sciendo

PRODUCTION ENGINEERING ARCHIVES 2022, 28(4), 336-345

PRODUCTION ENGINEERING ARCHIVES

ISSN 2353-5156 (print)
ISSN 2353-7779 (online)

Exist since 4th quarter 2013
Available online at https://pea-journal.eu

A Review on Sustainable Value Creation Factors in Sustainable Manufacturing Systems

Ni Luh Putu Hariastuti[1,*], Lukmandono[1]

[1] Department of Industrial Engineering, Faculty of Engineering, Adhi Tama Institute of Technology, Surabaya, 60117, Indonesia; putu_hrs@itats.ac.id (NLPH); lukmandono@itats.ac.id (L)
*Correspondence: putu_hrs@itats.ac.id

Article history
Received 14.01.2022
Accepted 28.09.2022
Available online 26.10.2022

Keywords
business system
competitive advantages
flexibility
partnership
transformation

Abstract
This article describes in detail the elements of value creation through the transformations and flexibility, which is carried out in the implementation of sustainable manufacturing. The purpose of this study is to generate the criteria or elements that build the sustainable value creation process through a literature review analysis. The overall classification of sustainable manufacturing implementation discussed shows several essential factors that support this. The process of review studies on selected papers strengthens the classification carried out to obtain the necessary elements of sustainable value creation. The value created can later be a hallmark of the company's superiority to survive the market competition. Besides, the role of partnerships, such as collaboration indicates a positive influence in generating value creation to increasing the company's competitive rate. In addition, the importance of partnership processes such as collaboration and cooperation between stakeholders, is needed to generate value creation to increase the company's competitive level. The partnership process is one of the critical factors in creating sustainable value in achieving sustainable manufacturing in the future.

DOI: 10.30657/pea.2022.28.42 JEL: L23, M11

1. Introduction

Nowadays, the market producer requires innovation to increase global competition. The development of technology, market politics, commercial products, and quality technology is required to survive against the dynamic market transformations (Haapala et al., 2013). The world's greatest issue due to global competition is about increasing population, consumption, industrialization, erosion of natural resources and high pollution, and climate change. This situation makes us aware that the purpose of development is not only to generate wealth and success, but it also must be passed on to next generations later (Abdul-Rashid et al., 2017a; Gupta et al.,2018). Therefore, the understanding of sustainable development is urgently needed.

Sustainable development triggers the existence of sustainable management in all aspects, for example, sustainable manufacturing. Manufacturing has a substantial influence on global expansion and growth. It is due to a high demand for consumer goods from the world population (Haapala et al., 2013). Manufacturing is crucial in the global economy. It is not only provides goods needed by consumers and industry but also contributes to a significant portion of employment, community, and economic power (Duflou et al., 2012). Manufacturing has a substantial contribution to creating a sustainable society. Sustainable construction requires simultaneous consideration between the economy, the environment, and its social impact. They are associated with the production system against the product distribution to consumers (Despeisse et al., 2012).

Brundtland Commission 1987 defines that sustainable development is the current necessities without compromising the ability of future generations to fulfil their needs (Gerasimova, 2017). The sustainability of economic development, social development, and environmental development are crucial factors in achieving the sustainability system. The main expected objective is to reduce environmental impacts associated with manufacturing activities. Sustainable manufacturing efforts are performed to develop friendly processes and products (Gunasekaran and

Spalanzani, 2012). The development of sustainable manufacturing systems generally involves factors such as Technology, engineering, economics, environmental management, health, and welfare essential factors for the development of sustainable manufacturing systems. These factors are related to the communities where they live, work, socialization, government strategies, procedures, and policies. Furthermore, sustainable manufacturing requires efforts to balance and integrate goals from social, economic, and environmental aspects. They are supported by policies and practices for implementing sustainability (Rosen and Kishawy, 2012).

The company's flexibility is a primary factor against global market challenges and achieving sustainable manufacturer (Wiendahl et al., 2007). The manufacturing industry must be able to make dynamic adaptations for transformations. It effects on external factors (market, economic, social, political, environmental) and internal factors (human resources, products, technology, new methods, network structure) in achieving sustainable competitiveness. Transformations in manufacturing activities focus on product objects, process, facilities, and organizational systems to create sustainable value.

The sustainability of the manufacturing process is critical for long-term high value in the manufacturing system. Sustainability has been recognized as a ubiquitous phenomenon that underlies the functioning and performance of companies. Sustainable value creation requires companies to have a good system during making business decisions (Ueda et al., 2009). Increasing competitiveness, profitability, and productivity in manufacturing activity are supported by the process of integrating sustainability in manufacturing (Rosen and Kishawy, 2012). During The last few years, the aspects of sustainability in manufacturing have been explored. The modeling and optimization of sustainable manufacturing against the product, process, and system-level have been reported (Jayal, et al., 2010;Kishawy et al., 2018). Sustainable supply chain design methodologies (Gunasekaran et al., 2008; Campos et al., 2017), development of friendly sustainable products (Shuaib et al., 2014; He et al.,2019), to the ongoing production process (Bocken et al., 2014; Buxel et al., 2015). Therefore, the importance of process transforming in achieving sustainable value is to be urgently investigated.

The discussion of manufacturing sustainability assessment allows it to be measured through all the aspects and implementation of sustainability. However, the overall implementation of existing sustainability still shows weaknesses and shortcomings in its implementation. Sustainability assessment through the implementation of the Life Cycle Sustainability Assessment (LCSA) as described by Bakes and Traverso, 2021, reviews that the actual sustainability assessment is still weak in the economic and social aspects. All sustainability pillars only focus on empowering environmental aspects if applied through life cycle measurements. In addition, institutional factors (law and legality) and organizational behavior greatly underlie decisions on sustainability assessments through measuring the manufacturing life cycle (Ebrahimi and Koh, 2021). The pressure exerted by institutional regulations, normative and legal aspects influence sustainability decisions made by interested parties when the manufacturing process needs to be changed. This is one of the weaknesses of the implementation of sustainability when the institutional pressure that occurs does not support production activities in the field.

Another weakness is also reinforced by (Schramm, et, al, 2020), that the sustainability assessment through the implementation of LCSA has ambiguity in the boundaries of the system used. The lack of elemental indicators and the immaturity of the LCSA application procedures are the cause of the unclear boundaries of the system being measured. This is the reason for the need for further research that is able to contribute to improving and building the implementation of LCSA in the sustainable manufacturing domain.

On the other hand, the adoption of sustainable manufacturing in various fields of the manufacturing industry such as the food, steel and chemical industries is still very limited (Malek and Desai, 2020). This labor-intensive industry certainly has negative environmental impacts that need to be identified and reduced as a result of manufacturing production activities themselves. The process of implementing sustainable manufacturing in the value creation process suggests that there is still a need for a new sustainable value creation system that involves three aspects of managerial capabilities which include: value chain operations, internal integration, and external integration (Li, et al, 2021; Hariastuti et al., 2022).

Formation of Collaborative Cooperation in creating a sustainable value stream and strategic alignment of the organization towards sustainable performance improvement, of course, if this can be realized, it will be able to form a framework that provides a holistic perspective for companies in forming strategies to create sustainable value and assist them in maintaining their persistence and position. their market (Malek and Desai, 2022). The overall weaknesses and gaps that occur in the implementation of sustainability are the main problems that need to be analyzed further in the next research in the realm of implementing sustainable manufacturing.

All transformations that occur in the implementation of economic, social, environmental aspects, the manufacturing life cycle can create sustainable value (Malek and Desai, 2022). In the end, all the transformations underlie the company's performance measurement system in achieving sustainable competitiveness.

The purpose of this study is to generate the criteria or elements that build the sustainable value creation process through a literature review analysis. In the present study, we focus on the current scientific framework for the application of sustainable manufacturing in creating sustainable value. In addition, it can use as a reference for further research in manufacturing activities. The remainder of this paper is organized as follows. In the next section explains the stages of the method for selecting papers used. The third section outlines each classification of sustainable manufacturing implementation. Finally, in section 4 is given conclusions and views for further research.

2. Experimental

In describing the concept of sustainable value factors in the manufacturing process, the implementation of literature reviews by analyzing the academic article journal database in Science Direct, Emerald journals, Scholarly journals, Scopus, and research gate. The authors have used the subject area for industrial and manufacturing engineering from the period from 2007 to 2018.

At first, approximately 100 journals consisting of article journals and conference proceedings were identified. Furthermore, each paper will be re-selected based on the content related to sustainable manufacture (SM). In the end, 80 journal articles were selected based on the expected specifications. Table 1 shows the final screening reviewed in the next section

Table 1. Summary of Citation on Sustainable Manufacturing Research

Article Source	Number of Paper
CIRP Annals	5
Book	6
Thesis	1
Procedia CIRP	7
Procedia Manufacturingacturing	3
Conference	3
Sustainability	2
Journal of Cleaner Production	17
The International Journal of Life Cycle Assessment ment	6
International Journal of Sustainable Engineering	3
International Journal of Production Economics	3
Manufacturing and Industrial Engineering	1
International Journal of Operations and Production Management	1
The Journal of Engineering Research	1
Journal of Manufacturing Technology Management	1
Omega	1
European Journal of Operational Research	1
Production Planning and Control	1
Advances in Sustainable Manufacturing	1
Journal of Manufacturing Science and Engineering	1
International Journal of Production Research	1
Others	13
Total	**80**

3. Results and discussion

3.1. Classification of sustainable manufacturing (SM) literature

The SM literature classification is shown based on the content categories, including SM base of the triple bottom line: life cycle analysis, SM base of value creation, and SM base of manufacture strategic. The purpose of this classification is to understand the value creation factors in achieving sustainable manufacturing.

Sustainability is a concept needed to achieve the expected goals. The implementation is not only at the policy level, but also in the business context. Many companies incorporate the idea of sustainability into their vision, mission, and describe the value factors generated in production activities. These factors are performed to increase the demand for product sustainability. Furthermore, it is more concerned against consumers and the environment (Zamagni et al;., 2013).

3.2. The triple bottom line of sustainable manufacture

The new paradigm relates to sustainable development concept involves economic growth, social equality, and preservation of the environment was first reported by Brundtland (Gerasimova, 2017). This report provides an understanding of the challenges facing sustainability in the future. The challenges of sustainable development embrace the three pillars of sustainability (Triple Bottom Line / TBL), which consist of environmental, economic, and social aspects (Sala et al., 2013; Seliger, 2007). Sustainable manufacturing development is a complex, normative, and subjective concept. It involves all inter- and inter-generational aspects that cannot only explain straightforwardly but also it is needed a commitment from all parties in the long term (Rosen and Kishawy, 2012).

Sustainability implementation involves all stakeholders, implemented on the product, process, manufacturing system levels, and the three pillars of sustainability. It indicates to achieve sustainability requires an integrated approach to all multi-dimensional indicators (Haapala et al., 201; Rosen and Kishawy, 2012; Moldavska and Welo, 2017; Amrina and Yusof, 2011). The scope of the implementation of SM is not only in prominent industries but also in applying the development process to the sustainability of SMEs (Thomas et al., 2012; Singh et al., 2016; Garbie, 2016). Sustainable manufacturing based on TBL and involves a plethora of aspects.

In a present study reveals the implementation of SM based on TBL involves the entire manufacturing activities, both macro, and micro. The hallmark of SM in manufacturing operations includes measurement of sustainability at the company level (Ocampo et al., 2011); environmental sustainability strategies, and minimalization of environmental impacts (Thirupathi et al., 2019; Despeisse et al., 2012), human development (Rosen and Kishawy, 2012); product sustainability (Koho et al., 2011; Huang and Badurdee, 2017); production and machine sustainability (Garretson et al., 2016; Mani et al., 2016); the determination of management strategies in balancing different factors for manufacturing operations, including ecology, economics, social and public planning (Patterson et al., 2017). Therefore, the implementation of the concept of sustainable manufacturing is critical indicators in achieving sustainable production (Rosen and Kishawy, 2012). These indicators involve economic, environmental, and social aspects according to the product and system process. Based on Moldavska and Melo (2017) reveals the understanding of SM; the discussion of various sustainability issues can be classified into 11 categories and spread across 67 sub-categories. Understanding the overall concept of SM is necessary to develop a framework. It reveals the change in implementing SM according to products, processes, customers, employees, technology,

and organizations. These change actions can provide value to manufacturers to increase the competitive level.

The SM shows the value factor in each measurement process in a present study. The resulting value creation is global and leads to the implementation of the three aspects. Sustainability-based on the value creation process (Seliger, 2007; Moldayska and Welo, 2017; Jawahir and Bradley, 2016); shows the interaction of the three elements in generating durability. TBL's lead to values and use in assessing the business's competitive ability. Value creation, in its implementation, is integrated with manufacturing activities (Seliger, 2007; Seliger, 2012). The relation between the three aspects and the value creation shows in Figure 1.

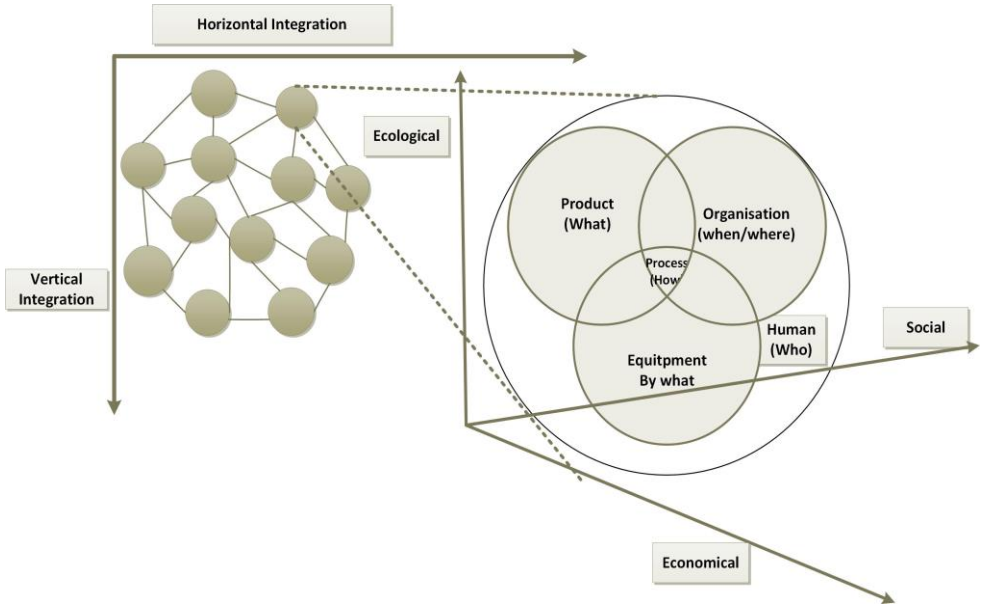

Fig. 1. Sensor The framework of sustainable value (Seliger, 2007; Seliger, 2012)

The three TBL interactions involve product value, process, equipment organization, and HR have a relationship in achieving sustainable value. The overall value factor formed is answering the 4W + 1H questions for the overall sustainability criteria. These indicate the ability of a business to carry out its manufacturing activities. The existence of these values is required in facing competition. Therefore, it can be survived compared to the existing competitors.

3.3. Analysis of sustainable manufacture of life cycle

Life cycle analysis (LCA) is an integration methodology in measuring the environment (Sala et al., 2013; Gbededo et al., 2018; Tarnawska, 2013). LCA offers a sustainable process in generating products and services in the business. The life cycle perspective of production process is related to environmental sustainability. In addition, the assessment of all materials and energy is considered in LCA. All process should be supported in achieving a sustainable environment. Furthermore, the cross-media approach should be minimalized the environmental consequences (the effect of sustainable ecological resources and the production process such as emissions to air, water, and land) (Sala et al., 2013).

The life cycle approach has been considered for providing valuable support. It is integrated against the sustainability process into the level of product design, innovation, and evaluation based on environmental policies (Zamagni et al., 2013). Product design and sustainable processes require innovation in the implementation process. New design methodologies and innovative manufacturing techniques should be developed to support the sustainability process. It involves sustainability aspects and the product life cycle (Jawahir et al., 2006). A sustainable product provides environmental, social, and economic benefits. In addition, it preserves the health, the well-being of consumers, and the environment throughout the product life cycle. Sustainable product design reduces production costs, product development time, use of raw materials, energy consumption, and waste, as well as efforts to improve operator safety, social benefits, product innovation, and minimize the environmental problems (Hatcher et al., 2011; Gremyr et al., 2014; Valdivia et al., 2012; Parent et al., 2013). Sustainable product development based on LCA involved not only in environmental aspects but also in economic aspects. It creates competitive value through sustainable and manufacturing activities (Yang et al., 2011; Dües et al., 2013). Furthermore, innovation and novel techniques increase the efficiency and competitiveness of company (Aguado et al., 2013).

Analysis of a sustainable life cycle creates eco-innovation, which results from the achievement of clean business growth on the influence exerted on environmental and economic aspects (Gbededo et al., 2018; Tarnawska, 2013). According to the 2011 OECD; eco-innovation is a business change innovation strategy that aims to increase competitiveness and reduce the negative impacts on the environment. The focus of eco-innovation is a transformation (Gbededo et al., 2018), which includes the process of redesigning and modification of products, processes, and systems, including in the use of technology, policies, and services provided. Transformations are performed to support the improvement of business performance to achieve sustainable development. This is corresponding with several other studies that describe life cycle analysis and focus on eco-design and product development processes (Bakker et al., 2014; Jayal et al., 2010); Besides the development of life cycle analysis research through the process of eco-innovation also refers to business performance (Hsu et al., 2017; Abdul-Rashid et al., 2017b) and manufacturing sustainability through manufacturing processes (Dües et al., 2013; Goshime et al., 2019). Eco-innovation refers to three dimensions in creating competitive

manufacturing activities (Gbededo et al., 2018). The first dimension is the target. It is an attribute of a company to transformations through an innovation process. These dimensions include products, processes, organizations, or technologies. The second dimension is the mechanism, which is the process or method to make transformations against the target dimension. The third dimension is an impact, which is the effect caused by the transformations against the target dimension.

Based on the three dimensions of eco-innovation, the concept of eco-innovation as a sophisticated system methodology in its implementation. It involves various scientific disciplines in manufacturing new products that are competitive and environmentally. Figure 2 provides an eco-innovation design and shows the relations among the three dimensions of sustainable manufacturing. Three dimensions include mechanism, target, and impact, integrated into carrying out the expected change process. The mechanism dimension as a tool to make changes (eco-design processes, manufacturing methods, as well as other methods), causing the target dimension through its factors (such as products, processes, organizations, technology, and services). It influences on the three pillars of the sustainability aspects. Transformations made to the target dimensions allow the creation of sustainable value. Furthermore, transformations must have a positive impact on the sustainability of environmental and economic aspects to increase a company's competitiveness. Therefore, the target dimension is sustainable value factors and influences transformations in manufacturing activities.

The manufacturing sustainability based on the life cycle analysis is only focused on environmental and economic aspects. It is not considered the social aspect. However, the focus of product transformations creates sustainable value through eco-innovation. The transformations indicate the product, process, organization, technology, and service factors are critical values in the analysis of a sustainable life cycle. It supports the achievement of the three fundamental aspects of sustainability (TBL).

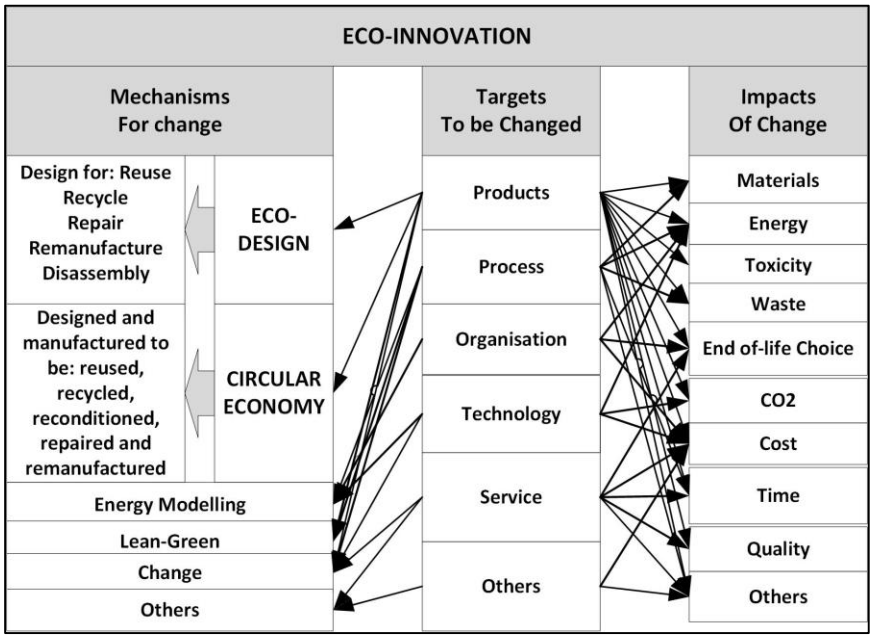

Fig. 2. Eco-innovation design in achieving production efficiency (Gbededo et al., 2018)

3.4. Sustainable manufacture of value creation factors

In manufacturing, value is generating through activities and interactions between suppliers, producers, and other stakeholders (Ueda et al., 2009). The change in the ratio between input and output in the use of raw materials, additional materials, and operational materials through physical and chemical processes impact the expected manufacturing value (Bilge et al., 2016). When there is an effort to recognize sustainable value creation, all activities must involve sustainability in the product, process, and system levels. The impact on all shareholders and stakeholders (Badurdeen and Jawahir, 2017).

The problem-solving in business and building strategies for sustainable manufacturing requires collaborative or comprehensive efforts. The strategy must create sustainable value for all stakeholders. Performance measurement and strategic methods build competitive advantages and efficiency. Several studies support this (Millar and Russell, 2011; Ülengin et al., 2014; Hsu et al., 2017; Goshime et al., 2019); explained the achievement of optimal efficiency through company performance. Other research related to the application of manufacturing and focus on minimizing costs (Yang et al., 2011; Thirupathi et al., 2019). However, both methods remain inadequate to create sustainable manufacturing value. Considering the decision process in sustainable manufacturing must involve the product domain, processes, and systems in the product life cycle (Bilge et al., 2015). Therefore, it is necessary for the company's efforts to develop innovative strategies in order to create sustainable value.

Value creation by companies is performed to provide satisfaction to all parties. The value must fulfil the demands expected by consumers and the shareholder's requirements. Products, processes, equipment, organizations and human beings are integrated into manufacturing activities (Seliger, 2007). The integration shows the value formed by the alliance between stakeholders in providing raw materials and other resources through the supply chain flow. Supply chain collaboration impact a positive influence on improving the three pillars of sustainability (Gimenez et al., 2012). In addition, the value creation is carried out throughout manufacturing activities by changing the input to the output of the product life cycle (Seliger, 2012).

The strategic alignment perspective and the sustainability perspective are required to achieve the value of manufacturing sustainability. Decision-makers must consider both perspectives in each process of improvement and change in a particu-

lar condition (Bilge et al., 2014; Bilge et al., 2016). Measurement of both perspectives is performed through the calculation of the sustainability matrix. It involves the assessment of perspectives to produce composite values. In addition, the determination of an alternative plan based on a comparison of the composite values is (Zhang et al., 2012; Shuaib et al., 2014). Alternative evaluation ratings can be used to support the design of short-term strategic decisions. It is related to operational activities. Therefore, the best alternative selection to support the implementation is to improve the profitability and sustainability of the company.

A comprehensive analysis of sustainable business must be able to balance the benefits received by the Triple Bottom Line sustainable aspect simultaneously. Decisions must be able to develop new alternatives for value creation factors. It also increases a competitive advantage on an ongoing basis. Therefore, it is essential to describe the characteristics factor of sustainable value. In a present study reveals several attributes as a characteristic to define the value creation factors (Ocampo and Clark, 2015; Aboelmaged 2018). In addition, the eco-innovation system is critical strategy in manufacturing activities (Ciasullo and Troisi, 2013). Products, processes, technology in equipment, employees and organizations must be considered as an important factor. Sustainability attributes must present the sustainability aspects in order to solve problems (Moldavska and Welo, 2017).

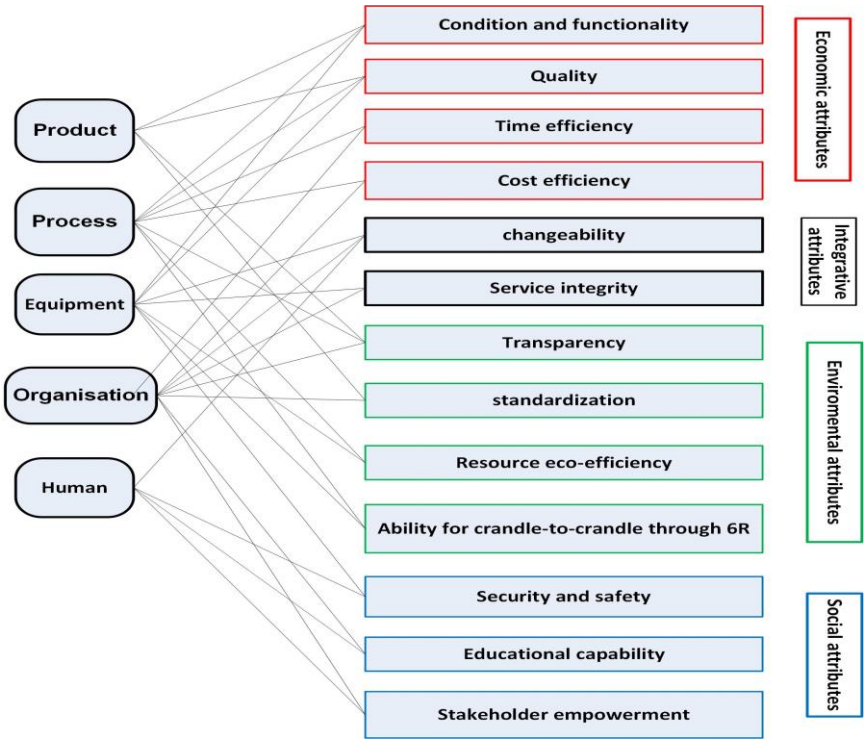

Fig. 3. Relation of sustainability attributes with aspects of sus-tainability against the value creation factor (Bilge et al., 2015)

Bilge et al. (2015) describes the relation of attributes that can explain the three aspects of sustainability with the five factors of value creation to achieve sustainability value. Figure 3 illustrates the intended connection. The results show that 13 sustainable attributes directly integrate with the five factors of value creation. The attributes themselves reflect the assessment of the three fundamental aspects: economic, environmental and social, as well as the integration aspects of the three existing elements. The level of connectivity illustrates those transformations to one of the sustainability values affect several factors of value creation. The calculation of sustainability metrics based on the assessment of weights and criteria values is the best choice to get the expected value of sustainable (Bilge et al., 2014; Hapuwatte et al., 2016). It indicates that sustainability achievement is closely related to the process of creating value. The interaction of each factor makes it easier for researchers and companies to carry out more in-depth analysis and calculation of the expected formation against sustainable values. Therefore, the value formed can be criteria for a competitive advantage.

3.5. Sustainable of manufacture strategies

Sustainable manufacturing measurement refers to achieving sustainability through the three aspects of sustainability. It involves the entire product life cycle as well as product levels, processes, and manufacturing systems. All of these elements are the basis for achieving sustainable manufacturing activities. Sustainable practice is a business model and company survival. It is due to directed and continuous action strategies (Lloret, 2016). However, the process does not deny the existence of gaps in achieving sustainable value against manufacturing activities (Despeisse et al., 2012).

There are several problems in achieving sustainable value. Various risks in the supply chain, efforts to apply new technologies and guarantees of trust and security between suppliers remain unclear. The lack of activities to increase the human resources can be a threat in achieving sustainable value (Hami et al., 2015; Bhanot et al., 2017; Trianni et al., 2017; Helleno et al., 2017). The existence of real-time information encourages the right decision-making process. It is needed in manufacturing strategies to minimize costs, reduce risks, and eliminate inefficient production activities (Jayal et al., 2010).

Sustainable manufacturing activity demands change and flexibility. It requires an appropriate strategy in designing transformations. Research on sustainable manufacturing practices and manufacturing performance strategy design explained the process of developing a sustainability strategy is needed. In a present study provides the value of sustainability. Dubey et al. (2015) develop a framework that shows leadership, regulatory pressure from the government, supplier relation management, employee involvement, and manufacturing process are an important role in achieving better economic, environmental, and social performance. This research shows that SM is the idea

of making dynamic transformations in the manufacturing structure. It creates an overall manufacturing competitiveness.

Another study suggested improving steps for the manufacturing industry to operate sustainability. Minimizing waste and promoting the recycling process immediately are urgently needed to save energy consumption. Furthermore, the use of chemicals and air emissions, maintain safe and standardized work practices are needed for workers and the environment. The overall proposed strategies outlined can represent the triple bottom line aspect to carry out the desired sustainability. Other strategies in implementing and practicing sustainability focus on increasing the role of employees. Therefore, sustainability implementation can be conducted as expected (Garbie, 2015). The ignorance for concepts related to the sustainability process, lack of adequate staff in carrying out the sustainable performance index, and inadequate human resource capabilities in understanding sustainability implementation are crucial factors. They trigger low sustainability implementation in manufacturing activities. It indicates improving sustainability performance not only enhances environmental performance and strengthens economic viability, but also improves business social performance.

Accuracy of information and security against the risks can support in manufacturing (Calik and Bardudeen, 2016; Shankar et al., 2017; Pesonen and Horn, 2012). The partnership strategy supports in creating sustainable value. Collaboration in minimizing the risks and the value of partnership can overcome various challenges (Evans et al., 2017; Granados, 2014). Other researchers also revealed that the partnership strategy supports industry necessities, guarantees funding sources, as well as transferring knowledge to technology. The partnership is critical in businesses to carry out manufacturing activities (Moore and Manring, 2009).

A partnership is a strategy to minimize the information gap, able to create collaborative value in achieving the goals. Therefore, a secure and beneficial collaboration platform is needed to share information quickly. The achievement of sustainable value significantly influenced by the implementation of partnership strategies and increasing business opportunities. The importance of partnership strategies affects the strength of the company to increase business opportunities, technological flexibility, and the process of reconfiguring manufacturing activities. Therefore, they can be more competitive in market competition (Cui and Jiao, 2011.

A partnership strategy is a critical factor in achieving sustainable performed by stakeholders and shareholders. It is crucial in facing market competition. Figure 4 shows the conceptual model in a present study. The model shows conceptually the influence of the partnership strategy in the process of change and the flexibility of value creation to achieve sustainable competitive advantage.

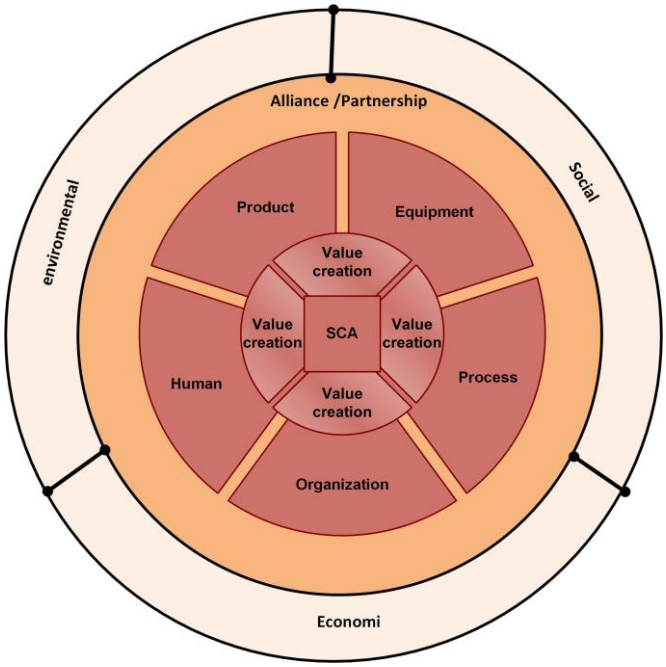

Fig. 4. Conceptual model of partnership strategy and the factor of sustainable value factors

We suggest investigating partnership factor as a critical factor in achieving sustainability value in future research. The partnership factor is the final choices in a sustainability discussion. It provides companies to achieve competitive advantage. This concept is required necessities to explore to reveal the critical role of partnership strategies in achieving manufacturing sustainability. Qualitative and quantitative analysis can be performed in strengthening existing conceptual values. According to the calculation of sustainability matrix or the process of measuring company performance useful in improving the company's competitive advantage

5. Summary and conclusion

Sustainable value requires companies to have proper system processes in making business decisions. Companies need to consider creating value for multi-stakeholders. They are consumers, suppliers, employees, society, and the environment. The classification of SM can produce sustainable value through its creation factors. Transformations and flexibility of products, processes, equipment, organization, and human resources increase sustainable value. A competitive manufacturing industry triggers sustainable value. The process of transformation and flexibility in the implementation of sustainable manufacturing certainly cannot be done independently, there needs to be a comprehensive collaboration and partnership between stakeholders and shareholders in creating the expected sustainable value. SM's achievements by involving well-integrated partnerships provide and strengthen a comprehensive view of sustainability research. This conceptual model is the basic thinking for further research in designing sustainable manufacturing strategies through value creation. However, the

limitation of this study is the focus on the elements of sustainable value creation generated through the implementation of sustainable manufacturing. Meanwhile, the latest references spanning the last five years that discuss this topic are very limited.

Acknowledgements

The author would like to thank all those who have helped and supported in the process of writing this paper, especially to the leadership and management of the Surabaya Adhi Tama Institute of Technology (ITATS) foundation who have assisted in providing facilities and infrastructure for the research process.

References

Abdul-Rashid, S.H., Sakundarini, N., Ariffin, R., Ghazilla, R., Thurasamy, R., 2017a. The impact of sustainable manufacturing practices on sustainability performance: Empirical evidence from Malaysia. International Journal of Operations & Production Management, 37(2), 182-204.

Abdul-Rashid, S.H., Sakundarini, N., Ariffin, R., Ramayah, T., 2017b. Drivers for the adoption of sustainable manufacturing practices: A Malaysia perspective. International Journal of Precision Engineering and Manufacturing, 8, 1619-1631.

Aboelmaged, M., 2018. The drivers of sustainable manufacturing practices in Egyptian SMEs and their impact on competitive capabilities: A PLS-SEM model. Journal of Cleaner Production, 175, 207-221.

Aguado, S., Alvarez, R., Domingo, R., 2013. Model of efficient and sustainable improvements in a lean production system through processes of environmental innovation, Journal of Cleaner Production, 47, 141-148.

Amrina, E., Yusof, S.M., 2011. Key performance indicators for sustainable manufacturing evaluation in automotive companies. In IEEE International Conference on Industrial Engineering and Engineering Management, Singapore, 1093-1097.

Backes, J.G. Traverso, M. 2021. Application of life cycle sustainability assessment in the construction sector: A systematic literature review. Processes, 9, 1248.

Badurdeen, F., Jawahir, I.S., 2017. Strategies for value creation through sustainable manufacturing. Procedia Manufacturingacture, 8, 20-27.

Bakker, C., Wang, F., Huisman, J., den Hollander, M., 2014. Products that go round: exploring product life extension through design. Journal of Cleaner Production, 69, 10-16.

Bhanot, N., Rao, P.V., Deshmukh, S.G., 2017. An integrated approach for analysing the enablers and barriers of sustainable manufacturing Journal of Cleaner Production, 142, 4412-4439.

Bilge, P., Badurden, F., Seliger, G., Jawahir, I.S., 2014. Model-based approach for assessing value creation to enhance sustainability in manufacturing. Procedia CIRP, 17, 106-111.

Bilge, P., Badurdeen, F., Seliger, G., Jawahir, I.S., 2015. Conceptual modelling of interactions among value creation factors for improved sustainable value creation. IJSEAM, 2(3), 287-311.

Bilge, P., Badurdeen, F., Seliger, G., Jawahir, I.S., 2016. A novel manufacturing architecture for sustainable value creation. CIRP Annals, 65(1), 455-458.

Bocken, N.M.P., Short, S.W., Rana, P., Evans, S., 2014. A literature and practice review to develop sustainable business model archetypes. Journal of Cleaner Production, 65, 42-56.

Buxel, H., Esenduran, G., Griffin, S., 2015. Strategic sustainability: Creating business value with life cycle analysis. Business Horizons, 58(1), 109-122.

Calik, E., Bardudeen, F.A., 2016. Measurement scale to evaluate sustainable innovation performance in manufacturing organizations. Procedia CIRP, 40, 449-454.

Campos, J.K., Straube, F., Wutke, S., Cardoso, P.A., 2017. Creating value by sustainable manufacturing and supply chain management practices – a cross-country comparison. Procedia Manufacturing, 8, 686-690.

Ciasullo, M.V., Troisi, O., 2013. Sustainable value creation in SMEs: a case study. TQM Journal, 25(1), 44-61.

Cui, Y., Jiao, H., 2011. Dynamic capabilities, strategic stakeholder alliances and sustainable competitive advantage: evidence from China. Corporate Governance, 11(4), 386-398.

Despeisse, M., Mbaye, F., Ball, P.D., Levers, A., 2012. The emergence of sustainable manufacturing practices. Production Planning & Control, 23(5), 354-376.

Dubey, R., Gunasekaran, A., Chakrabarty, A., 2015. World-class sustainable manufacturing: framework and a performance measurement system. International Journal of Production Research, 53(17), 5207-5223.

Dües, C.M., Tan, K.H., Lim, M., 2013. Green as the new Lean: How to use Lean practices as a catalyst to greening your supply chain. Journal of Cleaner Production, 40, 93-100.

Duflou, J.R., Sutherland, J.W., Dornfeld, D., Herrmann, C., Jeswiet, J., Kara, S., Hauschild, M., Kellensa, K., 2012. Towards energy and resource efficient manufacturing: A processes and systems approach. CIRP Annals, 61(2), 587-609.

Ebrahimi, S.M., Koh, L. 2021. Manufacturing sustainability: Institutional theory and life cycle thinking. Journal of Cleaner Production, 298(2021), 126787

Evans, S., Fernando, L., Yang, M., 2017. Sustainable value creation—from concept towards implementation. In: Stark, R., Seliger, G., Bonvoisin, J., editors. Sustainable manufacturing. Springer, Cham.

Garbie, I.H., 2015. Fundamental requirements for sustainability practices and implementation: an analytical modelling and empirical investigation. International Journal of Sustainable Manufacturing, 3(4), 333-362.

Garbie, I., 2016. Sustainability in small and medium-sized manufacturing enterprises: an empirical study. Journal of Engineering Research, 13(1), 42-57.

Garretson, I.C., Mani, M., Leong, S., Lyons, K.W., Haapala, K.R., 2016. Terminology to support manufacturing process characterization and assessment for sustainable production. Journal of Cleaner Production, 139, 986-1000.

Gbededo, M.A., Liyanage, K., Garza-Reyes, J.A., 2018. Towards a life cycle sustainability analysis: A systematic review of approaches to sustainable manufacturing. Journal of Cleaner Production, 184, 1002-1015.

Gerasimova, K., 2017. Our common future. Macat Library, London.

Gimenez, C., Sierra, V., Rodon, J., 2012. Sustainable operations: Their impact on the triple bottom line. Int J Prod Econ, 140(1), 149-159.

Goshime, Y., Kitaw, D., Jilcha, K., 2019. Lean manufacturing as a vehicle for improving productivity and customer satisfaction. International Journal of Lean Six Sigma, 10(2), 691-714.

Granados, M.H., 2014. Sustainable Value Creation in Manufacturing through Maintenance Services. Unpublished Ph.D dissertation. Department of Management, Economics Industrial Engineering. Milan, Italy.

Gremyr, I., Siva, V., Raharjo, H., Goh, T.N., 2014. Adapting the robust design methodology to support sustainable product development. Journal of Cleaner Production, 79, 231-238.

Gunasekaran, A., Lai, K., Edwin, Cheng, T.C., 2008. Responsive supply chain: A competitive strategy in a networked economy. Omega, 36(4), 549-564.

Gunasekaran, A., Spalanzani, A., 2012. Sustainability of manufacturing and services: Investigation for research and applications. International Journal of Production Economics, 140(1), 35-47.

Gupta, S., Dangayach, G.S., Singh, A.K., Meena, M.L., Rao, P.N., 2018. Implementation of sustainable manufacturing practices in Indian manufacturing companies. Benchmarking: An International Journal, 25(7), 2441-2459.

Haapala, K.R., Zhao, F., Camelio, J., Sutherland, J.W., Skerlos, S.J., Dornfeld, D.A., Jawahir, I.S., Clarens, A.F., Rickli, J.L., 2013. A review of engineering research in sustainable manufacturing. Journal of Manufacturing Science and Engineering, 135(4), 041013.

Hariastuti, N. L. P., Pratikto, P., Santoso, P. B., & Tama, I. P., 2022. Identifying Driving Factors of Technological Innovation to Create Sustainable Value in Metal Manufacturing SMEs. Industrial Engineering & Management Systems, 21(1), 43–57.

Hami, N., Muhamad, M.R., Ebrahim, Z., 2015. The impact of sustainable manufacturing practices and innovation performance on economic sustainability. Procedia CIRP, 26, 190-195.

Hapuwatte, B., Seevers, K.D., Badurdeen, F., Jawahir, I.S., 2016. Total life cycle sustainability analysis of additively manufactured products. Procedia CIRP, 48, 376-381.

Hatcher, G.D., Ijomah, W.L., Windmill, J.F.C., 2011. Design for remanufacture: A literature review and future research needs. Journal of Cleaner Production, 19(17-18), 2004-2014.

He, B., Luo, T., Huang, S., 2019. Product sustainability assessment for product life cycle. Journal of Cleaner Production, 06, 238-250.
Helleno, A.L., de Moraes, A.J.I., Simon, A.T., 2017. Integrating sustainability indicators and Lean Manufacturing to assess manufacturing processes: Application case studies in Brazilian industry. Journal of Cleaner Production, 153, 405-416.
Hsu, C.H., Chang, A.Y., Luo, W., 2017. Identifying key performance factors for sustainability development of SMEs – integrating QFD and fuzzy MADM methods. Journal of Cleaner Production, 161, 629-645.
Huang, A., Badurdee, F., 2017. Sustainable manufacturing performance evaluation: integrating product and process metrics for systems level assessment. Procedia Manufacturing, 8, 563-570.
Jawahir, I.S., Dillon, O.W., Rouch, K.E., Joshi, K.J., Venkatachalam, A., Jaafar, I.H., 2006. Total life-cycle considerations in product design for sustainability: A framework for comprehensive evaluation. Paper presented at 10th International Research/Expert Conference Trends in the Development of Machinery and Associated Technology. Barcelona-Lloret de Mar, Spain,
Jawahir, I.S., Bradley, R., 2016. Technological elements of circular economy and the principles of 6R-based closed-loop material flow in sustainable manufacturing. Procedia CIRP, 40, 103-108.
Jayal, A.D., Badurdeen, F., Dillon, Jr. O.W., Jawahir, I.S., 2010. Sustainable manufacturing: Modeling and optimization challenges at the product, process system levels. CIRP Journal of Manufacturing Science and Technology, 2(3), 144-152.
Kishawy, H.A., Hegab, H., Saad, E., 2018. Design for sustainable manufacturing: Approach, implementation, and assessment. Sustainability, 10(10), 3604.
Koho, M., Nylund, H., Arha, T., Torvinen, S., 2011. Towards manufacturing system sustainability assessment: An initial tool and development plans. In: Seliger, G., Khraisheh, M., Jawahir, I., editors. Advances in sustainable manufacturing. Springer, Berlin, Heidelberg, 309-314.
Li, J., Li, Y., Song, H., Fan, C. 2021. Sustainable value creation from a capability perspective: How to achieve sustainable product design. Journal of Cleaner Production, 312(2021), 127552.
Lloret, A. 2016. Modeling corporate sustainability strategy. Journal of Business Research, 69(2), 418-425.
Malek, J., Desai, T.N. 2020. A systematic literature review to map literature focus of sustainable manufacturing. Journal of Cleaner Production, 256(2020), 120345.
Malek, J., Desai, T.N. 2022. Investigating the role of sustainable manufacturing adoption in improving the organizational performance. Technology in Society, 68(2022), 101940
Mani, M., Larborn, J., Johanson, B., Lyons, K.W., Morris, K.C., 2016. Standard representations for sustainability characterization of industrial processes. Journal of Manufacturing Science and Engineering, 138, 10.
Millar, H.H., Russell, S.N., 2011. The adoption of sustainable manufacturing practices in the Caribbean. Bussines Strategy Environmental, 20, 8.
Moldavska, A., Welo, T., 2017. The concept of sustainable manufacturing and its definitions: A content-analysis based literature review. Journal of Cleaner Production, 166, 744-755.
Moore, S.B., Manring, S.L., 2009. Strategy development in small and medium sized enterprises for sustainability and increased value creation. Journal of Cleaner Production, 17(2), 276-282.
Ocampo, L., Clark, E., 2015. A sustainable manufacturing strategy decision framework in the context of multi-criteria decision making. Jordan Journal of Mechanical and Industrial Engineering, 9(3), 177-186.
Ocampo, L., Vergara, V.G., Impas, C., Tordillo, J.A., Pastoril, J., 2011. Identifying critical indicators in sustainable manufacturing using analytic hierarchy process (AHP). Journal of Manufacturing and Industrial Engineering, 14, 3-4.
Parent, J., Cucuzzella, C., Revéret, J.P., 2013. Revisiting the role of LCA and SLCA in the transition towards sustainable production and consumption. International Journal of Life Cycle Assessment, 18, 1642-1652.
Patterson, M., McDonald, G., Hardy, D., 2017. Is there more in common than we think? Convergence of ecological footprinting, emergy analysis, life cycle assessment and other methods of environmental. Accounting, 362, 19-36.
Pesonen, H.L., Horn, S., 2012. Evaluating the sustainability SWOT as a streamlined tool for life cycle sustainability assessment. International Journal of Life Cycle Assessment, 18, 1780-1792.
Rosen, M.A., Kishawy, H.A., 2012. Sustainable manufacturing and design: Concepts, practices and needs. Sustainability, 4(2), 154-174.
Sala, S., Farioli, F., Zamagni, A., 2013. Life cycle sustainability assessment in the context of sustainability science progress (part 2). International Journal of Life Cycle Assessment, 18(9), 1686-1697.
Schramm, A., Richter, F., Gotze, U. 2020. Life Cycle sustainability assessment for manufacturing – analysis of existing approaches. Procedia Manufacturing, 43(2020), 712–719.
Seliger, G., 2007. Sustainability in manufacturing. Springer, Berlin.
Seliger, G., 2012. Sustainable manufacturing for global value creation. In: Seliger, G., editor, Sustainable manufacturing. Springer, Berlin), 3-8.
Shankar, K.M., Kannan, D., Kumar, P.U., 2017, Analyzing sustainable manufacturing practices – A case study in Indian context. Journal of Cleaner Production, 164, 1332-1343.
Shuaib, M., Seevers, D., Zhang, X., Badurdeen, F., Rouch, K.E., Jawahir, I.S., 2014. Product Sustainability Index (ProdSI). J Ind Ecol, 18, 4.
Singh, S., Olugu, E.U., Musa, S.N., 2016. Development of sustainable manufacturing performance evaluation expert system for small and medium enterprises. Procedia CIRP, 40), 608-613.
Tarnawska, K., 2013. Eco-innovations- tools for the transition to green economy. Economics and Management, 18, 4.
Thirupathi, R.M., Vinodh, S., Ruben, R.B., Antony, J., 2019. Application of environmentally conscious manufacturing strategies for an automotive component. International Journal of Sustainable Engineering, 12(2), 95-107.
Thomas, A., Francis, M., John, E., Davies, A., 2012. Identifying the characteristics for achieving sustainable manufacturing companies. Journal of Manufacturing Technology Management, 23(4), 426-440.
Trianni, A., Cagno, E., Neri, A., 2017. Modelling barriers to the adoption of industrial sustainability measures. Journal of Cleaner Production, 168, 1482-1504.
Ueda, K., Takenaka, T., Váncza, J., Monostori, L., 2009. Value creation and decision-making in sustainable society. CIRP Annals, 58(2), 681-700.
Ülengin, F., Önsel, Ş., Aktas, E., Kabak, Ö., Özaydin, Ö., 2014. A decision support methodology to enhance the competitiveness of the Turkish automotive industry. European Journal of Operational Research, 234(3), 789-801.
Valdivia, S., Ugaya, C.M.L., Hildenbrand, J., Traverso, M., Mazijn, B., Sonnemann, G., 2012. A UNEP/SETAC approach towards a life cycle sustainability assessment—our contribution to Rio+20. International Journal of Life Cycle Assessment, 18, 1673-1685.
Wiendahl, H.P., El-Maraghy, H.A., Nyhuis, P., Zäh, M.F., Wiendahl, H.H., Duffie, N., Brieke, M., 2007. Changeable manufacturing - classification, design and operation. CIRP Annals, 56(2), 783-809.
Yang, M.G.M., Hong, P., Modi, S.B., 2011. Impact of lean manufacturing and environmental management on business performance: An empirical study of manufacturing firms. International Journal of Production Economics, 129(2), 251-261.
Zamagni, A., Pesonen, H., Swarr, T., 2013. From LCA to life cycle sustainability assessment: Concept, practice and future directions. International Journal of Life Cycle Assessment ment, 18(9), 1637-1641.
Zhang, X., Lu, T., Shuhaib, M., Rotella, G., Huang, A., Feng, S.C., Rouch, K., Badurdeen, F., Jawahir, I.S., 2012. A metrics-based methodology for establishing Product Sustainability Index (ProdSI) for manufactured products. In: Dornfeld, D., Linke, B., editors. Leveraging technology for a sustainable world. Springer, Berlin, 435-441.

可持续制造系统中的可持续价值创造因素综述

關鍵詞
业务系统
竞争优势
灵活性
合伙
转型

摘要
本文详细描述了通过转型和灵活性创造价值的要素，这些要素在可持续制造的实施中进行。本研究的目的是通过文献回顾分析产生建立可持续价值创造过程的标准或要素。所讨论的可持续制造实施的总体分类显示了支持这一点的几个基本因素。对选定论文的审查研究过程加强了为获得可持续价值创造的必要要素而进行的分类。所创造的价值后来可以成为公司在市场竞争中生存优势的标志。此外，合作伙伴关系（如协作）的作用表明在创造价值以提高公司竞争力方面具有积极影响。此外，利益相关者之间的协作和合作等伙伴关系过程的重要性对于创造价值以提高公司的竞争水平是必要的。合作过程是在未来实现可持续制造中创造可持续价值的关键因素之一。