, indicating that social factors can affect sustainable manufacturing by 27%, and other residual values that affect sustainable manufacturing are 73%. Science and technology's value of influence on sustainable manufacturing is Υ_{41}=0.18, so, its affect on sustainable manufacturing is 18%, and other residual values that affect sustainable manufacturing by 82%. Meanwhile, the effect of sustainable manufacturing on manufacturing competitiveness is calculated at β_{21}=0.99, indicating that sustainable manufacturing affect manufacturing competitiveness by 99%, and other residual values that affect manufacturing competitiveness by 1%. For this reason, manufacturers should prioritize sustainability in their operations in order to maintain high competitiveness, and if manufacturing sustainability trends downwards, manufacturing competitiveness can also decline.

Table 3: Index criteria analysis

Fit Indices	**Index Criteria**	**Fit Criteria**	**Result**	**Remark**
Absolute	GFI	≥ 0.90	0.92	Fit
	AGFI	≥ 0.90	0.88	Marginal
Incremental	RFI	≥ 0.90	0.87	Marginal
	IFI	≥ 0.90	0.97	Fit
	CFI	≥ 0.90	0.96	Fit
Parsimony	NFI	≥ 0.90	0.9	Fit
	NNFI	≥ 0.90	0.95	Fit
	PNFI	≥ 0.90	0.7	Marginal

Standard criteria must be determined based on goodness of fit of the results of analysis. The requirements that must be met include minimum of five criteria index from calculating the goodness of fit for measured model. The goodness of fit test uses eight index criteria to measure the suitability of model being tested. Model can be determined from its fit index value. Fit index values include goodness of fit-index, relative fit-index, incremental fit-index, normed fit-index, non-normed fit-index, comparative fit-index, adjusted goodness of fit-index, and parsimonious fit-index. A model is declared fit if resulting index value is 0.9 or greater. Results of index criteria (Table 3) obtained five models that were declared fit, while the other three models were declared marginal. Resulting index values include GFI (0.92), NFI (0.90), NNFI (0.95), CFI (0.96), IFI (0.97) where these five indexes have value equal to or greater than 0.9. While the other three indexes are RFI (0.87), AGFI (0.88), and PNFI (0.70) with index values below 0.9 but still above or equal to 0.7, so, they are included in marginal model category.

Table 4: Hypothesis results

Hypothesis Criteria	**Effect Value**	**Significance**	**Conclusion**
ECO ➡ SM	0.36	3.42	Accepted
ENV ➡ SM	0.24	2.47	Accepted
SOC ➡ SM	0.27	2.58	Accepted
SCI ➡ SM	0.18	2.05	Accepted
SM ➡ MC	0.99	17.15	Accepted

Exposure to the suitability of the proposed hypothesis refers to several variables used which consist of economic, environmental, social, and science and technology factors, sustainable manufacturing and manufacturing competitiveness, stating that all hypotheses can be accepted (Table 4). The basis of a conclusion to all the proposed hypotheses is if it has t value greater than 1.96, the proposed hypothesis can be declared significant.

Results of analysis can be stated that economic factors have significant effect on sustainable manufacturing in industrial estate. Cost is most influential indicator to improve sustainable manufacturing. Environmental factors have significant effect on sustainable manufacturing, where resources consumption is an indicator of its important role in increasing sustainable manufacturing. Social factors also have a significant affect on sustainable manufacturing, where employees are one of the important indicators that strengthen sustainable manufacturing. Science and technology have significant effect on sustainable manufacturing, where research and development support sustainable manufacturing. Likewise, sustainable manufacturing has significant effect on manufacturing competitiveness, where process indicators are an important part of forming sustainable manufacturing, so that it is able to develop manufacturing competitiveness competitiveness (Figure 5).

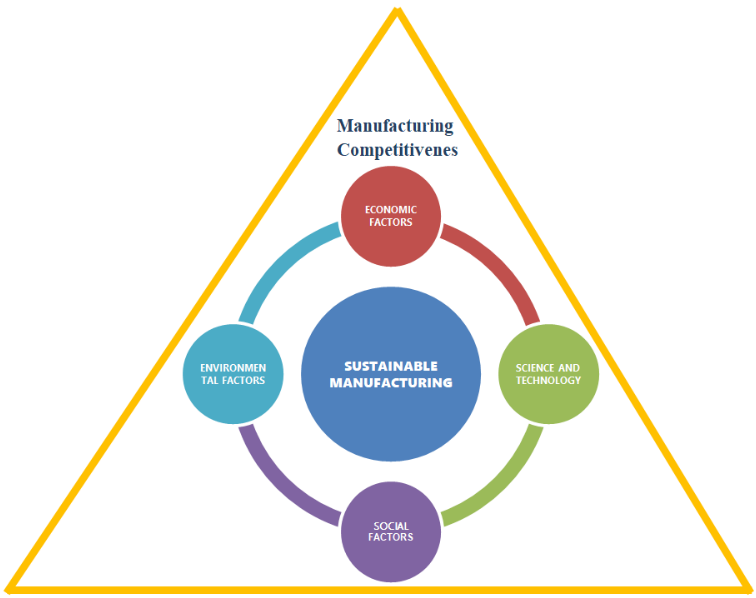

Figure 5: Manufacturing competitiveness model in industrial estate

Some of the indicators that have full contribution in creating sustainable manufacturing come from the internal and external capabilities of the manufacturing industry. They include resources in the form of human, organization, process, product, and equipment. These resources will have high effectiveness value in supporting sustainable manufacturing success if economic, environmental, social, and science and technology factors can be utilized optimally. Cost, profit, and investments are some important indicators in controlling economic growth as the manufacturing industry runs its operations. Emissions, pollution, and resource consumption are part of environmental factors that must be considered to maintain sustainability and reduce the damage that might occur until solutions are found. In addition, social factors including employees, customers, and community, need further attention so that their contribution made can continue to be significant in achieving the company goals. Moreover, the importance of science and technology through research and development, and the creation of high-tech products is the key to successful business competition in the manufacturing industry through strengthening creativity and innovation in making new products that have distinctive values according to the needs of the community. By optimally implementing sustainable manufacturing, it is hoped that what will arise is manufacturing competitiveness that is supported by appropriate strategies in carrying out business processes including through the selection of marketing, business, financial, and technology strategies.

Conclusion

Economic, environmental, social, and science and technology factors have significant effect on sustainable manufacturing and have significant impact on manufacturing competitiveness. Sustainable manufacturing has significant contribution to strengthening manufacturing competitiveness for the manufacturing industry. Sustainable manufacturing makes an important contribution to the competitive advantage of the manufacturing industry (Ahmadi-Gh & Bello-Pintado, 2022). Indicators developed in this study can be used to help solve problems in achieving sustainable manufacturing so that manufacturing industry has strong competitiveness through application of appropriate business strategies. Sustainable manufacturing is expected to be the standard for development of manufacturing industry in industrial estates, and can contribute to economic improvement, environmental sustainability, and social protection. Sustainable manufacturing development has a strategic function in the long-term to create economic development, maintain resources and environmental sustainability, maintain harmony in social life and utilize technology developed by industry, so that it can be enjoyed by next generation. Various strategies developed in the manufacturing industry have evolved to meet various business, social, and sustainability needs (Hariyani & Mishra, 2022). Manufacturing industry needs to plan long-term by considering three different aspects: Social, economic, and environmental, that can lead to increasing the competitiveness of the company's business (Mundra & Mishra, 2021).

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