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THE IMPLEMENTATION OF LEAN MANUFACTURING AND INDUSTRIAL TECHNOLOGY 4.0 ON BUSINESS PERFORMANCE

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Abstract

The problem of this reasearch has entered the industrial revolution 4.0 (4IR), then strategy implementation need to be done through 4IR road map. Specific aspect which has effect to Industry 4.0 Technology Adoption are technology intensity, strict capital & human resources investment, therefore performances measurement which consider whole organization become more relevant. The purpose of this research was to test moderation effect of Industry 4.0 Technology process-related and product/service-related into the lean manufacturing implementation to business performance. The methodology of this research is using PLS-SEM approach with SMART-PLS software. Measurement of variable datas were obtained through 1-5 Likert scale survey which was distributed to PT.XYZ employee. The finding of this research show those Industry 4.0 Technology process-related and product/service-related were not moderating implementation of lean manufacturing to business performance in PT. XYZ. The limitation in this study were only for PT. XYZ operational scope and were using data from Aug – Nov 2020. Conclusion of this research can not be generalized to other research object or to describe PT. XYZ in another time.

Keyword: industry 4.0 technology; lean manufacturing, business performance, process-related, product/service-related.

Preliminary

The Ministry of Industry (2019) the manufacturing industry is a sector that forms the backbone of the economy in Indonesia. The manufacturing industry in Indonesia contributes 20 percent of the total National Gross Domestic Product (GDP). Indonesia is ranked 5th among the G-20 member countries. When compared with the average GDP value of countries around the world which is only 15 percent, the manufacturing industry in Indonesia is quite good. In 2018, the manufacturing industry also became the largest contributor to state revenue in the form of taxes amounting to IDR 363.60 trillion or a total of 30 percent of total tax revenue.

Ministry of Industry (2018) Indonesia has entered the fourth industrial revolution or industrial revolution 4.0 (4IR), it is necessary to implement a strategy through the 4IR road map in Indonesia which involves stakeholders in the manufacturing industry. The aim is to provide a clear direction for the movement of Indonesian industry in the future.

(Tortorella, Giglio, & Van Dun, 2019) the concept of industry 4.0 has not been fully understood by practitioners, but some researchers (Rüßmann et al., 2015) agreed to define industry 4.0 as an industry that involves a set of digital technologies such as embedded systems, wireless sensor networks, 3D printing, cloud computing, & big data that have been developed before the year (Wan, Cai, & Zhou, 2015). 2011 (Lasi, Fettke, Kemper, Feld, & Hoffmann, 2014) explain the implementation of industry 4.0 related to digital elements that monitor and control physical devices, sensors, information & communication technologies (ICT), and the Internet of Things (IoT).

(Tortorella & Fettermann, 2018) defines that industry 4.0 represents an industry characterized by interconnectivity between machines, systems and smart products, as well as interrelated solutions. (Tortorella et al., 2019) classifies industrial technology 4.0 into two directions, namely process-related technology and product / service-related technology.

Lean manufacturing (LM) or lean production (LP) is a common practice in industry, especially the manufacturing industry. (Shah & Ward, 2003) explained that LM practice focuses on reducing activities that do not provide added value and at the same time improving productivity and quality from the customer's point of view. The practice of LM has been started since the 3.0 industrial revolution along with the presence of the Just In Time (JIT) practice promoted by Toyota. (Al Haraisa, 2017) explains the effect of implementing JIT which consists of equipment layout, suppliers quality, setup time reduction and pull production which has a positive effect on operational excellence in industrial companies in Jordan.

Previous research related to industrial technology 4.0, (Tortorella et al., 2019) regarding the adoption of industrial technology 4.0 as a moderating effect of LM implementation and its impact on the operational performance (OP) improvement of companies in Brazil. The results of this study found a partial relationship between the aspects of industrial technology adoption 4.0. Research related to LM (Nawanir, 2016) examined the effect of LM implementation on business performance (BP) in manufacturing companies in Indonesia. The study found that overall LM practices contributed significantly to improving business performance as measured by profitability, sales, and customer satisfaction.

(Nawanir, 2016) examined the influence of LM and its positive impact on business performance. (Tortorella et al., 2019) examined the relationship between LM variables and moderation of industrial technology adoption 4.0 to OP. Research related to LM and its impact on OP and business performance has been widely studied, but the measurement of LM application on company business performance with moderation in the adoption of industrial technology 4.0 is still very little. (Anderl, 2014), one of the specific aspects that affect the adoption of industrial technology 4.0 into manufacturing companies in developing countries is low technology intensity, tight investment in capital & human resources.

Performance measurements in terms of the overall organization such as profit, sales and customer satisfaction are more relevant when compared to measurements from the operational level alone. Therefore, this study examines the impact of LM implementation moderated by the adoption of industry 4.0 technology on business performance (profitability, sales, & customer satisfaction).

DeLoitte University Press (2016) explains that at the beginning of the 21st century, industry 4.0 connects the internet of things (IOT) with manufacturing techniques to allow the system to share information, analyze and use it as an intelligent execution guide. It also combines various cutting-edge technologies such as additive manufacturing, robotics, artificial intelligence and all cognitive technologies, cutting edge materials, and augmented reality.

Research Methodology

Testing on the outer model aims to measure how well each indicator is related to reflect and explain latent variables. Things that need to be considered are the validity and reliability of the data generated from the research instruments. Testing the validity in this study using convergent validity and discriminant validity, while for reliability using indicators of reliability and internal consistency reliability.

Convergent validity is done by measuring the average variance extracted (AVE). There are three discriminant validity measurements, namely Fornell-Larcker criterion, cross loading, and heterotrait-Monotrait (HTMT) ratio. Indicator reliability is based on measuring indicators of outer loading, while internal consistency reliability uses Cronbach's alpha and composite reliability.

Inner model testing is used to measure the level of suitability or feasibility of data in a modeling using test (GoF). The GoF test on the outer model can be done through 2 approaches, namely measuring the relationship between variables (R2) or predictive relevance (Q2). The coefficient of determination explains the proportion of variability Y described by the least square X regression. The coefficient of determination is determined by the value of R2.

Discussion of Research Results

The discussion of the research results includes the results of the validity test, reliability test, GoF test and hypothesis testing. Target respondents at PT. XYZ totaled 60 employees, but only 55 employees filled out the questionnaire, so the data used became n = 55. Based on the level of position, respondents who had staff positions were 39 respondents (70.9%), supervisors were 8 respondents (14.5%), managers were 5 respondents (9.1%), deputy general managers were 3 respondents (5, 5%), while for the General Manager level, no one filled out the quisoner.

Based on shop, respondents who work in shop casting are 11 respondents (20%), shop welding is 8 respondents (14.5%), shop painting is 12 respondents (21.8%), shop machining is 9 respondents (16.4 %), and shop assembling as many as 15 respondents (27.3%).

Reliability in this study considers indicator reliability using indicators of outer loading and internal consistency reliability using Cronbach's alpha and composite reliability. Based on the results of the calculation of 1st order construct, the indicator's outer loading on each latent variable shows that there are several values that do not meet the criteria value> 0.6 (Hair, Hult, Ringle, Sarstedt, & Thiele, 2017). Indicators that do not meet the criteria are not used in the next stage.

(Sarstedt, Ringle, & Hair, 2014) discriminant validity refers to the extent to which constructs actually differ from one another empirically, also measuring the degree of difference between overlapping constructs. Discriminant validity can be measured using the fornell-larcker criterion, cross-loading, or HTMT method. Based on the test results, the fornell-larcker criterion on the 1st order construct and 2nd order construct of all variables was declared valid and sufficient to meet the discriminant validity requirements.

Testing the feasibility of the model through GoF considers the GoF value with the input coefficient of determination (R2). Based on the results of the calculation of the R2 value in table 15., the simultaneous effect of LM to PROF is 0.042 (4.2%), the simultaneous effect of LM to SALE is 0.204 (20.4%), and the simultaneous effect of LM to CUST is 0.111 (11.1%). This value shows that R2 for LM against the dependent variable SALE is categorized as weak, while the dependent variables PROF and CUST are outside the recommended value category. Based on this value, the effect of LM on SALE at PT. XYZ is the biggest and can be explained by LM at 20.4%.

The results of hypothesis testing show that none of the interactions of industrial technology 4.0 process-related (H1; H3; H5) moderate the application of LM to BP. (Tortorella et al., 2019) moderation by industrial technology 4.0 process-related to OP is the practice of LM low setup. The low setup aspect in LM practices in this study lies in the QS variable (Nawanir, 2016). Outer loading on the QS variable in the 2nd order construct shows values that do not meet the criteria so they are eliminated in hypothesis testing. PT. XYZ does not fully practice QS in its operations. Therefore the results of hypothesis testing are in line with (Tortorella et al., 2019) that apart from low setup practices, industrial 4.0 process-related technology does not moderate OP. (Nawanir, Teong, & Othman, 2013) Partially OP is a mediating variable for the relationship between LM and BP.

The results of hypothesis testing show that none of the interactions of industrial technology 4.0 product / service-related (H2; H4; H6) moderate the application of LM to BP. (Tortorella et al., 2019) moderation by industrial technology 4.0 product / service-related to OP is the practice of LM flow. (Tortorella et al., 2019) practice flow includes improvement through planned layout arrangements according to product families and balancing work station cycle time. This flow practice is actually in line with CL practice involved in hypothesis testing. The difference between (Tortorella et al., 2019) and this study occurs due to the industrial 4.0 product / service technology involved, IND6 (3D printing) and IND7 (simulation) which are industrial technology 4.0 which is less closely related to the manufacturing process of PT. XYZ.

PT. XYZ produces mass production automotive components, 3D printing or additive manufacturing is not suitable for mass production because of the low processing speed in making one item. Therefore, IND6 (3d printing) technology investment is not suitable for strengthening LM practices at PT. XYZ. (Tortorella & Fettermann, 2018) virtual models and IoT technology aim to support processes related to product development and service innovation, so that the use of virtual model technology (IND7) alone will not strengthen LM practices related to processes.

Conclusion

This study concludes that industry 4.0 process-related & product / service-related technology does not moderate the implementation of lean manufacturing on business performance in terms of profitability, sales, and customer satisfaction at PT. XYZ. From the lean manufacturing side, the factor that affects this is the implementation of lean manufacturing which is not done completely by PT. XYZ. In terms of industrial technology 4.0, the influencing factor is the adoption of industrial technology 4.0 PT. XYZ focuses on technology to improve the design stage rather than the process. Besides that, the understanding of the practitioners of PT. XYZ on industrial technology 4.0 to moderate the implementation of lean manufacturing may be another factor.

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