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QUALITY DETERMINING OF MACHINING PRODUCTS BASED ON MANUFACTURING INDUSTRY STANDARDS: AN EXPLORATION SURVEY OF VOCATIONAL STUDENTS

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ABSTRACT

The quality of a machining product depends on many factors. The manufacturing industry has standardized processes that need to be disseminated to vocational students in order to achieve alignment in the achievement of competence needs relevant to the needs of the industrial world. This study aims to reveal the influential determinant variable in machining process in manufacturing industry and develop conceptual model that can be used as a theory in producing quality products. The research method used survey with exploratory sequential with approach used mix method. The sample of this research is 122 students of National Vocational School Berbah program of machining engineering. Data collection used is questionnaires and interviews. The results showed that there are variables of creativity, completeness of machine accessories, the use of measuring tools, and concerns of occupational health and safety as a critical determinant of the success of a qualified machining process. The Lisrel analysis shows that there are both direct and indirect effects of these variables on the quality of machining products of industry-standard manufacturing.

Keywords: machining product qualified, standard of manufacturing industries, mechanical engineering research

INTRODUCTION

The development of the manufacturing industry in Indonesia in the two decades of the millennium has been progressing rapidly. The seizure of the hulurization industry has become a downstream trend causing many local industries to grow and expand by adjusting the local needs of the local industrial area. Changes in the mindset of processing resources or raw materials into semi-finished, now it has been abandoned and shifted from the industry of producing raw goods to the ready to market products (Rauner & Maclean, 2008).

Data released by the Central Bureau of Statistics in the year 2013 on the number of large industrial companies, especially the metal or machinery manufacturing industry mentions there are about 1227 industrial manufacturing sub-sector of about 23,941 large industries in Indonesia or about 5.31%. This shows that the growth of the manufacturing industry contributes substantial foreign exchange in the economy of Indonesia. The needs of consumers are diverse and complex, making many industries competing to compete competitively in absorbing many consumers in its manufacturing products. Futuristic designs that prioritize product quality and assurance make the choice of product and product support facilities vary or diverse forms and options.

The manufacturing industry in 2015 is progressing. According to the Ministry of Industry is able to provide foreign exchange to the state of IDR. 2,097.71 trillion or 18.1% to the national GDP (http://www.kemenperin.go.id/artikel/627). The latest data surveyed by the United Nations Industrial Development Organization (2016) suggests that Indonesia's manufacturing industry is reported to have contributed nearly a quarter of the nation's gross domestic product (GDP). This is a great advantage for Indonesia in answering the rapidly growing and competitive globalization.

A qualified human resources reserve depends on the labor-saving power that joins the industry. The open and closed recruitment system makes a lot of speculation that will have an impact on the progress of the manufacturing industry. Currently, the Ministry of Industry targets the number of workers in the industrial sector to reach 16.3 million workers by the end of 2017 (Antara News, 19 February 2017). The enormous amount is expected to increase the labor force by producing skilled graduates with either formal education through vocational and higher education, or non-formal education channels through vocational education and skill training.

Ministry of Industry predicts that the number of workers in the manufacturing sector continues to increase from year to year, from 12.37 million people in 2011 to about 15.73 million people in 2013. The impact of downstream manufacturing industries resulted in the industry being able to absorb more less 13.87% of Indonesia's workforce and ranked 4th largest after agriculture, trade and services sector (http://www.kemenperind.go.id/). One of the contributors to the fulfillment of manpower in the manufacturing sector is graduated from vocational high schools.

VHS revitalization policy in the framework of Improving the Quality and Competitiveness of Human Resources through the Presidential Instruction Number 9 of 2016 is of particular concern to all ministries to focus on strengthening the link and match and accelerating the preparation of Indonesian National Work Competency Standards (SKKNI) between SMK (VHS) with 12 Indonesian Government Ministries. SKKNI is expected to meet the qualifications expected by the business and industry. In fact, the number of spectrum of expertise in VHS referring to the Decree of the Director General of Secondary Education No. 7013 / D / KP / 2013 dated December 4, 2013 on the Spectrum of Vocational Secondary Education

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Skills consists of 9 areas of expertise, 46 skill programs, and 128 skill packages. Such a large amount will be a challenge for developers SKKNI to accelerate SKKNI formulate in accordance with business and industry standards in order to produce graduates who are competent according to the needs of the world of work.

One of the most popular skill programs is mechanical engineering (Grose: 2008 in Suharto & Mahyuddin: 2008). The wide range of engineering techniques such as Spectrum Expertise SMK consists of: machining techniques, welding techniques, metal fabrication techniques, metal casting techniques, mechanical maintenance techniques, and drawing machine techniques. With this broad program expertise will certainly result in great graduates and the ability to absorb labor into the workforce is also high. Therefore, field-related research will contribute greatly to the revitalization of vocational schools and the absorption of graduate needs in the world of work.

The success of machining practice in VHS is influenced by many factors, both internal and external factors (Grote & Antonsson, 2008; Mudzakir & Sutrisno, 1997).). Internal factors include students' abilities, knowledge, and attitudes, while external factors include the support of equipment and practical equipment and the environment around the workshop (Kalpakjian & Schmid, 2009). Prosser & Quigley (1950) in one of his theories put forward "The training jobs are carried on in the same way as in the occupation itself". This means that effective vocational education can only be provided where the exercise tasks are performed in the same manner, tool and machine as defined in the workplace. Students in machining practice need to adapt the operational standards of procedures similar to those employed by manufacturing industry operators in order that the results / lab products are in accordance with industry standards.

Based on the above explanation, it can be drawn a major problem how to determine the factors of determination that affect the quality of product practice of SMK vocational students in DIY that product qualified manufacturing industry standards. The existence of this study will determine which priorities most teachers emphasize on their students especially in machining practice. With this research, it is expected to improve students' competence in machining practices with qualification of products with industry standard of manufacture.

RESEARCH METHODE

This research is included in the type of descriptive research with combination approach (mix method). Combined research design used is sequential exploratory model. This research method combines qualitative and quantitative research methods in sequence. In the first phase of the study used are qualitative methods and the second stage using quantitative methods. According

Sugiyono, (2013), qualitative methods serve to find the hypothesis in certain cases or limited samples, and quantitative methods serve to test the hypothesis in the wider population. So this method aims to find the hypothesis and simultaneously prove the external validity of the hypothesis.

This research was conducted at two places namely PT. Mega Andalan Kalasan (MAK) of Sleman Regency and SMK Nasional Berbah Sleman District. The selection of this place is based on the MoU conducted by the industry and the agency. The study lasted for 8 months, started in industry and continued to school. The subject of research is divided into two. The subjects of the research are the operator of manufacturing industry machinery and the students of SMK Nasional Berbah majoring in Machining Engineering. The sample technique used in this qualitative research is using purposive sampling. The second research subjects were students of the Mechanical Engineering Skills Package in DIY that were taken randomly stratified with a 5% error rate with the formulation used from the Issac & Michael formula. The sample is used for quantitative research. A total of 122 students were sampled in this study.

The data collection technique in this combination study is divided into two. Data collection techniques in qualitative research used is interviews, observation, and documentation. This technique aims to obtain data on the quality of machining products with industry-standard manufacturing industry. The results of the data collection are then tested back to school quantitatively through observation and questionnaires. Instrument indicators are determined based on the findings of the qualitative research variables in the industry as follows:

1. Student Creativity (KRM) as exogenous variables and latent variables for some manifest variables such as:
   - Sensitive to Problems (SENSI)
   - Disclosure of Idea (IDE)
   - Flexibility (FLEX)
   - Originality in Thinking (ORI)
   - Using the imagination approach (IMAJI)
2. Machine Completeness (KMES) as endogenous variable and latent variable for some manifest variable as follows:
   - Accessories for work piece setting (SETT)
   - Accessories in assisting machining parameters (PRMTR)
   - K3 Supplies (PERK3)
   - Tools and Equipment that help Process Machining (MACH)
3. Use of Measuring Instruments (PAUs) as endogenous variables and latent variables for several manifest variables as follows:
   - Selection of measuring tools (UKUR)
   - Technical use of measuring tools (TEKUR)
   - Maintenance and maintenance of measuring tools (RAWAT)

4. Attention to Occupational Safety and Health (PK3) as endogenous and latent

variables for several manifest variables as follows:

- Safety (protection) for yourself (SELF)
- Safety for work environment (LINGK)
- Safety for tool / machine (KESAL)
- Policy / discipline of practice (TATIB)
- K3 supporting equipment and equipment (PENK3)

5. Quality of Machining Practice Results (KHP) as endogenous and latent variables for several manifest variables as follows:
   - Work preparation (SIAKER)
   - machining process (PROMES)
   - Results of practice products (PRODUCT)
   - Time needed (TIME)
   - Occupational Safety and Health Measures (TINK3).

The arrangement of conceptual models built on the theory can be shown in the following figure:

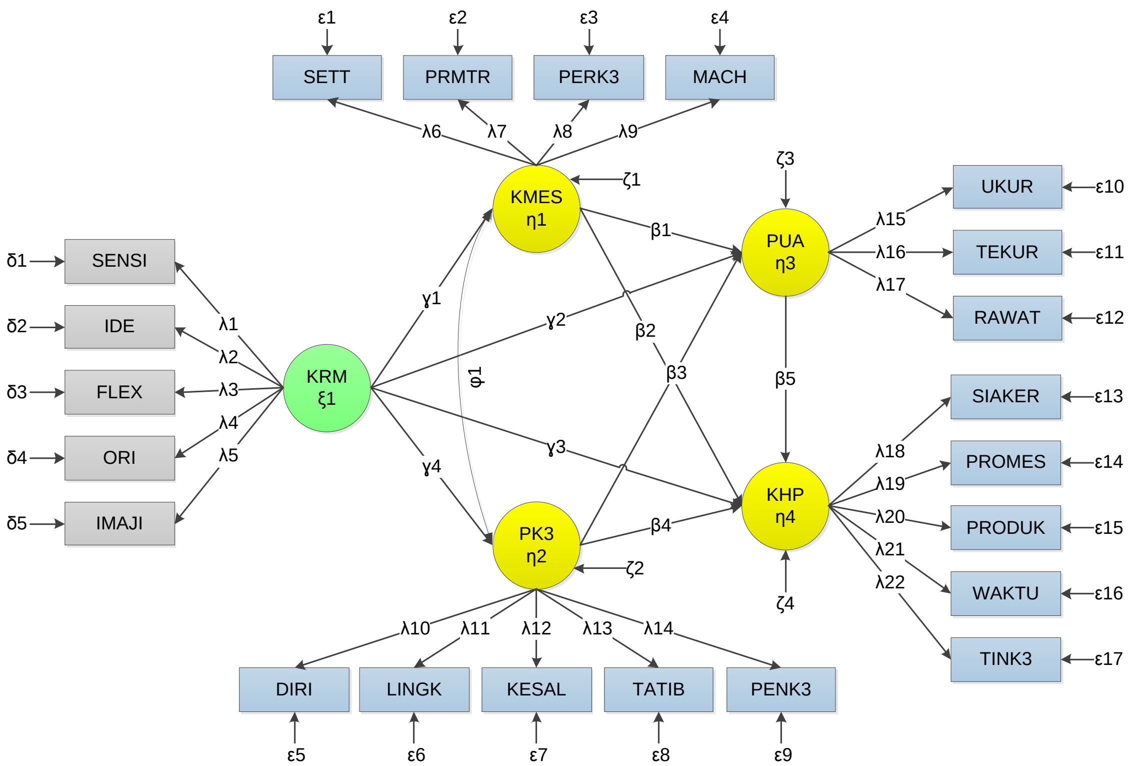

Fig 1. Model of product quality determination path of standard machining practice of manufacturing industry

RESULT AND DISCUSSION

This research was conducted for 8 months with the first research phase that is by qualitative method to get what factors affect the quality of machining product of industry standard of manufacture. The subjects used are the head of the production workshop and a machine operator who is considered senior in terms of working on products with conventional machines. The results obtained in this qualitative study include the findings of variables such as: the skills of interpreting engineering drawings, the ability in analyzing machining parameters, the skills of using measuring tools, the workshop layout, the completeness of the machinery and its supporting components, the use of equipment and equipment of occupational safety and health; quality geometric chisel.

The research variables that have been obtained in qualitative research in manufacture industry (PT.MAK) then developed in the instrument of questionnaire research. Questionnaire instrument in content validation by lecturer / expert of education evaluation so that in making item can be feasible and easily understood by respondent. Furthermore, a limited test of the instrument involving 30 students of National SMK Berbah Sleman remember the school has established mutual cooperation in the form of industrial-built classes. There are 19 items that fall from the 121 points of the statement, so that the rest of the question worth being used amounted to 102 questions.

The result of the obtained variables will then be assessed based on students' perceptions. From the data tabulation results obtained the quality values of each variable as follows:

Table 1. Quality of research variables

Research Variables	Percentage	Quality
Student Creativity (KRM)	75,39%	**Good**
Completeness of accessories in machine (KMES)	69,78%	**Good**
Skills using measuring tools (PAU)	71,42%	**Good**
Work safety equipment (PK3)	57,06%	**Enough**
The quality of machining practice products (KHP)	79,39%	**Good**

The table above shows that the lowest value included in the sufficient category is the use of safety equipment. This indicates that students in machining practice in the production workshop have not yet interpreted the safety of work consciously and cultured. If this can be a concern for students and workshop managers are expected to provide comfort students in the process lab in the workshop.

Before performing the hypothesis test, then tested the classical assumption with three stages of data normality test, linearity test, and multicolinearity test. From result of analysis with SPSS obtained result that all prerequisite of hypothesis test fulfilled. For that, the next process can be calculated correlation bivariate between latent variables with the presentation as follows:

Table 2. Correlation matrix between latent variables

	KRM	KMES	PUA	PK3	KHP
KRM	1,000	0,211	0,317	0,176	0,424
KMES	0,211	1,000	0,465	0,542	0,577
PUA	0,317	0,465	1,000	0,552	0,781
PK3	0,176	0,542	0,552	1,000	0,628
KHP	0,424	0,577	0,781	0,628	1,000

The results obtained from the bivariate correlation are used to determine the lisrel syntax in the input manually. The output diagram results obtained as follows:

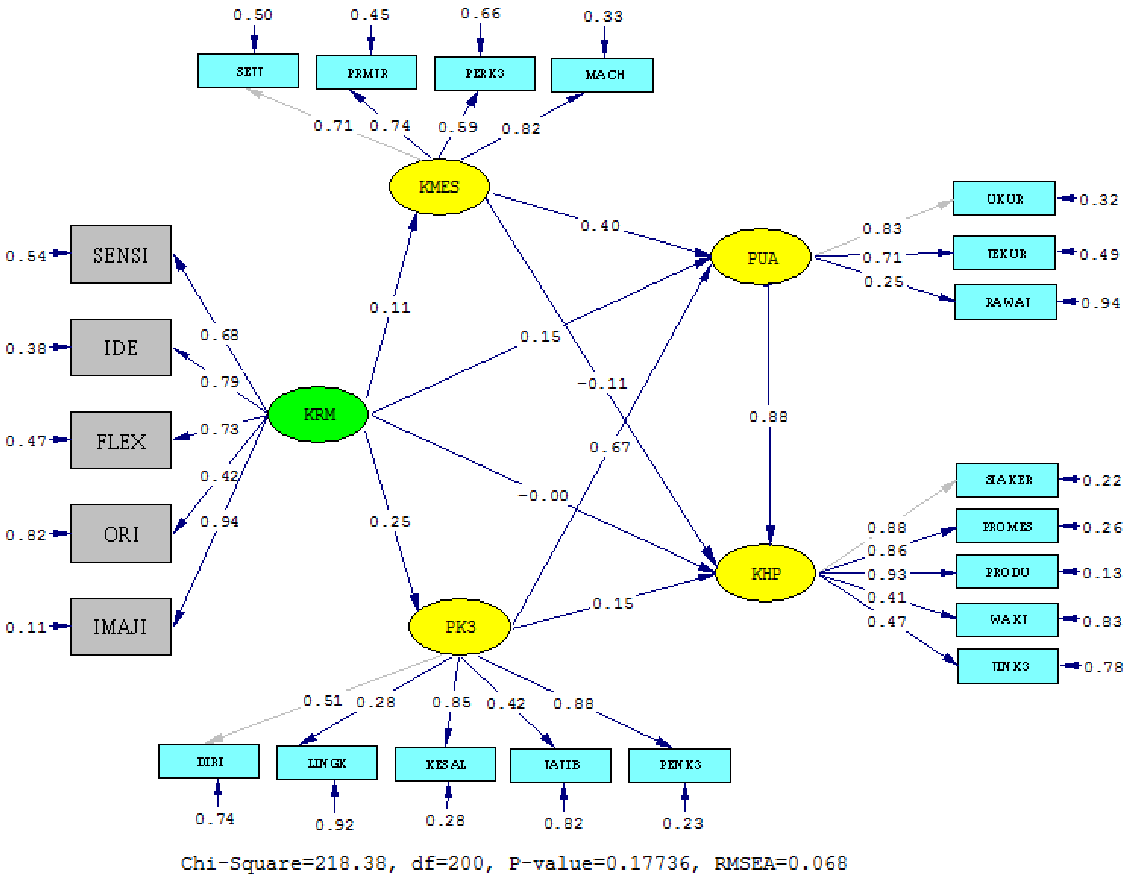

Fig 2. Result of path diagram with Lisrel

Based on the path diagram above, there are several paths that have not met the t-values based on the output of Lisrel diagrams. Therefore, the path diagram needs to be modified by disconnecting paths that do not meet the fit criteria in the t-values presented. The revision of the model of determination path of product quality of machining practice can be shown in the following figure:

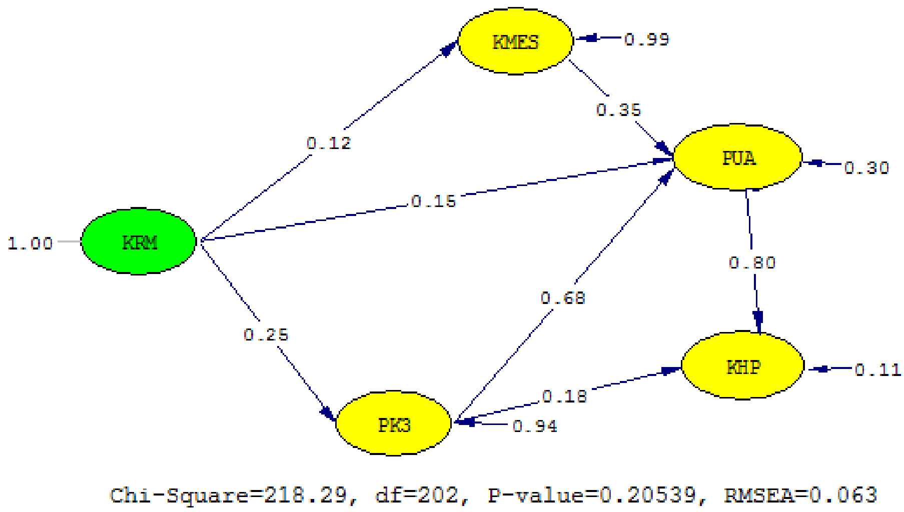

Fig 3. Modified path model

The image provides an understanding that the completeness of the mesher may be an impediment in the quality of machining products. This may be felt by respondents as something that inhibits the machining process because respondents tend to work with standard machine components / accessories in general. Another lane diagram that eliminates the relationship of quality is creativity to practice products. Based on the revised diagram, shows that creativity is very dependent on work safety, machine completeness, and use of measuring instruments.

Based on the output of the LISREL diagram in the above hypothetical model, the following results can be interpreted:

Table 2. Calculation results of structural equation model

Causality Corr.	Path Coeffiency (γ) dan (β)	Determination Coefficiency (R^2)	ζ
KRM → KMES	0,12	0,014	0,37
KRM → PK3	0,25	0,064	0,33
KMES → PUA	0,35		
PK3 → PUA	0,18	0,70	0,55
KRM → PUA	0,15		
PUA → KHP	0,80	0,89	0,54
PK3 → KHP	0,18		

The table above shows that the largest causality relationship built is the use of measuring devices on product quality has the greatest relationship. This shows that the accuracy in the use of measuring devices, the selection of measuring instruments, and the care in measuring tools has a significant effect on success in standardized industrial machining practices. The lowest quality is the relationship between creativity and use of tools. The small value of this relationship shows that learners have not really understood and use other measuring instruments more precise. Only familiar to commonly used measuring instruments such as: sliding, steel ruler, and micrometer.

The result of calculating the determination value then developed to develop the measurement and structural equation. The result of the structural equation and the measurement obtained from the analysis using Lisrel obtained the result equation as follows:

- KMES = 0,072 KRM + 0,37
- PK3 = 0,15 KRM + 0,33
- PUA = 0.77 KMES + 1,56 PK3 + 0,20 KRM + 0,55
- KHP = 0,71 PK3 + 1,35 PUA + 0,54
- SENSI = 0.87 KRM + 0.89
- IDE = 1.15 KRM + 0.82
- FLEX = 1.77 KRM + 2.76
- ORI = 0.72 KRM + 2.38
- IMAJI = 1.31 KRM + 0.20
- SETT = 2.93 KMES + 3.23
- PRMTR = 3.32 KMES + 3.15
- PERK3 = 1.00 KMES + 0.75
- MACH = 5.16 KMES + 5.35
- DIRI = 1.00 PK3 + 0.94
- LINGK = 1.06 PK3 + 4.45
- KESAL = 2.05 PK3 + 0.56
- TATIB = 1.12 PK3 + 1.92
- PENK3 = 3.97 PK3 + 1.68
- UKUR = 1.00 PUA + 0.83
- TEKUR = 1.00 PUA + 1.54
- RAWAT = 0.47 PUA + 5.61
- SIAKER = 1.26 KHP + 2.27
- PROMES = 1.58 KHP + 4.58
- PRODU = 1.00 KHP +0.83
- WAKT = 0.21 KHP + 1.22
- TINK3 = 0.31 KHP + 1.77

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Based on the above tabulated structural and measurement equations, the results of the calculations of direct, indirect, and total effects can be seen in the following tables:

Table 3. Total effect ζ to η

	KRM (ζ)	Explanation
KMES (η1)	0,07	Total Effect KRM→KMES = 7%
PK3 (η2)	0,49	Total Effect KRM→PK3 = 49%
PUA (η3)	0,15	Total Effect KRM→PUA = 15%
KHP (η4)	0,77	Total Effect KRM→KHP = 77%

The table above shows that the intervening variable gives KRM a high influence value to KHP through KMES, PK3, and PUA. The strength of this variable is able to contribute contribution to KHP variable of 77%. The opposite result is a low KRM value against KMES. The low total influence is due to the students are reluctant to use various kinds of technical aids and can also be caused by the limited facilities and infrastructure supporting the practice of machining practicum.

The effect of total manifest variables on KRM (Table 4) varies greatly. The very high influence that KRM needs to prepare is the readiness of work (SIAKER). The high readiness of work shows the existence of job loyalty in achieving the quality of the product expected according to the standards of the manufacturing industry. The smallest effect in student creativity is K3 equipment in machine accessories. This small influence is due to the students not yet deeply familiar with the function of additional accessories on machines aimed at producing safety and health during the production process. This neglect is not due to the lack of facilities, but the students' willingness to use the safety tools provided by the machine.

The existence of the mediator variable gives the KRM value indirectly increased to 77% (Table 3). Compared to Table 5, the significant indirect effect of giving KRM is stronger with KHP provided that third parties are KMES, PUA, and PK3. The high roles of these three roles in increasing the influence of KRM on KHP then need to be a consideration for students in carrying out the lab that is tailored to the standardization of manufacturing process industry.

Table 4. Total effect η to η

Endogen Var. (η)	**Endogen Manifest Var. (Y)**	**KRM (ζ)**	**Explanation**
KMES (η1)	SETT	0,21	Total effect KRM→SETT = 21%
	PRMTR	0,24	Total effect KRM→PRMTR = 24%
	PERK3	0,07	Total effect KRM→PERK3 = 7%
	MACH	0,37	Total effect KRM→MACH = 37%
PK3 (η2)	DIRI	0,15	Total effect KRM→DIRI = 15%
	LINGK	0,16	Total effect KRM→LINGK = 16%
	KESAL	0,31	Total effect KRM→KESAL = 31%
	TATIB	0,17	Total effect KRM→TATIB = 17%
PUA (η3)	PENK3	0,59	Total effect KRM→PENK3 = 59%
	UKUR	0,49	Total effect KRM→UKUR = 49%
	TEKUR	0,49	Total effect KRM→TEKUR = 49%
	RAWAT	0,23	Total effect KRM→RAWAT = 23%
KHP (η4)	SIAKER	0,98	Total effect KRM→SIAKER = 98%
	PROMES	0,72	Total effect KRM→PROMES = 72%
	PRODU	0,77	Total effect KRM→PRODU = 77%
	WAKT	0,17	Total effect KRM→WAKT = 17%
	TINK3	0,24	Total effect KRM→TINK3 = 24%

Table 5. Indirect effect η to η

	KMES (η1)	PK3 (η2)	PUA (η3)	KHP (η4)	Keterangan
KMES (η1)					There is no indirect effect
PK3 (η2)					There is no indirect effect
PUA (η3)					There is no indirect effect
KHP (η4)	**0,104**	**0,212**			- There is an indirect effect of KMES->KHP through PUA of = 10,4%. - There is an indirect effect of PK3 ->KHP through PUA of = 21.2%.

Based on Lisrel's above output results on Goodness of Fit, it is necessary to clarify whether the developed model of construction is included in Fita's criteria then it is necessary to compare the statistical criteria in the following table:

Table 6. Comparison of goodness of fit indicators

Statistik	Kriteria "Fit"	Nilai Hitung	Concl.
p-value X^2	p > 0,05	0,20539	**Fit**
Root Mean Square Error of Approximation (RMSEA)	p < 0,08	0,063	**Fit**
Expented Cross-Validation Index (ECVI)	ECVI sat. < ECVI Ind.Model	25,30 < 36,78	**Fit**
Akaike Information Criteria (AIC)	AIC sat. < AIC Ind.Model	30,00 < 70,38	**Fit**
Normed Fit Index (NFI)	p > 0,9	0,30	**Tidak**
Parsimony Normed Index (PNI)	p > 0,9	0,26	**Tidak**
Comparative Fit Index (CFI)	p > 0,9	0,38	**Tidak**
Incremental Fit Index (IFI)	p > 0,9	0,42	**Tidak**
Relative Fit Index (RFI)	p > 0,9	0,19	**Tidak**

Based on the Goodness of Fit table above, it can be concluded that the model construction diagram that has been built as a hypothetical model is declared Fit considering many stititic criteria that Fit is mainly the value of Chi-Square and P-Value. If the developed model has been declared Fit and has a high path match, then the model can be used to determine the success of the students of Machining Engineering Department in obtaining high Quality of Machinery Practice Results.

CONCLUSION

Based on the above research results obtained the following conclusions:

1. Variables that affect the quality of standard machining practice products manufacturing industry based on findings in the manufacturing industry are: creativity, completeness / machine accessories, the use of measuring instruments, and the use of safety and health equipment work.
2. There is a direct and indirect influence between exogenous latent variables with endogenous latent, latent endogenous with latent manifest, and exogenous latent with latent manifest
3. The presence of machine completeness variables, the use of appropriate measuring tools, and attention to safety of work gives indirect effect of students 'creativity on the quality of standard industrial machining products by 77% based on SMK students' perceptions.

4. Structural equations derived from the causal influence between latent variables, including: KMES = 0.072 KRM + 0.37; PK3 = 0.15 KRM + 0.33; PUA = 0.77 KMES + 1.56 PK3 + 0.20 KRM + 0.55; KHP = 0.71 PK3 + 1.35 PUA + 0.54

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