Performance Measurement Conceptual Model Creation case study in the SMEs Machinery

Yusuf Widharto[1*] and Amalia Suzianti[2]

[12] Universitas Indonesia, Depok Western Java, Indonesia
yusuf.widharto@ui.ac.id

Abstract - Small and Medium Enterprises (SMEs) are one of the main support of the economy in Indonesia. One way to increase competitiveness of SMEs is through appropriate performance measurement methods (PMM). This research take a case study in SMEs Machinery Industry, because SMEs Machinery Industry which is the backbone for other SME (their product is use by other SME) need a specific PMM that is suitale to the characteristics of Machinery Industry SMEs. To create PMM this research propose a conceptual model based on Performance Indicator (PI). The PI that use in this research came from several source to make sure that the PI fit for SMEs Machinery Industry. The source for PI are from previous research of ordinary SMEs, combine with previous research PI in the field of innovation maturity level and previous research about Engineer to Order (ETO) business process . The Innovation maturity level PI is use because, currently innovation is a way for companies to survive. The use of ETO business process because machinery industry is company that use Engineer to Order System (ETO). This research use systematic literature review method to study previous research on performance measurement especially for SME to formulate the conceptual model.

***Keywords*:** performance measurement, SMEs Machinery industry, engineering

1. Introduction

Currently, SMEs are the backbone of the economy in Indonesia [1]. Based on previous research Indonesian SMEs still have challenges, including production and marketing [1-8], institutional and human resources [1-3, 5, 7-10], technology understanding [1, 3, 10], capital [4, 5, 10, 11] and raw material [1, 5, 7, 11]. More specific in term of Machinery Industry challenge that being faced such as capital [12-15], green production [16-19], maintenance [20-23] and government policy [24-27]. The obstacles above will make it difficult for Machinery SMEs Indonesia to develop their business. Requires cooperation between stakeholders (government, private sector and academics) to be able to overcome the above problems. Approaching business units through performance measurement can be one solution to overcome the above problems. This is done because performance measurement can provide guidance for stakeholders to identify problems, assess customer satisfaction, carry out control

S. C. Asih et al. (eds.), *Proceedings of the 19th International Conference on Quality in Research (QiR 2025)*, Advances in Engineering Research 303,
https://doi.org/10.2991/978-94-6239-717-0_20

initiatives on improvement program and can acommodate the process of decision making [28, 29]

2. Literature Review

2.1. Performance Measurement

Measuring performance can be described as a process to measure the effectiveness and efficiency of actions [30]. Regarding measuring efficiency and effectiveness, this is in line with the statement by Neely[31, 32] which states that performance measurement is a balanced system and dynamically capable to support process of decision making based on collection, information analysis and elaboration process through a series of metrics (non financial and/or financial) to measure effectiveness , efficiency of actions in the past where decision making and action taking were carried out through obtaining, collecting, sorting, analyzing and interpreting appropriate data and information. Another definition stated that process of performance measurement is an integrated approach and planned that used to create great achievement at organization which being characterized by performance growth of the people involved in the work and can contribute to develop capabilities as an individual and a team[33]. A performance measurement system requires indicators and procedures to measure a company's performance continuously [34]. The advantages of implementing performance measurement including increased profits; cost reduction; improving internal strategic communications; focus more on organizational interest; achieving better organizational interest results and purpose; greater on effectiveness management control; business processes improvement and performance information quality, and a more clearly organizational vision members about purpose and roles that organization need to achieve.[28, 35]; Problems identification and efficiency improvement of certain tasks; assessing satisfaction of customer [29]; able to evaluate how well the organization is arranged and organizational value that provide to customers and stakeholders [36]. Performance measurement requires indicators that are balanced between financial and/or non-financial aspects [32]. This statement was confirmed by Stojkic [37] who stated that company performance is divisible into : financial an operational performance. SMEs needs to measure performance because SMEs must improve or evaluate performance in addition other than financial aspects, so a system that tailored to SMEs is needed to measure performance that usef to present all SME activities, in the field SMEs of internal and external activities [33]. Due to the differences in characteristics between SMEs and large companies, SMEs need a performance measurement process and tools that are simple and clear for both implementation and maintenance [38]. Performance measurement needs to use appropriate and relevant performance indicators because this affects business interests, inappropriate performance measurement can provide negative feedback and as a result can indirectly impact the health of the organization and ultimately be detrimental to the overall organizational structure[39, 40]

2.2 Innovation Maturity Level (IML)

Maturity Model (MM) is a tool used to evaluate the level of progress of an organization on various issues and to establish action plans to achieve set goals, helping to objectify performance improvements through evidence of goal implementation [41, 42]. MM can help determine the position of SMEs and find out what they should do next in overcoming problems commonly found in research on MM, namely limited resources, small workforce, inadequate workforce experience [43]. Although there are a number of MMs in the management discipline, only a few are oriented towards SMEs, and even fewer SMEs have integrated various key approaches such as innovation into one MM [44], eventhough in the field of performance management, innovation have been done as one of the organization core business processes [45]. MM measurement is very important SMEs especially in the term of innovation management because SMEs have limited resources and barriers in cultural area to measure issues that related and pertinent to management and performance of the innovation [46]. The advantage of integrating innovation into MM is increased competitiveness and long-term performance which is a product of innovation [47].

2.3 Engineer to Order (ETO)

ETO is a sort of product manufacturing process that have a high customization degree, the product needs detail design and engineering process according to the specification of the customer order [48]. In the current ETO process, customers actively collaborate begin with engineering concept in the area of life cycle product phase to evolve products that meet functionally with the customer requirements and ending with the production of goods in small quantities [49, 50]. Some problem that happened at ETO process that came as a result of high degree customization are adversity in costs projection, lead time and delivery time, high cost due to rework that came from errors, waste of material, opposition between schedule project manufacturing , inefficiency or ineffectiveness in management. information and difficulties in integrating the process stakeholders [48, 51]. In the ETO process it is generally agreed that production and design activities carried out following the actual order customer order has been received [52, 53]. Previous researchers tried to overcome the problems that exist in ETO companies through several approaches. The use of lean principles [54] and another approach use a maturity assessment methodologies to assess ETO companies based on existing processes in ETO companies [55].

3. Methodology

This research using literature review technique to explore the content of literature and relevant articles in a combination of Performance Assessment, Innovation Maturity Level and Engineer to Order (ETO). Systematic literature review (SLR) combining with analysis of bibliometric use to create more friendly form for organizing data. SLR contains information that need to transform into more insightful information. SLR method already used in the multiple fields and can be representing high number of bibliographic [56-58].

The Performance Indicator search use the keyword "performance measurement tool small medium enterprise machinery industry product development". Database from science direct use in this research. From the initial search, 2853 articles were obtained related to the keyword performance measurement tool small medium enterprise machinery industry product development. After selecting articles based on language criteria, subscribed journals, article type and subject, 992 suitable articles were obtained. Then screening was carried out again by reading the abstract and reading it in full and a total of 70 suitable articles were obtained. The performance indicators used in this research are performance indicators used in more than 5 research articles

The Innovation Maturity Level search use the keyword innovation maturity level. Science Direct database use in this SLR. From the initial search, 1158 articles were obtained related to the keyword innovation maturity level. After selecting articles based on language criteria, subscribed journals, article type and subject, 395 suitable articles were obtained. Then screening was carried out again by reading the abstract and reading it in full and a total of 28 suitable articles were obtained for further reading.

4. Result and Discussion

The outcome of a literature process study using keyword "performance measurement tool small medium enterprise machinery industry product development", articles related to these keywords were obtained. Of the 70 articles, 22 articles used SMEs as research objects, while the rest did not use or did not specifically include SMEs as research objects. This shows that performance measurement research with SME objects still has areas for development.

The articles that use SMEs as research objects, if viewed from the objective side, have the following objectives (can be seen at Fig 1)

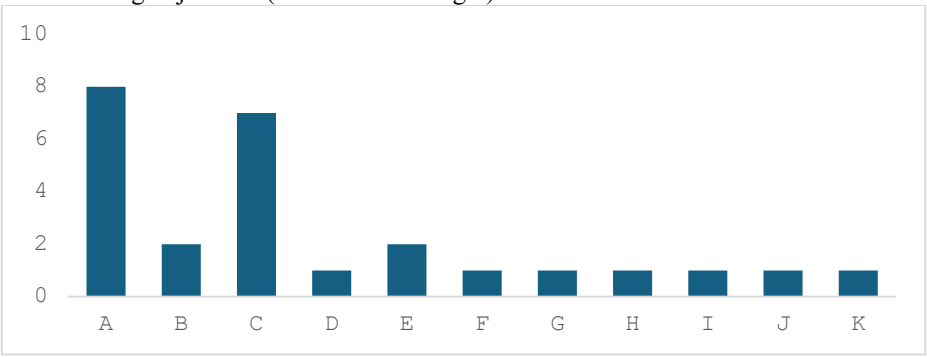

Fig 1. The articles that use SMEs as research objects, if viewed from the objective side

Symbol Explanation

Table 1. The Explanation of Symbol in Figure 1

Symbol	Explanation
A	Researching performance indicators that can be used to determine performance and implementing indicator steps to produce performance
B	Investigate the role of performance measurement in increasing employee productivity
C	Performance evaluation assessment methods
D	Developing a conceptual model of performance measurement factors
E	Examining performance measures in the area of financial and non-financial
F	Research performance measurement guidelines
G	Implementation of performance measurement
H	Implementing open innovation in SMEs with emphasis: open innovation process and open ambidextrous innovation
I	Highlighting critical factors that are important for implementing sustainable practices oriented towards innovation
J	Examining the challenges of implementing innovation measurement
K	Identify activities and indicators used to make decisions to continue or stop pro-jects in SMEs

From the literature study carried out on articles regarding innovation maturity level, several articles were obtained which became a guide for making performance measurements for SMEs. If you look at the aim of the article, you can briefly see that there are several objectives that can be seen at Figure 2

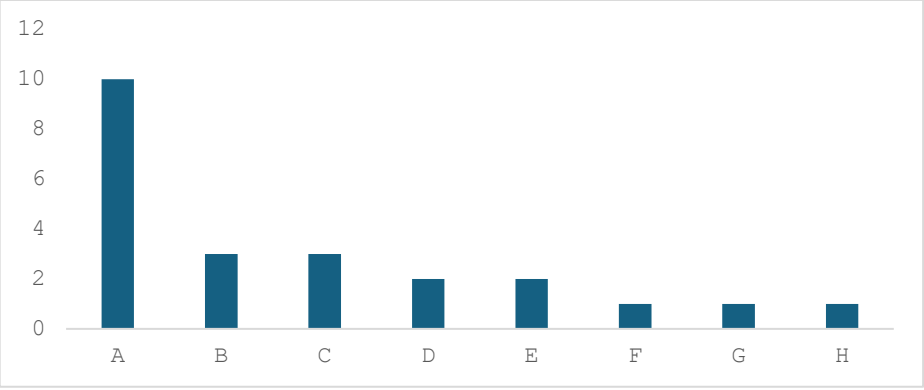

Fig 2. Aim of literature study carried out on articles regarding innovation maturity level.

Symbol Explanation

Table 2. The Explanation of Symbol in Figure 2

Symbol	Explanation
A	Form MM regarding capabilities and assess innovation
B	Forming MM related to Industry 4.0 and 5.0
C	Form a MM to assess digitalization
D	Related to suggestion systems
E	bridging and aligning MM with the business model
F	create MM to improve services for engineering-based companies ,
G	create a MM for ambidextrous organization
H	create MM for the product life cycle in new product development

Based on the comparison of objectives to increase the competitiveness of SMEs, if seen from the existing objectives in MM it is in accordance with objective symbol A that is to form MM regarding capabilities and assess innovation. After further reading the aim of our research is in accordance with the aim of the paper "Measurement models of community innovation and technology maturity for the quality of innovation and technology in Indonesia" [59]. So this research adopt indicator in this paper as one of the source for determining performance indicators of a SMEs Machinery.

In the ETO process, previous researchers tried to overcome the problems that exist in ETO companies through several approaches. The use of lean principles is one approach to overcome the problems that exist in ETO[54]. Another approach to overcome ETO problems is maturity assessment methodologies to assess ETO companies based on existing processes in ETO companies[55]. The process in ETO companies are divided into main process consist of commissioning , procurement, engineering, construction and maintenance. And the supporting process are safety, environment, health and welfare (HSEW) processes, planning, logistics, finance, cost control and acquisition, configuration and change management, quality assurance (QA), information management control system (IM), information technology (IT) and human resources [55].

5. Conclusion

The conceptual model of the performance measurement framework for SMEs in the machinery industry was developed based on literature studies that have been introduced by previous researchers. There is a combination of literature studies to produce a conceptual model for measuring performance of SMEs in the Machinery Industry. The combination cab be seen in Fig 3. The outline of the source can be divided into :

1. Literature study on performance measurement and performance indicators
2. Literature study on Innovation Maturity Level
3. Literature study on Engineering to Order

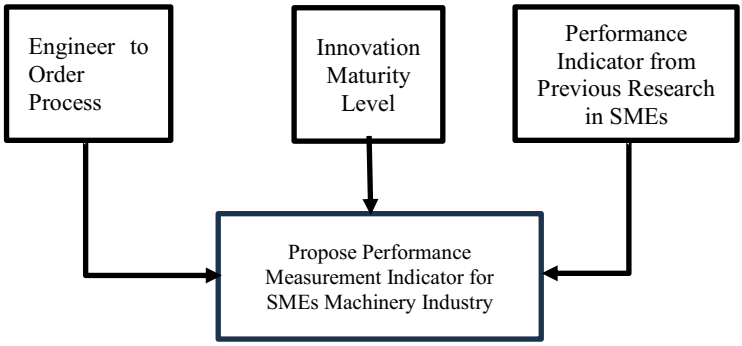

Fig 3. The Three Mainstream Source that propose to Measuring Performance of SMEs Machinery Industry

Acknowledgements

Thanks to the Department of Industrial Engineering, Diponegoro University and the Department of Industrial Engineering, Universitas Indonesia for their support so that this paper can be completed.

References

[1] M. Irjayanti and A. M. Azis, "Barrier Factors and Potential Solutions for Indonesian SMEs," *Procedia Economics and Finance,* vol. 4, pp. 3-12, 2012/01/01/ 2012, doi: https://doi.org/10.1016/S2212-5671(12)00315-2.

[2] L. Anatan, "Micro, Small, and Medium Enterprises' Readiness for Digital Transformation in Indonesia," *Economies,* Article vol. 11, no. 6, 2023, Art no. 156, doi: 10.3390/economies11060156.

[3] A. R. P. Octasylva, L. N. Yuliati, H. Hartoyo, and A. W. Soehadi, "Innovativeness as the Key to MSMEs' Performances," *Sustainability,* Article vol. 14, no. 11, 2022, Art no. 6429, doi: 10.3390/su14116429.

[4] A. R. Fauzi, A. Y. Ridwan, and W. Juliani, "Supply Chain Performance Measurement System Development for Shoes SME using Subcontract Production Strategy Based on Integrated SCOR-BSC Model," *IOP Conference Series: Materials Science and Engineering,* vol. 598, no. 1, p. 012126, 2019/08/01 2019, doi: 10.1088/1757-899X/598/1/012126.

[5] B. Jatmiko, U. Udin, R. Raharti, T. Laras, and K. F. Ardhi, "Strategies for MSMEs to Achieve Sustainable Competitive Advantage: The SWOT Analysis Method," *Journal of Asian Finance, Economics and Business,*

Article vol. 8, no. 3, pp. 505-515, 2021, doi: 10.13106/jafeb.2021.vol8.no3.0505.

[6] E. Febriani and W. S. Dewobroto, "Problems and requirement analysis as a first step to connect researchers and small and medium enterprises (SMEs)," *Cogent Business and Management,* Article vol. 5, no. 1, pp. 1-9, 2018, doi: 10.1080/23311975.2018.1513774.

[7] T. T. H. Tambunan, "Development of micro, small and medium enterprises and their constraints: A story from Indonesia," *Gadjah Mada International Journal of Business,* Article vol. 13, no. 1, pp. 21-43, 2011, doi: 10.22146/gamaijb.5492.

[8] J. Hamdani and C. Wirawan, "Open Innovation Implementation to Sustain Indonesian SMEs," *Procedia Economics and Finance,* vol. 4, pp. 223-233, 2012/01/01/ 2012, doi: https://doi.org/10.1016/S2212-5671(12)00337-1.

[9] S. Candra, I. N. A. D. Wiratama, M. A. Rahmadi, and V. Cahyadi, "Innovation process of micro, small and medium enterprises (MSMEs) in greater Jakarta area (perspective from foodpreneurs)," *Journal of Science and Technology Policy Management,* Article vol. 13, no. 3, pp. 542-560, 2022, doi: 10.1108/JSTPM-10-2020-0153.

[10] I. Ridwan Maksum, A. Yayuk Sri Rahayu, and D. Kusumawardhani, "A Social Enterprise Approach to Empowering Micro, Small and Medium Enterprises (SMEs) in Indonesia," *Journal of Open Innovation: Technology, Market, and Complexity,* vol. 6, no. 3, p. 50, 2020/09/01/ 2020, doi: https://doi.org/10.3390/joitmc6030050.

[11] R. Fitrios, U. Afifah, and M. Khoiriyah, "Improving SMEs Performance Through Partnership Program: Accounting Information System as Mediator," *Quality - Access to Success,* Article vol. 25, no. 201, pp. 374-383, 2024, doi: 10.47750/QAS/25.201.40.

[12] H. Bo and Z. Zhang, "The impact of uncertainty on firm investment: evidence from machinery industry in Liaoning province of China," *Economic Systems,* vol. 26, no. 4, pp. 335-352, 2002/12/01/ 2002, doi: https://doi.org/10.1016/S0939-3625(02)00058-4.

[13] T. Sueyoshi and M. Goto, "Can R&D expenditure avoid corporate bankruptcy? Comparison between Japanese machinery and electric equipment industries using DEA–discriminant analysis," *European Journal of Operational Research,* vol. 196, no. 1, pp. 289-311, 2009/07/01/ 2009, doi: https://doi.org/10.1016/j.ejor.2008.02.021.

[14] U. Goel, S. Chadha, and A. K. Sharma, "Operating Liquidity and Financial Leverage: Evidences from Indian Machinery Industry," *Procedia - Social and Behavioral Sciences,* vol. 189, pp. 344-350, 2015/05/15/ 2015, doi: https://doi.org/10.1016/j.sbspro.2015.03.230.

[15] G. S. Smania, G. H. d. S. Mendes, M. Godinho Filho, L. Osiro, P. A. Cauchick-Miguel, and W. Coreynen, "The relationships between digitalization and ecosystem-related capabilities for service innovation in agricultural machinery

manufacturers," *Journal of Cleaner Production,* vol. 343, p. 130982, 2022/04/01/ 2022, doi: https://doi.org/10.1016/j.jclepro.2022.130982.

[16] Y. Du, Q. Yi, C. Li, and L. Liao, "Life cycle oriented low-carbon operation models of machinery manufacturing industry," *Journal of Cleaner Production,* vol. 91, pp. 145-157, 2015/03/15/ 2015, doi: https://doi.org/10.1016/j.jclepro.2014.12.028.

[17] B. Lin and W. Liu, "Estimation of energy substitution effect in China's machinery industry--based on the corrected formula for elasticity of substitution," *Energy,* vol. 129, pp. 246-254, 2017/06/15/ 2017, doi: https://doi.org/10.1016/j.energy.2017.04.103.

[18] A. Trentin, C. Forza, and E. Perin, "Embeddedness and path dependence of organizational capabilities for mass customization and green management: A longitudinal case study in the machinery industry," *International Journal of Production Economics,* vol. 169, pp. 253-276, 2015/11/01/ 2015, doi: https://doi.org/10.1016/j.ijpe.2015.08.011.

[19] Z. Zhang, W. Chen, and C. Li, "Repurchase or pledge? Financing and production decisions of engineering machinery remanufacturing firms," *Journal of Cleaner Production,* vol. 429, p. 139309, 2023/12/01/ 2023, doi: https://doi.org/10.1016/j.jclepro.2023.139309.

[20] A. Canito, Alda Fernandes, Marta Conceição, Luís Praça, Isabel Santos, Magno Rato, Ricardo Cardeal, Gonçalo Leiras, Francisco, Marreiros, Goreti, "An Architecture for Proactive Maintenance in the Machinery Industry," in *Ambient Intelligence– Software and Applications – 8th International Symposium on Ambient Intelligence (ISAmI 2017)* Eds., 2017// 2017: Springer International Publishing, pp. 254-262.

[21] J.-R. Ruiz-Sarmiento, J. Monroy, F.-A. Moreno, C. Galindo, J.-M. Bonelo, and J. Gonzalez-Jimenez, "A predictive model for the maintenance of industrial machinery in the context of industry 4.0," *Eng Appl Artif Intell,* vol. 87, p. 103289, 2020/01/01/ 2020, doi: https://doi.org/10.1016/j.engappai.2019.103289.

[22] C. V. Giada and P. Rossella, "Barriers to Predictive Maintenance implementation in the Italian machinery industry," *IFAC-PapersOnLine,* vol. 54, no. 1, pp. 1266-1271, 2021/01/01/ 2021, doi: https://doi.org/10.1016/j.ifacol.2021.08.152.

[23] P. Burggräf, J. Wagner, F. Steinberg, B. Heinbach, M. Wigger, and T. Saßmannshausen, "Life Cycle Assessment for Adaptive Remanufacturing: incorporating ecological considerations into the planning of maintenance activities – a case study in the German heavy machinery industry," *Procedia CIRP,* vol. 105, pp. 320-325, 2022/01/01/ 2022, doi: https://doi.org/10.1016/j.procir.2022.02.053.

[24] J. M. Kerr, "Institutional barriers to policy reform in Egypt: The case of the agricultural machinery industry," *World Development,* vol. 22, no. 6, pp. 877-888, 1994/06/01/ 1994, doi: https://doi.org/10.1016/0305-750X(94)90059-0.

[25] P.-C. Chang, C.-P. Wang, B. J. C. Yuan, and K.-T. Chuang, "Forecast of development trends in Taiwan's machinery industry," *Technological Forecasting and Social Change,* vol. 69, no. 8, pp. 781-802, 2002/11/01/ 2002, doi: https://doi.org/10.1016/S0040-1625(00)00117-7.

[26] C. O. Tuncel and A. Polat, "Sectoral System of Innovation and Sources of Technological Change in Machinery Industry: An Investigation on Turkish Machinery Industry1," *Procedia - Social and Behavioral Sciences,* vol. 229, pp. 214-225, 2016/08/19/ 2016, doi: https://doi.org/10.1016/j.sbspro.2016.07.131.

[27] Y. Yang and C. Lin, "Impact of the "Belt and Road Initiative" on machinery production networks," *Economic Modelling,* vol. 104, p. 105642, 2021/11/01/ 2021, doi: https://doi.org/10.1016/j.econmod.2021.105642.

[28] M. a. U. Saunila, J. , "Facilitating innovation capability through performance measurement: A study of Finnish SMEs " *Management Research Review,* vol. 36 10, pp. 991-1010, 2013.

[29] S. Sousa and E. Aspinwall, "Development of a performance measurement framework for SMEs," *Total Quality Management & Business Excellence,* vol. 21, no. 5, pp. 475-501, 2010/05/01 2010, doi: 10.1080/14783363.2010.481510.

[30] C. Valmohammadi and A. Servati, "Performance measurement system implementation using Balanced Scorecard and statistical methods," *International Journal of Productivity and Performance Management,* Article vol. 60, no. 5, pp. 493-511, 2011, doi: 10.1108/17410401111140400.

[31] C. A. Andy D. Neely, Mike Kennerley, *The Performance Prism: The Scorecard for Measuring and Managing Business Success*. Pearson Education, 2002.

[32] M. K. a. A. Neely, "Performance measurement – frameworks and methodologies," in *Business performance measurement Theory and practice*, A. Neely Ed.: Cambridge University Press, 2004.

[33] F. Irhamni, B. Khusnul Khotimah, and D. Rahmawati, "Improvement integrated performance measurement system (IPMS) for small and medium enterprise impact of information technology," vol. 95, pp. 319-327, 01/31 2017.

[34] A. Ouazzani-Chahidi, L. Abdellatif, J.-F. Jimenez, and L. Berrah, "Maturity levels of management process for improving industrial performance," *Scientific African,* vol. 21, p. e01852, 2023/09/01/ 2023, doi: https://doi.org/10.1016/j.sciaf.2023.e01852.

[35] A. de Waal and K. Kourtit, "Performance measurement and management in practice: Advantages, disadvantages and reasons for use," *International Journal of Productivity and Performance Management,* Article vol. 62, no. 5, pp. 446-473, 2013, doi: 10.1108/IJPPM-10-2012-0118.

[36] H. Kogetsidis, "Systems approaches for organisational analysis," *International Journal of Organizational Analysis,* Article vol. 19, no. 4, pp. 276-287, 2011, doi: 10.1108/19348831111173414.

[37] Ž. Stojkić and I. Bošnjak, "An overview of performance measurement methods in smes," in *Annals of DAAAM and Proceedings of the International DAAAM Symposium*, 2019, vol. 30, 1 ed., pp. 518-524, doi: 10.2507/30th.daaam.proceedings.070. [Online]. Available: https://www.scopus.com/inward/record.uri?eid=2-s2.0-85077875871&doi=10.2507%2f30th.daaam.proceedings.070&partnerID=40&md5=aa9a1a0228c50163ca6100db37e88b79

[38] X. Rojas-Lema, J.-J. Alfaro-Saiz, R. Rodríguez-Rodríguez, and M.-J. Verdecho, "Performance measurement in SMEs: systematic literature review and research directions," *Total Quality Management & Business Excellence,* vol. 32, no. 15-16, pp. 1803-1828, 2021/11/17 2021, doi: 10.1080/14783363.2020.1774357.

[39] N. M. Mustapha and S. Sorooshian, "SME performance measurement: A technical review of Malaysia," *International Journal of Innovative Technology and Exploring Engineering,* Review vol. 8, no. 8, pp. 1808-1812, 2019. [Online]. Available: https://www.scopus.com/inward/record.uri?eid=2-s2.0-85067852303&partnerID=40&md5=aa4e93c1528ed59868836be6f494de3d.

[40] N. Rompho and S. Boon-itt, "Measuring the success of a performance measurement system in Thai firms," *International Journal of Productivity and Performance Management,* Article vol. 61, no. 5, pp. 548-562, 2012, doi: 10.1108/17410401211232966.

[41] N. Niewöhner, N. Lang, L. Asmar, D. Röltgen, A. Kühn, and R. Dumitrescu, "Towards an ambidextrous innovation management maturity model," in *Procedia CIRP*, 2021, vol. 100, pp. 289-294, doi: 10.1016/j.procir.2021.05.068. [Online]. Available: https://www.scopus.com/inward/record.uri?eid=2-s2.0-85107898464&doi=10.1016%2fj.procir.2021.05.068&partnerID=40&md5=eda5752e26bff36b7e0142a0812a11ae

[42] M. Röglinger, J. Pöppelbuß, and J. Becker, "Maturity models in business process management," *Business Process Management Journal,* vol. 18, no. 2, pp. 328-346, 2012, doi: 10.1108/14637151211225225.

[43] P. Virkkala, M. Saarela, K. Hänninen, J. Kujala, and A.-M. Simunaniemi, "Business Maturity Models for Small and Medium-Sized Enterprises: A Systematic Literature Review," *Management,* vol. 15, pp. 137-155, 06/01 2020, doi: 10.26493/1854-4231.15.137-155.

[44] J. I. Igartua, J. Retegi, and J. Ganzarain, "IM2, a maturity model for innovation in SMEs," *Direccion y Organizacion,* Article vol. 64, pp. 42-49, 2018. [Online]. Available: https://www.scopus.com/inward/record.uri?eid=2-s2.0-85052729979&partnerID=40&md5=0dbee3d634704e3e7d494ca2c0853547.

[45] M. Saunila, "Managing continuous innovation through performance measurement," *Competitiveness Review,* Article vol. 27, no. 2, pp. 179-190, 2017, doi: 10.1108/CR-03-2015-0014.

[46] H. F. C. Macedo Filho and M. F. L. Almeida, "Measuring and evaluating innovation management in small and medium enterprises: Proposition of a multicriteria model for selecting indicators and metrics," in *Journal of Physics: Conference Series*, 2018, vol. 1065, 7 ed., doi: 10.1088/1742-6596/1065/7/072029. [Online]. Available: https://www.scopus.com/inward/record.uri?eid=2-s2.0-85057482092&doi=10.1088%2f1742-6596%2f1065%2f7%2f072029&partnerID=40&md5=e05a5d842f0d6198027ec959de985966

[47] K. Issau, I. S. K. Acquah, R. I. Gnankob, and Z. Hamidu, "Innovation orientation and performance of small and medium-sized enterprises (SMES) in Ghana: evidence from manufacturing sector," *Innovation & Management Review,* vol. 19, no. 4, pp. 290-305, 2022, doi: 10.1108/INMR-07-2020-0092.

[48] A. Pandit and Y. Zhu, "An ontology-based approach to support decision-making for the design of ETO (Engineer-To-Order) products," *Automation in Construction,* Article vol. 16, no. 6, pp. 759-770, 2007, doi: 10.1016/j.autcon.2007.02.003.

[49] S. E. Birkie and P. Trucco, "Understanding dynamism and complexity factors in engineer-to-order and their influence on lean implementation strategy," *Production Planning & Control,* vol. 27, no. 5, pp. 345-359, 2016/04/03 2016, doi: 10.1080/09537287.2015.1127446.

[50] C. S. Chen, "Concurrent Engineer-To-Order operation in the Manufacturing Engineering Contracting industries," *International Journal of Industrial and Systems Engineering,* Article vol. 1, no. 1-2, pp. 37-58, 2006, doi: 10.1504/ijise.2006.009049.

[51] P. Cocca, G. Schiuma, M. Viscardi, and F. Floreani, "Knowledge management system requirements to support Engineering-To-Order manufacturing of SMEs," *Knowledge Management Research & Practice,* vol. 20, no. 6, pp. 814-827, 2022/11/02 2022, doi: 10.1080/14778238.2021.1939174.

[52] J. Gosling, D. R. Towill, M. M. Naim, and A. R. J. Dainty, "Principles for the design and operation of engineer-to-order supply chains in the construction sector," *Production Planning and Control,* Article vol. 26, no. 3, pp. 203-218, 2015, doi: 10.1080/09537287.2014.880816.

[53] O. Willner, J. Gosling, and P. Schönsleben, "Establishing a maturity model for design automation in sales-delivery processes of ETO products," *Computers in Industry,* vol. 82, pp. 57-68, 2016/10/01/ 2016, doi: https://doi.org/10.1016/j.compind.2016.05.003.

[54] M. Chiera, F. Lupi, A. Rossi, and M. Lanzetta, "Lean maturity assessment in eto scenario," *Applied Sciences (Switzerland),* Article vol. 11, no. 9, 2021, Art no. 3833, doi: 10.3390/app11093833.

[55] J. Veldman and W. Klingenberg, "Applicability of the capability maturity model for engineer-to-order firms," *International Journal of Technology Management,* Article vol. 48, no. 2, pp. 219-239, 2009, doi: 10.1504/IJTM.2009.024917.

[56] L. Paganin and M. Borsato, "A Critical Review of Design for Reliability - A Bibliometric Analysis and Identification of Research Opportunities," *Procedia Manufacturing,* vol. 11, pp. 1421-1428, 2017/01/01/ 2017, doi: https://doi.org/10.1016/j.promfg.2017.07.272.

[57] A. C. Benabdellah, I. Bouhaddou, A. Benghabrit, and O. Benghabrit, "A systematic review of design for X techniques from 1980 to 2018: concepts, applications, and perspectives," *The International Journal of Advanced Manufacturing Technology,* vol. 102, no. 9, pp. 3473-3502, 2019/06/01 2019, doi: 10.1007/s00170-019-03418-6.

[58] A. Juniani, M. Singgih, and D. Karningsih, *Design for Manufacturing, Assembly, and Reliability on Product Redesign: Literature Review and Research Direction*. 2021.

[59] A. Prasetyo, M. S. Budiarto, Y. Anggraini, and Y. Suharyana, "Measurement models of community innovation and technology maturity for the quality of innovation and technology in Indonesia," in *AIP Conference Proceedings*, 2023, vol. 2706, doi: 10.1063/5.0120530. [Online]. Available: https://www.scopus.com/inward/record.uri?eid=2-s2.0-85160062303&doi=10.1063%2f5.0120530&partnerID=40&md5=c508657e86631b2e8df86054eb3b1590