Curriculum development of vocational electrical engineering to accommodate industry revolution 4.0

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Abstract. The curriculum is an important component of education which has a role to prepare students to face opportunities and challenges in the future. Nowadays, the industry revolution 4.0 era has a major influence on the educational changes. In developing the curriculum as a whole, adjusting to the latest conditions and demands of the working world in the form of upskilling and reskilling projections, as well as the students' needs. The purpose of this study was to describe the direction of developing a vocational curriculum in order to accommodate the demands of industry revolution 4.0 as an innovative content curriculum in vocational electrical engineering education. Method this study was qualitative approach with literature review. The results obtained showed that the curriculum development of vocational electrical engineering education must pay attention to the latest trends of the working world which can lead students to work independently and be able to develop the 4C soft skills (critical thinking, creativity, collaboration and communication) skills as a complement to the hard skills which basically leads to the presence of the complex and collaborative measure to prepare students to compete in the working world and accommodate the demands of industry revolution 4.0.

1. Introduction
Technology development is one of the biggest causes that have an impact on changes that occur in the working world, both the workforce requirements and the characteristics of employment that are difficult to predict [1]. Economic sector is also shifted because of the impact of global transformation which leads to the demands of more competent human resources, and the emergence of creative industries require changes on the vocational education [2]. Those above oblige vocational education curricula to be dynamic and adaptable to the shifting circumstances and latest demands of the working world. Fundamentally, in the implementation of vocational education, the applied curriculum must accommodate all the students’ needs because of the requirements on both hard skills and soft skills so that they can adapt well in society in the future [1]. Dewey said in his view of vocational education is to meet the needs of students in meeting personal needs and preparation for a career so that every effective work-based education system must meet the needs of students as a whole [3]. What might they need? What resources will be needed? What challenges must be met to prepare the future workforce. According to Tessaring [4], curriculum development requires skills in finding competency qualifications that are "suitable for the future", and have meaning for students as an index of the relevance of vocational education itself. In other words, how we develop the curriculum can be interpreted that as a whole, adjustment to the latest conditions and demands the working world in the forms of upskilling and reskilling projections, as well as the needs of students themselves to prepare for career planning. The
demand of relevance between the education world and the working world in the broadest sense implies the need to master a number of competencies needed to be demonstrated while working. To be ready to work and employed, mastering certain attributes and skills in routine and creative work have been considered key in the era of the industry revolution 4.0. [3].

Indonesia has compiled an integrated road map called Making Indonesia 4.0, implementing a number of strategies to enter the era of industry revolution 4.0 that making vocational education institutions have to change the paradigm of thinking in education. The curriculum should be tailored to the needs of industry and business of the future. In line with this in the study [5], said that in reality the curriculum developed still tends to pay attention to the needs of hard skills and the thought of soft skill competency needs is still minimal in the curriculum which often becomes an obstacle in job acceptance for students in the work world [4]. Other research says curriculum development requires public-private-community involvement are needed, a new mindset, the development of learning networks to improve the skills of educators and students, and the use of technology. The curriculum should be designed to have synergy between government, industry, and education. Synergy is needed for the preparation of a link and match curriculum between educational institutions and industry, always updated curriculum material according to industry needs and includes the required competencies to enter the working world.

This is clearly related to vocational education which produce working ready graduate. From the curriculum, learning tools, facilities and infrastructure, learning patterns, to the role of instructors need to experience rethinking and redesign. The challenges that exist in the industry revolution 4.0 demand the vocational education to produce graduates who are able to work in the current and future context. Therefore, there needs to be an effort to readjust the vocational education curriculum with the labor requirements of the industry revolution era 4.0 to accommodate reinforcement forms on the required hard skills or soft skills [6].

2. Methods

The method used in writing this article is to use a qualitative approach and literature review with the aim of identifying competencies that need to be developed in the development of vocational curriculum and the needs of revolution 4.0 competencies. The following stages of research applied include: (1) determining the variables to be studied, namely competence to accommodate the needs of the industrial revolution 4.0, (2) determining the object of research, among others, industry and vocational schools, (3) collecting documents using a literature review approach with reviewing from various international journals such as Google Scholar, Springer, Elsevier and other articles in accordance with studies on the development of vocational curriculum and the need for revolution 4.0 competence to select the topic of questions and develop questions in interviews with industry and schools, (4) analyzing data and information obtained from interviews and relevant literature with a qualitative approach, (5) draw conclusions by analyzing the competencies that are most needed for the world of work then develop a list of various literature that is relevant to the results of a detailed study to me provide direction for developing competencies that need to be strengthened in the development of vocational curriculum.

3. Results and discussion

3.1. Vocational education curriculum

Curriculum development has now been regulated and refers to the National Work Competency Standards or international standards and KKNI. One of the policy roadmaps in Indonesia's vocational development in 2017 - 2025 is the existence of a too general vocational education curriculum [7]. This too general vocational education curriculum is creating problems in vocational education, so there needs to be improvement and readjustment of curriculum to have high relevance and compatibility.

Vocational education curriculum in its development must have a high relevance to: 1) the demands, needs, conditions, and development of society, 2) the suitability of curriculum components starting from the contents, processes, evaluation and objectives of the curriculum itself [6]. The Technical and Vocational Education and Training (TVET) curriculum which have guidelines of the standard of work
competency development program for the graduates. The TVET curriculum is a complete learning program that includes a theoretical philosophy program foundation, graduate competency profiles, graduate competency standards, learning outcomes, subjects structure, syllabus description, lesson plans, learning modules, lab sheets, work sheets, assessment tools, tests competency, and competency certification [8]. Curriculum development also requires selectable approaches, policies, support, and participation from various stakeholders including education administrators, education experts, curriculum experts, science experts, teachers, parents of the students, community leaders, and most importantly the industry [6]. Jobert, Mary, Tanguy and Rainbirs stated that there needs to be an interconnection between the education and the work [9]. Technological developments triggered vocational training, the development and implementation of education to prepare competent workforce capable of working professionally supported by skills to use modern digital equipment [10]. Based on various relevant researches, the teacher has a central role in developing the curriculum, collaborating with DUDI, to develop a curriculum compatible with the needs of the working world. In this case the stakeholders involved in education must take strategic steps to tackle the challenging industrial revolution 4.0 era [11].

3.2. Vocational education in the industry revolution 4.0
Technical and Vocational Education and Training (TVET) reform or often known as the Vocational Education and Training System is compatible with the development of the industry revolution 4.0, and 21st century requiring changes in the development of technology, culture, social, and science. To improve the quality of the training and the student satisfaction, three important TVET reform factors are needed: human resources, training equipment, and the ability to use technology [11]. In the era of the industry revolution 4.0 competency in technology, science and engineering are required. This era is marked by the physical world, digital, artificial intelligence, internet of things, advanced robotics, biotechnology, 3D printing, automatic vehicles, and virtual and physical systems that work together globally. The transformation of education in the era of the industry revolution 4.0 changed the paradigm of learning, teacher centered evolve into student center where the teacher only acts as a guide and facilitator.

The industry revolution 4.0 are not only an opportunity but also a threat, and has an impact on the states and the business sectors who are not ready for the change. Education in Indonesia which quality still have many gaps and mismatches between the graduates with the needs of the workforce is also impacted by the industry revolution 4.0 [5]. Factors causing this discrepancy including the lack of the quality of the curriculum, the infrastructure, the unavailability of technology in learning, and most importantly the teaching staff. Absorption of workforce in the working world from vocational education graduates is still not optimal because the low level of knowledge and skills of the graduates, and their competencies do not meet the requirements the working world [12]. Thus, it is necessary to have reformative and transformative changes in the vocational education system especially the vocational education curriculum in order to be compatible with the needs of DUDI and the demands of the industry revolution 4.0.

3.3. Reform of the vocational education curriculum
Reforms are needed in the vocational education curriculum to adjust to the demands of the industry revolution 4.0 by paying attention on two things which are: 1) The curriculum must be able to equip learners with the knowledge and skills to develop and use new things (up to date). 2) The curriculum must cover the learning process of blended learning [13]. Mastery of competencies are demanded by the industry revolution 4.0 which means that literacy competencies mastery of data, technology, and human resources. The development of the vocational education demands to the industry revolution 4.0 demands does not require the vocational education to open or create new department but how to integrate 21st century learning context and the competencies adjustments to the compatible competencies required in the industry revolution 4.0. The adjustment of several competencies in the development of a curriculum are needed, which includes: 1) Critical thinking, problem solving, collaboration, and creativity and innovation. 2) Digital literacy skills including information literacy, media literacy, and ICT literacy. 3)
Career and life skills including flexibility and adaptation, initiative, social and cultural interaction, productivity, and leadership and responsibility [14]. Everyone needs life skills. Vocational education is very important in the career development process. Development of 21st century learning curriculum to be able to accommodate the demands of the industry revolution 4.0 is needed. The most important competence is the problem-solving ability that requires Learning and Innovation Skills 4C (LIS-4C): (1) Creativity, (2) Critical thinking, (3) Communication, (4) Collaboration [16]. LIS-4C is vocational education learning skills and innovation which essential in developing creativity, critical thinking, communicating and collaborating with others, and celebrating the best learning outcomes in every problem-solving process. The direction of learning in vocational education is skills to solve problems creatively which cannot be replaced by robot technology. The ability to solve problems creatively is always needed to live the life in the 21st century. The main impact of vocational learning is the production of superior human resources who are able to solve various problems using ways of thinking, working creatively and innovatively. The competency profile is needed to live in the XXI century and be able to accommodate the demands of the industrial revolution era 4.0. Vocational education educators must also keep up with changes in technological developments so as not to be left behind. Research states that educators in the era of the industrial revolution 4.0 must be able to adapt to change, act as facilitators and mentors of students, and familiarize students with independent learning [16].

4. Conclusion
Entering the era of the industrial revolution 4.0, the vocational curriculum is demanded to be always dynamic and adapt to the conditions, changes, and needs of the world of work trends that lead to the demands of the industrial revolution 4.0. The curriculum development undertaken must need to integrate new competencies and literacy relevant to the world of work of the industrial revolution era 4.0. C4 soft skill competency becomes important in its development in curriculum development as a competency that cannot be easily replaced by the robotic era, artificial intelligence in the R.I 4.0 era. In order for curriculum changes to have a high impact on the impact of student learning outcomes, all educators must be able to display good performance in conducting teaching and learning activities that are supported by high self-competence, quality curriculum, advanced academic atmosphere, adequate facilities and infrastructure, abundant learning resources.

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