An industrial competency-based curriculum alignment model

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ABSTRACT: The aim of this study was to develop a model of industry-based curriculum alignment for mechanical engineering in vocational high schools. A research and development (R&D) method was adopted for the study. The subjects of the study consisted of the principal, teacher and chair of the mechanical engineering programme; the head of vocational education; a professional association and industry partners. The results of the study revealed that the alignment of curriculum model to meet the competency-based vocational needs of the industry has effectiveness, accuracy, reliability and efficiency in implementation. Therefore, the model is feasible to be implemented and developed to increase the competence and the employability of the graduates in industry. This model is supported by the Indonesian government policy, which in turn supports change agents in accelerating the alignment of the mechanical engineering curriculum in order to revitalise vocational school.

INTRODUCTION

The vocational high school is a part of Indonesian national education, which plays a strategic role in producing a competent national workforce that is globally competitive and promotes sustainable development. Vocational education must be pro-job, pro-activity, pro-growth, pro-distribution and pro-prosperity. Vocational education significantly affects sustainable development. The learning content must meet labour requirements [1].

The vocational school graduates should have the knowledge, skills and expertise required by the 21st Century. These include life and career skills, learning and innovation skills, as well as information, media and technology skills [2]. Students need a broad set of skills and the ability to work effectively across multiple disciplines to tackle complex global challenges [3].

One of the crucial problems of mechanical engineering programmes in vocational schools is the lack of alignment between the vocational school and industry in terms of quantity, quality, location and time [4]. The graduates of vocational schools are not ready for the workforce due to lack of competence [5].

To overcome these problems, the Indonesian government's policy is to revitalise vocational schools in a planned, comprehensive, integrated and sustainable manner, to improve their quality and capability. Revitalisation is achieved through the improvement of educational infrastructure; the transparency of financial management; and policy formulation for the supervision, monitoring and implementation of vocational education programmes [6].

The Presidential Instruction No. 9 Year 2016 on *Vocational High School Revitalisation* is expected to have a positive impact on improving the quality of vocational schools and their graduates, who are the human resources essential for the development of Indonesia. One of the aspects of the revitalisation of vocational schools is vocational curriculum alignment to produce the competencies required by industry. The demand by industry for graduates with the necessary competencies continues to grow. As a consequence, changes are required in vocational education curricula [7].

The curriculum alignment policy should include reforms of curricula and textbooks, as well as implementation and assessment [8]. The curriculum alignment is interdisciplinary with the involvement of external stakeholders [9].

The relevancy to industry of the vocational school curriculum can be achieved through the involvement of the stakeholders [10]. Therefore, a curriculum alignment model is required, which fulfils the principle of alignment and considers measures to achieve the appropriate learning objectives by involving related parties [11]. The alignment model must prioritise the development of the required competencies and the role of industry and stakeholders. Resource requirements, curriculum integration, the learning process and performance evaluation should be addressed [12].

This study was conducted to determine the feasibility of a model for managing vocational school curriculum alignment with industry. Specifically considered was the alignment between the mechanical engineering programme and industry.

METHOD

A research and development approach (R&D) was adopted for this study. Research and development can be used to develop and validate products in the field of education [13]. The feasibility of the alignment management model for the mechanical engineering curriculum was conducted using an experimental design involving pre- and post-tests of a sample, with the results analysed using a statistical *t*-test.

The subjects of this study consisted of the principal, teacher and chair of the mechanical engineering programme; the head of vocational education; a professional association and industry partners. The objects of the study were schools known as SMKN 1, 4, 5, 7 in Semarang, Indonesia, and the partner industry.

RESULTS OF THE STUDY

The feasibility test of the industrial competency-based curriculum alignment model was achieved by comparing the new with the old model with respect to effectiveness, accuracy, reliability and efficiency.

Table 1 shows that the implementation improved from 60.7% to 92.9%, mechanical engineering competence from 57.1% to 92.9%, stakeholder involvement from 46.6% to 92.9% and student competence from 60.7% to 100%.

Table 1: Effectiveness of the curriculum alignment model.

Old model %	Assessment aspects of the model	New model %
60.7	a. Implementation of alignment management	92.9
57.1	b. Development of mechanical engineering competence	92.9
46.6	c. Stakeholder involvement	92.9
60.7	d. Increased student competence	100
56.3	Average	94.6

Table 2 shows the results of a one-tailed T_{test} with five degrees of freedom and significance level $\alpha = 0.05$ (5%); T_{table} was 2.015. The calculated $T_{stat} = -7.682$. The null hypothesis H_0 that there is no difference between the old and new model is, therefore, rejected in favour of the alternative hypothesis Ha that the new curriculum alignment model of mechanical engineering is more effective than the old model. It was found that the new curriculum alignment model of mechanical engineering is more effective than the old model, in terms of implementation, development of competence, stakeholder involvement and improvement of student competence.

Table 2: *T*-test on the effectiveness of the curriculum alignment model.

Paired samples test									
	Effectiveness	Paired differences							
					95% confidence interval of difference				
		Mean	SD	Std. error mean	Lower	Upper	*t*	df	Sig. (2-tailed)
Pair 1	Old - New	-6.14286	2.11570	0.79966	-8.09955	-4.18616	-7.682	6	0.000

Table 3 shows that the accuracy of the new curriculum alignment model is higher than the old model. The average accuracy of the old curriculum alignment management model was 69.0%, whereas the new model was 93.5%. Based on these data, *target of the model* increased from 64.3% to 92.9% from old model to new, the purpose of the model from 67.9% to 92.9%, the substance (component) of the model from 71.4% to 89.3%, the systematical (sequence) of the model from 75.0% to 96.4%, the relationship of the components from 71.4% to 92.9% and the design of the model from 64.3% to 96.4%.

Table 3: Accuracy of the curriculum alignment model.

Old model %	Assessment aspects of the model	New model %
64.3	a. Target of the model	92.9
67.9	b. Purpose of the model	92.9

71.4	c. Substance (components) of the model	89.3
75.0	d. Systematic (sequence) of the model	96.4
71.4	e. Relationship between components	92.9
64.3	f. Design of the model	96.4
69.0	Average	93.5

Table 4: Results of the *t*-test on the accuracy of the curriculum alignment model.

Paired samples test									
	Accuracy	Paired differences							
					95% confidence interval of difference				
		Mean	SD	Std. error mean	Lower	Upper	*t*	df	Sig. (2-tailed)
Pair 1	Old - New	-5.85714	3.38765	1.28041	-8.99020	-2.72409	-4.574	6	0.004

Table 4 shows the results of a one-tailed T_{test} with five degrees of freedom and a significance level $\alpha = 0.05$ (5%); T_{table} was 2.015. $T_{stat} = -4.574$ was greater than the T_{table}, and therefore the alternative hypothesis Ha was accepted that the new model of curriculum alignment was more accurate than the old model.

The new model of curriculum alignment was more accurate than the old model in terms of the target model, the purpose of the model, the substance (components) of the model, systematical (sequence) of the model, the relationship of the components and the design of the model.

Table 5: Reliability of curriculum alignment management model.

Old model %	Assessment aspects of the model	New model %
67.9	a. Model procedure	85.7
64.3	b. Applicative	89.3
71.4	c. Easy to understand	96.4
64.3	d. Measurement of success	96.4
67.0	Average	92.0

Table 5 shows that the reliability of the new curriculum alignment model is higher than the old model. The average reliability of the old model was 67.0% and the new model 92.0%. Based on these data, the new curriculum alignment model improved the model procedure from 67.9% to 85.7%, applicative (easy to do) from 64.3% to 89.3%, easy to understand from 71.4% to 96.4% and the measurement of success from 67.0% to 92.0%.

Table 6: Results of the *t*-test on the reliability of the curriculum alignment model.

Paired samples test									
	Reliability	Paired differences							
					95% confidence interval of difference				
		Mean	SD	Std. error mean	Lower	Upper	*t*	df	Sig. (2-tailed)
Pair 1	Old - New	-4.00000	2.16025	0.81650	-5.99790	-2.00210	-4.899	6	0.003

Table 6 shows the results of a T_{test} on the reliability of the curriculum alignment model yielding $T_{stat} = -4.889$, which means that the alternative hypothesis Ha was accepted. As a consequence, the new curriculum alignment model is more reliable than the old model. It can be concluded that there is a significant difference between the new curriculum alignment model and the old model in model procedure, applicative, easy to understand and measurement of success, with the new model being the better one.

Table 7 shows that the efficiency of the new curriculum alignment model is higher than the old model. The average efficiency of the old model was 61.9% and the new model 83.3%. The new curriculum alignment model increased the practicality of the model from 67.9% to 89.3%, model financing from 60.7% to 71.4% and model performance from 57.1% to 89.3%.

Table 7: Efficiency of the curriculum alignment management model.

Old model %	Assessment aspects of the model	New model %
67.9	a. Practicality of the model	89.3
60.7	b. Model finance	71.4
57.1	c. Model performance	89.3
61.9	Average	83.3

Table 8: The results of the *t*-test on the efficiency of the management model synchronisation.

Paired samples test									
	Efficiency	Paired differences							
					95% confidence interval of difference				
		Mean	SD	Std. error mean	Lower	Upper	*t*	df	Sig. (2-tailed)
Pair 1	Old - New	-2.57143	1.27242	0.48093	-3.74822	-1.39464	-5.347	6	0.002

Table 8 shows the results of a T_{test} on the efficiency of the curriculum alignment model and yielded a T_{stat} = -5.347, which is greater than $T_{table.}$ As a consequence, the alternative hypothesis Ha is accepted. Based on the paired samples *t*-test, the new curriculum alignment model was more efficient than the old model. Therefore, it can be concluded that there is a significant difference between the new alignment curriculum model and the old model in terms of the model practicality, model financing and model performance with the new model being the better one.

The mechanical engineering industrial competency-based curriculum alignment model is shown in Figure 1.

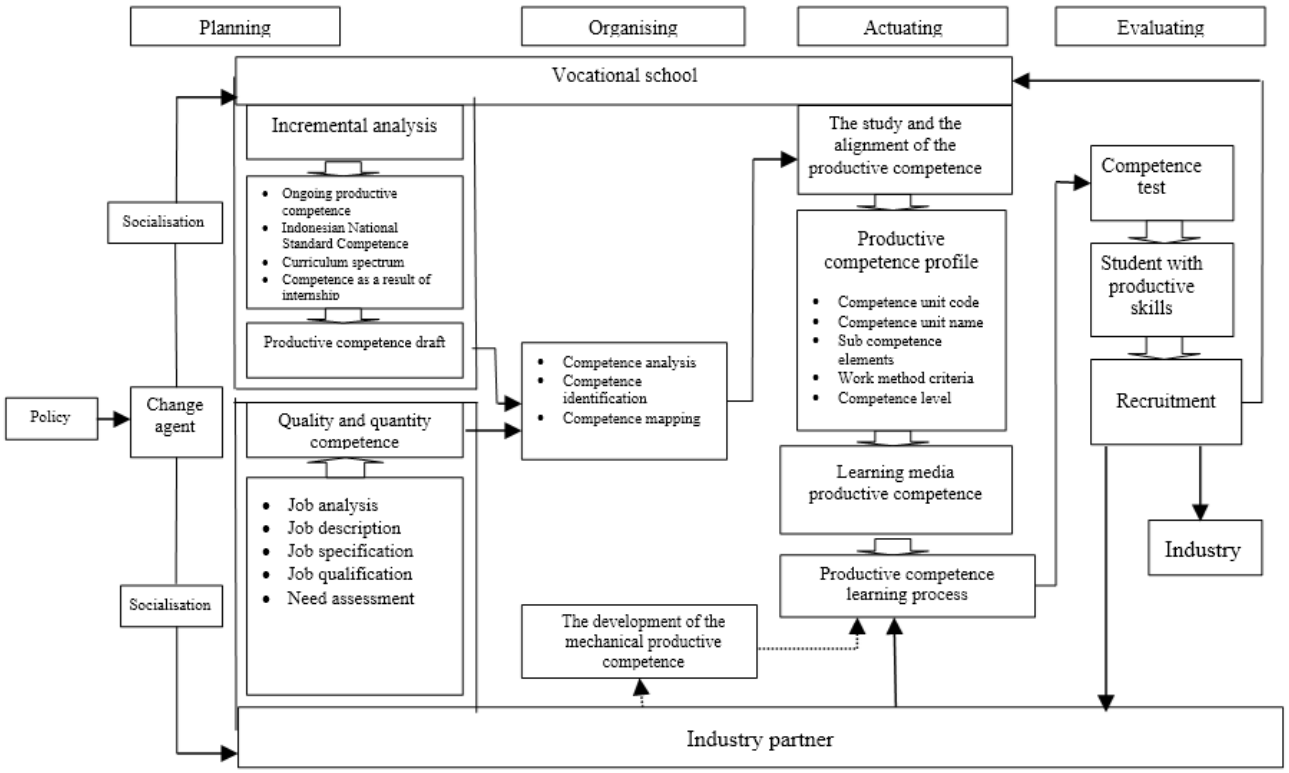

Figure 1: Industry-based competence curriculum alignment management model.

DISCUSSION

The industry competency-based curriculum alignment model of mechanical engineering has effectiveness, accuracy, reliability; and can increase graduate competence; hence, the vocational graduates' employability in industry. Therefore, the implementation of the model needs to be supported by an integrated, comprehensive and sustainable framework.

A conceptual framework and an industry-based approach are required for the development of competence in vocational education and the improvement of the educational curriculum [14]. The curriculum alignment framework involves

concepts, aligning actors, actions and processes [15]. The mechanism of curriculum alignment must be effective and efficient to ensure the implementation of the programme [12].

The industry-based competency alignment model for mechanical engineering allows students and teachers to develop themselves due to the involvement of industry and other stakeholders. The development of the engineering curriculum alignment can also encourage students to develop soft skills, such as social competence, ethical awareness and the ability to express themselves easily, both verbally and in writing [16]. Teachers are able to develop an engaging and interesting environment conducive to student learning. The learning experience is better when it relates to project work relevant to industry [3].

The mechanical engineering curriculum alignment model was supported by government policy through Presidential Instruction Number 9 of 2016, which allows the acceleration of curriculum alignment to improve students' competence and the quality of vocational education. Education policy can support the implementation of curriculum alignment, in addition to teacher professional development, curriculum policy and accountability [17].

CONCLUSIONS

Some conclusions from this research are:

1. The industry competency-based curriculum alignment model of mechanical engineering has effectiveness, accuracy and reliability. It is more efficient in its implementation. Therefore, this model is feasible to be implemented and developed to improve the competence of students in mechanical engineering programmes and graduates' employability in industry.

2. The industry competency-based curriculum alignment model is supported by government policy related to the revitalisation of vocational schools through change agents that enables the acceleration of curriculum alignment to improve education and graduate quality.

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