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The Effect of Six Sigma on Quality, Innovation Capability and Work Productivity of Tyre Industries

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Abstract *- This research is an empirical study on the Tire Industries in Jakarta, Indonesia. The main objective of this research is to analyze the practical and strategic effects of the implementation of Six Sigma on innovation capabilities, work productivity, and quality to customers as part of the comparative and competitive advantages of companies engaged in tire industries. The population of this research is all employees of tyres industries. Sampling using a questionnaire with a simple random sample technique that is distributed to the entire population. The number of incoming and valid questionnaires was 443 samples. Data processing using the SEM method with SmartPLS 3.0 software. From the results of data analysis, it can be seen that all hypotheses are accepted, indicating that the implementation of the Six Sigma has a positive and significant effect on innovation capabilities, work productivity, and quality. Innovation capabilities and employee work productivity also have a positive and significant effect on quality. Another important point is that innovation capability and work productivity have a positive and significant effect as a mediator on the influence relationship between the Six sigma and service quality. This study proposes a model to improve the quality of tyre industries through increasing and strengthening the application of the Six Sigma concept through innovation capabilities and work productivity as a mediator. This research can pave the way for increasing the readiness of employees and companies to face the era of the industrial revolution 4.0.*

Keywords: *Innovation capability, six sigma, quality, work productivity.*

1. INTRODUCTION

Damaged products produced in the production process are a big loss for the company. For that we need improvement and quality control to overcome this. Six Sigma is a method that can be used to bring the company to the level of defective products so that the products produced meet predetermined specifications. The more defective products during the product process will make the production costs incurred more. If this is the case, the cost of production will be higher, resulting in a high selling price as well. These products will be less competitive with similar companies that produce products with lower selling prices and better quality for the same type of product. Six Sigma is a new management tool used to change the overall Quality Management (TQM), very focused on quality control by understanding the structure of industrial production by means of totality. has a goal to, eliminate production defects, cut product production time, and eliminate costs. Six sigma is also called a comprehensive structure, which means strategies, disciplines, and tools to reach and support business success. Six Sigma is called a strategy because it focuses on increasing consumer satisfaction, is called a scientific discipline because it follows the

official form, namely DMAIC (Define, Measure, Analyze, Improve, Control) and tools because it is used in conjunction with others, such as Pareto charts and histograms. . The success of improving the quality and ability of business, depends on performance to identify and solve problems. This performance is a fundamental state in the Six Sigma philosophy.Six Sigma is a new management tool used to change overall quality. The purpose of Sigma is to reduce variations in expenditure so that it does not cross the six standard deviations (Sigma) between the general (mean) and the nearest detailed boundary. Sigma processes must be able to generate errors of at least 3.4 per million opportunities or achieve a 99.9966% success rate. the higher the sigma value, the less variation a process will experience and the less error it will experience. Six Sigma implementation focuses on processes, be it production processes or services. if successful, then Six Sigma will be able to determine if the entire production process is moving at optimal capabilities.

Every company that can compete and maintain its business must have a program regarding the quality because through a good quality program, the company will be able to effectively reduce the number of defective products produced. So, quality control activities are related to the quality standards set by the company. The implementation of quality control aims to minimize the number of defective products, to ensure that the finished products are produced following the quality standards of the company, and to avoid passing defective products into the hands of consumers. So to maintain product quality following predetermined quality standards, companies need to carry out intensive and continuous control and supervision both on the quality of raw materials, production processes, and final products. In the product guarantee program, the company will always carry out quality *control* intensive(QC) activities on its products starting from the components of the basic ingredients of the product, to the production process. Efforts are made to control the quality by using the method *six sigma* . Six Sigma is a quality control method that is often used in large companies, which goes through a continuous and continuous process.

The problem is the extent of the influence of the application of the six sigma on innovation capabilities, work productivity, and service quality of employees to customers. Where the three variables above are important components for efforts to improve the sustainable competitiveness of telecommunications service contracting companies. Several previous studies analyzed the effect of applying the six sigma on service quality, the effect of the six sigma on work productivity, and the effect of the six sigma on innovation capabilities. However, no research has been found that comprehensively analyzes the effect of implementing the six sigma on service quality through innovation capabilities and employee work productivity as a single research model. Therefore, this *research gap* is considered important and critical to be analyzed more deeply so that in turn, comprehensive knowledge is obtained and has an impact on policymaking by the leaders of tyre industries.

2.METHODS

The method used in this research is the quantitative method. Data was collected by distributing questionnaires to all employees of four tyre industries. The list of variables and items is mentioned in Table 1. The questionnaire is designed closed except for questions/statements regarding the identity of the respondent in the form of a semi-open questionnaire. Each closed question/statement item is given five answer options, namely: strongly agree (SS) score 5, agree (S) score 4, neutral (N) score 3, disagree (TS) score 2, and strongly disagree (STS) score 1. The method for processing data is by using PLS and using *software* SmartPLS version 3.0as *its tool.*

Table 1. Descriptive Sample Information

Criteria		Number	%
Age (as of September 2020)	≤ 30 years	317	71.78%
	31 - 40 years	104	23.25%
	41 - 50 years	17	4.06%
	≥51 years	5	0.90%
Work experience	1 - 5 years	333	74.72%
	6-10 years	81	18.74%
	> 10 years	29	6.55%
Education	≤ Senior High School	392	88.04%
	Diploma Degree	15	3.84%
	Bachelor Degree	36	8.13%

The population in this study were all employees of four tyre industries, amounting to 3.056 people. Determination of the number of samples using the Slovin formula, so in this study, the minimum sample is 354 people (Umar, 2002). The questionnaires were distributed using a simple *random sampling technique*. The results of the questionnaire returned were 503 and 443 samples were valid (88.07 percent). So, the sample obtained has exceeded the minimum sample size required according to the Slovin formula (Umar, 2002).

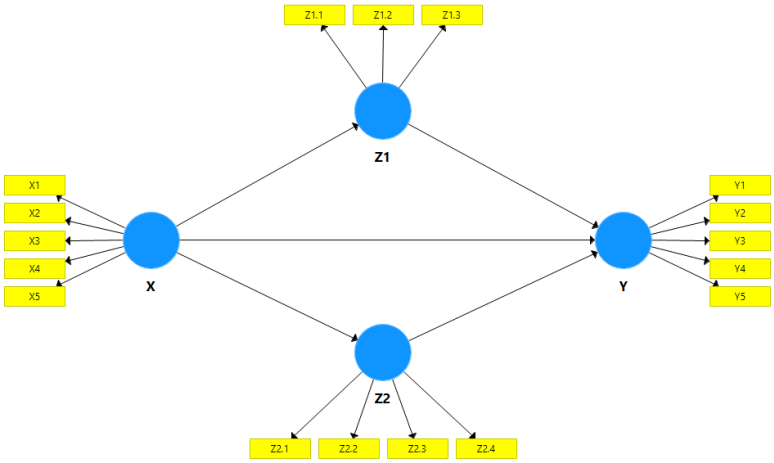

Figure 1. Research Model

The researcher proposes the following hypothesis:

H1: Six Sigma have a positive and significant effect on innovation capabilities
H2: Six Sigma have a positive and significant effect on work productivity
H3: Six Sigma have a positive and significant effect on quality
H4: Innovation capability has a positive and significant effect on service quality
H5: Work productivity has a positive and significant effect on service quality
H6: Six Sigma have a positive and significant effect on quality through the mediation of innovation capabilities.
H7: Six Sigma have a positive and significant effect on quality through mediating work productivity.

3.RESULTS AND DISCUSSION

The measurement model testing phase includes testing for convergent, validity discriminant validity. Meanwhile, to test the construct reliability,*Cronbach's alpha* and *composite reliability were used*. The results of the PLS analysis can be used to test the research hypothesis if all indicators in the PLS model have met the requirements of convergent validity, discriminant validity, and reliability testing.Convergent validity test is done by looking at thevalue *loading factor* of each indicator against the construct. In most references, a factor weight of 0.5 or more is considered to have sufficiently strong validity to explain latent constructs (Chin, 1998; Ghozali, 2014; Hair et al., 2010). In this study, the minimum limit for *loading factor accepted* is 0.5, provided that the AVE value of each construct is> 0.5 (Ghozali, 2014). Based on the results of SmartPLS 3.0 processing, after items that do not meet the requirements are discarded, in Table 2, all indicators have a value *loading factor* above 0.7. So thus, the convergent validity of this research model has met the requirements. The value of loadings, *Cronbach's alpha, composite reliability*, and AVE for each complete construct can be seen in Table 3 below:

Table 2. Items Loadings, Cronbach's Alpha, Composite Reliability, and Average Variance Extracted (AVE)

Variables	Items	Loadings	Cronbach's Alpha	Composite Reliability	AVE
Six Sigma (X)	X1	0.772	0.833	0.883	0.601
	X2	0.882			
	X3	0.840			
	X4	0.746			
	X5	0.705			
Innovation Capability(Z1)	Z1.1	0.877	0.852	0.859	0.714
	Z1.2	0.895			
	Z1.3	0.854			
Work Productivity(Z2)	Z2.1	0.838	0.885	0.921	0.774
	Z2.2	0.952			
	Z2.3	0.848			
	Z2.4	0.745			
Quality (Y)	Y1	0.871	0.881	0.931	0.677
	Y2	0.805			
	Y3	0.812			
	Y4	0.836			
	Y5	0.706			

Discriminant validity is done to ensure that each concept of each latent variable is different from other latent variables. The model has good *discriminant validity* if the AVE square value of each exogenous construct (the value on the diagonal) exceeds the correlation between this construct and other constructs (values below the diagonal) (Ghozali, 2014). The results oftesting *discriminant validity* using the square AVE value, namely by looking at the Fornell-Larcker Criterion Value are obtained as referred to in Table 3.The discriminant validity test results in table 3 above show that all constructs have a square root value of AVE above the correlation value with the construct. other latency, through the Fornell-Larcker criteria, so that it can be concluded that the model has met the discriminant validity (Fornell&Larcker, 1981).

Moreover, collinearity evaluation is done to discover whether there is collinearity in the model. To find out about collinearity, VIF estimation from every construct is required. If the VIF score is higher than 5, then the model will show collinearity (Hair et al., 2014). It is shown the same way as in Table 4, all VIF scores that are less than 5 means that the model has no collinearity. The construct reliability can be assessed from *Cronbach's alpha value* and the *composite reliability* of each construct. The recommended *composite reliability* and *Cronbach's alpha* value is more than 0.7 (Ghozali, 2014), you can use a measure of one of them. If thevalue *composite reliability* is above 0.7, then it is sufficient (Ghozali, 2014). The reliability test results in table 2 above show that all constructs have avalue *composite reliability* greater than 0.7 (> 0.7). In conclusion, all constructs have met the required reliability.

Hypothesis test

Hypothesis testing in PLS is also known as the inner model test. Hypothesis testing in this study includes testing the significance of direct effects and measuring the influence of exogenous variables on endogenous variables. The effect test was carried out using the t-statistic test in theanalysis model *partial least square* (PLS)using the *software* SmartPLS 3.0. With thetechnique *bootstrapping*, the obtained *R Square* value and thevalue are significance testas shown in the table below:

Tabel 3 Discriminant Validity

Variables	X	Y	Z1	Z2
X	**0.757**			
Y	0.755	**0.832**		
Z1	0.715	0.720	**0.816**	
Z2	0.485	0.501	0.435	**0.864**

Tabel 4. Collinearity Statistics (VIF)

Variables	Y	Z1	Z2
X	2.309	1.000	1.000
Z1	2.334		
Z2	1.332		

Tabel 5. *R Square*Value

	R Square	R Square Adjusted
Y	0.645	0.625
Z1	0.546	0.536
Z2	0.201	0.290

Tabel 6. Hypotheses Testing

Hypotheses	Relationship	Beta	SE	T Statistics	P-Values	Decision
H1	X→Z1	0.715	0.027	28.091	0.000	Supported
H2	X →Z2	0.484	0.043	10.771	0.000	Supported
H3	X → Y	0.532	0.051	10.254	0.000	Supported
H4	Z1 → Y	0.253	0.057	4.124	0.000	Supported
H5	Z2 → Y	0.146	0.037	4.407	0.011	Supported
H6	X →Z1 → Y	0.167	0.045	3.956	0.000	Supported
H7	X → Z2 → Y	0.057	0.019	3.922	0.000	Supported

Based on Table 5 above, the value of *R Square* for service quality (Y) is 0.634 which means that the variable service quality (Y) can be explained by the variable application of the Six Sigma (X), innovation capability (Z1), and employee work productivity (Z2) of 64.5 %, while the remaining 35.5% is explained by other variables not discussed in this study. The value of *R Square* innovation capability (Z1) is 0.546, which means that the innovation capability variable (Z1) can be explained by the Six Sigma application variable (X) of 54.6%, while the remaining 45.4% is explained by other variables not discussed in this study. The value *R Square* of employee work productivity (Z2) is 0.201 which means that the employee work productivity variable (Z2) can be explained by the Six sigmaapplication variable (X) of 21.0%, while the remaining 79.0% is explained by other

variables not discussed in this study. Meanwhile, Table 6 shows the *T Statistics* and *P-Values* that show the influence between the research variables that have been mentioned.

The results of data analysis indicate that the application of the Six Sigma has a positive and significant effect on innovation capabilities. Evidenced by the t-statistics value of 28.019, greater than 1.96, and a p-value of 0.000 less than 0.05. Because the effect is positive, the conclusion is that the H1 hypothesis is accepted. So, it can be concluded that there is a positive and significant effect of the application of the Six Sigma on innovation capabilities. The application of the Six Sigma has a positive and significant effect on employee work productivity. Evidenced by the t-statistics value of 10.717, greater than 1.96, and a p-value of 0.000 smaller than 0.05. Since the effect is positive, the conclusion is that the H2 hypothesis is accepted. So, it can be concluded that there is a positive and significant effect of the application of the Six Sigma on employee work productivity. The application of the Six Sigma has a positive and significant effect on service quality. Evidenced by the t-statistics value of 10.254, greater than 1.96, and a p-value of 0.000 smaller than 0.05. Because the effect is positive, the conclusion is that the H3 hypothesis is accepted. So, it can be concluded that there is a positive and significant effect of the application of the Six Sigma on the quality of employee service to customers. Innovation capability has a positive and significant effect on service quality. Evidenced by the t-statistics value of 4.124, greater than 1.96, and a p-value of 0.000, less than 0.05. Because the effect is positive, the conclusion is that the hypothesis H4 is accepted. So, it can be concluded that there is a positive and significant impact of innovation capabilities on service quality. Employee productivity has a positive and significant effect on service quality. Evidenced by the t-statistics value of 4.407, greater than 1.96, and a p-value of 0.015 which is smaller than 0.05. Because the effect is positive, the conclusion is that hypothesis H5 is accepted. So, it can be concluded that there is a positive and significant influence on employee work productivity on service quality. The application of the Six Sigma has a positive and significant effect on service quality mediated by the innovation capability variable. Evidenced by the t-statistics value of 3.956, greater than 1.96, and a p-value of 0.000 smaller than 0.05. Because the effect is positive, the conclusion is that hypothesis H6 is accepted. The application of the Six Sigma has a positive and significant effect on service quality that is mediated by employee work productivity variables. Evidenced by the t-statistics value of 3.922, greater than 1.96, and a p-value of 0.000 smaller than 0.05. Because the effect is positive, the conclusion is that hypothesis H7 is accepted.

Discussion

Analysis of the data in the previous section shows that the application of the Six sigmahas a positive and significant effect on innovation capabilities, work productivity, and service quality. This fact is consistent with the results of research which states that the Six sigmahas a positive and significant effect on innovation, employee work productivity, and service quality.The data analysis above shows that the innovation capabilities and work productivity of employees have a positive and significant impact on service quality.Qquality is the most crucial part and a differentiating factor between one company and another. Competitive advantage is felt to be increasingly necessary to build sustainably so that companies canexist in the era of industrial revolution 4.0 which necessitates a unique and significant advantage.The best competitive advantage in a business is very much dependent on the defense of the company's unique resources and skills. The position of *competitive advantage* that can is the key to survive long-term business performance superiority. Position of *advantage* strong will create value that is

perceived by customers higher than others and can create relatively low costs and ultimately drive the achievement of job differentiation, which is supported by *skills* market-oriented and company resources.Competitive advantageis a dynamic process, so it must be done on an ongoing basis. Competitive advantage illustrates that a company can act better than other companies even though they operate in the same industrial environment (Hasan, 2008). The better the *intellectual capital and* innovation capabilities of the company's employees, the higher the competitiveness (Jose & Gonzales, 2012). The ability to innovate is very important to create competitive advantage (Larsen & Lewis, 2007), the ability to innovate can increase competitive advantage (Parkman et al., 2012).The fact obtained from the results of data analysis in the previous section shows that the application of the Six sigmahas a positive and significant effect on service quality through the mediation of the innovation capability and work productivity variables. This fact is following the results of research which state that the Six sigmahas a positive and significant effect on quality. service through the mediation of innovation capability variables and work productivity Pis a feedback cycle in which a planned process responds to non-conformity, improvements, and all feedback as a result of the constructive evaluation to become materials for making further improvements in a continuous process. Feedback in the dynamics of organizational activities occurs at the smallest and individual process levels. Suppose an employee gets feedback in the form of an individual performance appraisal from his superior, gets a variety of inputs from people around him (colleagues, suppliers, customers), and can even be all information or input from various sources and facts in the field that lead to individual and organizational improvements. . This is the importance of the extent to which an individual responds to all input or feedback to improve himself and his performance. The continuous improvement feedback cycle which is will be driven more effectively if it is responded well by individuals in responding not only to the scope of the work operation process but in all aspects that are an improvement for themselves and the organization. In the perspective of work characteristics theory, feedback is defined as information that conveys how well or at the individual level the worker does his job, while from the perspective of goal setting theory, feedback is defined as information that conveys the most up-to-date progress that has been achieved on the target or goals that have been set (Colquitt & Wesson, 2009). This study found the fact that feedback from the Six sigmain terms of performance is an important factor in organizational change towards better performance.

5.CONCLUSIONS

From the data analysis that has been done previously, it has been proven that the application of the Six sigmahas a positive and significant effect on innovation capabilities, work productivity, and service quality of employees to customers. Likewise, innovation capabilities and employee work productivity have a positive and significant effect on service quality. Another important point from the conclusion of this study is that innovation capabilities and work productivity have a positive and significant effect on the influence relationship between the application of the Six sigma and quality at four tyre industries in Jakarta Indonesia. Future studies shouldresearch other units of analysis, such as customers and suppliers. Likewise, development research can be carried out in other sectors such as education, social, and other public sectors. In future studies, it will be better to add and involve other relevant variables so that it will make research in this theme more complete and comprehensive.

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