The Role Of Vocational Education In The Era Of Industrial Automation

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Abstract. In Industry 4.0 there is a production process with a quick reaction to changes in market demand, inventory requirements, and excellent service with very small errors. This happened because of the implementation of Cyber-Physical Productions Systems (CPPS). CPPS works to integrate computers that work as devices for Artificial Intelligence (AI), Augmented Reality (AR), Virtual Reality (VR), Internet of Thinks (IoT), Internet of Service (IoS), intelligent robots, 3D printers in production systems. In order for the role of vocational education to be more effective in supporting the development needs of industrial automation 4.0, it requires a frog leap in curriculum development, learning, program management through a multi and transdisciplinary approach across study programs. Vocational education is truly link and match with super large changes in industry 4.0.

1. Introduction

Initiating the role of Vocational Education (VE) in the industrial revolution 4.0 can be reviewed from six main questions: (1) How does the world of work change in the next five to twenty years, and what is the meaning of vocational education in Indonesia ?; (2) What needs to be learned by the Indonesian people to be able to compete in the world of work and develop their work careers brilliantly in the digital era, the knowledge-based industry, and industrial revolution 4.0?; (3) What competencies and skills are needed by Indonesian children to be able to maintain a career for the next 35 years ?; (4) How should they learn everything effectively ?; (5) What is the setting of learning environment conditions to realize a meaningful and beneficial learning experience?; (6) What is an effective vocational learning design in XXI century? The main role of VE is to prepare high skill workforce according to the era.

Industrial Revolution 4.0 still remains the trending topic of international seminars and conferences around the world. The Industrial Revolution 4.0 was made the central theme of international seminars and conferences, the reference to the development of secondary and higher education policies, academic studies at universities, and the development of labor quality standards. The Industrial Revolution 4.0 is important to study and discuss because it has a gray space that needs to be answered properly. Regarding

the discussion of the role of vocational education in the industrial revolution era 4.0, this gray space is a problem, a challenge and an opportunity for the development of the role of VE.

In Industry 4.0 there is a production process with a quick reaction to changes in market demand, inventory requirements, and excellent service with very small errors. This happened because of the implementation of Cyber-Physical Productions Systems (CPPS). CPPS works to integrate computers that work as devices for Artificial Intelligence (AI), Augmented Reality (AR), Virtual Reality (VR), Internet of Thinks (IoT), Internet of Service (IoS), intelligent robots, 3D printers in production systems. Production and service issues with new values and production and service errors are responded quickly and transparently with real time through the global value chain network. The entire value chain of product development and production systems is engineered in an integrated and coordinated manner according to the life cycle of a product. Industrial automation uses AI cognition, robotics, sensor technology, transducers, and actuators so that they can accelerate production speed exponentially. This kind of revolution can certainly change work requirements, job competency demands, work methods, and work values.

Logically, industrial automation in the industry 4.0 increases labor market competition and increases demands for labor competency qualifications including threats to incompetent workers. Industrial automation in industry 4.0 then changes the pattern of work towards creative work and routine work, based on machines and intelligent robots. While the routine work done by humans is narrowing. This new pattern gives a signal, the need for a change in the education curriculum and training in vocational education. Changes in the vocational education and training curriculum are urgent as a proactive response from vocational education in order to provide a real role in the development of human resources.

2. Automation in Industries

Automation in industry 4.0 applies three key technologies namely; (1) AI as a logical layer; (2) Internet of Thinks (IoT) as a Connectivity Layer; and (3) Virtual Reality (VR), Augmented Reality (AR), Wearable Devices (WD), Smart Robots (SR), 3D printers as Physical Layer. The intelligence of machines in the industry supported by AI causes the machine to be able to learn and solve problems like the human mind. IoT provides an extension of the benefits of internet connectivity that is connected continuously. IoT provides object identification, sensors, and connection capabilities as a basis for service development.

Integrating the computer as an AI, AR, VR device with an internet network in a CPPS can oversee the physical processes of the extraction, manufacturing, assembly, marketing and distribution of products or services. Extraction, manufacturing and assembly machines can communicate with each other, exchange information in various applications and respond to environmental changes like humans in working to solve problems. This kind of work system is realized because of IoT and IoS technology support. IoS works to connect one device with other devices, machines with machines, machines with customers through the internet network.

Industrial automation 4.0 provides a smart factory system that is a factory system with CPPS where the extraction, manufacturing and assembly processes are carried out where machines work autonomously and communicate with each other with IoT through IoS networks. Industrial automation 4.0 produces smart products, smart services, works with big data, and cloud computing. Industrial automation 4.0 works with the principle of interconnecting machines, sensors, intelligent robots, actuators, and few people connected, connected, communicating through IoT-based IoS media. Intelligent machines and robots work collaboratively, communicate with each other, and creativity solve problems with high and safe work standards. Intelligent information systems that have the ability to create a variety of virtual copies of the

physical world (virtual reality) facilitate the creation of models of digital processing, analysis, decision making, and data provision.

The application of sensors in the AI system through IoS and IoT makes the system work with real time capabilities. The system becomes smart and becomes a fast, accurate, real time servant. Data is collected, stored, analyzed in real time making production customer-oriented. Customers can interact directly in real time on the system through the network from anywhere and anytime. Industrial automation 4.0 makes the work service system efficient, effective, cheaper, safer, convenient, fun, and flawless.

Industrial automation 4.0 makes the process of extraction, manufacturing, assembly, marketing, distribution become more flexible, smart, and efficient as an advantage. This advantage occurs because there are: (1) collaboration between humans and robots, between robots in working in an environmentally friendly way; (2) Human-Machine-Interface (HMI) which connects the convenience of humans interacting with machines or vice versa; (3) Intelligent, ergonomic, reliable machines and robots that are connected in a network and have the intelligence to practice theories, principles, laws, methods in processing and analyzing data to make decisions in lieu of humans; (4) Robots and automated equipment that is capable of learning and increasing intelligence in thinking and making decisions; (5) The management and storage of large, safe, easily accessible data with a data security system that is sufficiently maintained.

Industrial automation 4.0 is applied, among others for: (1) additive manufacturing in 3D molds; (2) product and process customization; (3) monitoring and control of energy systems; (4) generation, recovery and conversion of energy; (5) chemical images for quality control and food safety; (6) Bacteriophage, a biological method of food security; (7) active packaging; (8) precision agriculture; (9) high density power storage battery; (10) smart building; (11) smart lighting; (12) bioenergy; (13) Intelligent Transportation System (ITS); (14) Advanced Travelers Information System (ATIS); (15) Advanced Transfortaion Management System (ATMS); (16) Advanced Public Transfortaion System (APTS); (17) big data based Traffic Management and Control (TMC); (18) Smart Zebra Crossing (SZC); (19) built-in sensor car; (20) Visual Passenger Information System (VPIS); (21) Taxi and Ojek on-line; (22) Logistics and supply chain management systems, etc.

3. Role of Vocational Education in Industries 4.0

The Industrial Revolution 4.0 has given a new context and a leap of super-big changes in the ways of working and working systems in extraction, manufacturing, assembly, marketing, distribution and service industries. Industrial automation that recognizes artificial intelligence (AI) supported by VR, AR, IoT on IoS, makes production systems and services more intelligent and humanistic. Through VR and AR integrated with AI, a system that can detect anyone in a location and give greetings, directions, and various machine-based needs services automatically through various media such as screens, loudspeakers, mobile phones.

The revolutionary changes of the 4.0 industrial system and work processes certainly change drastically the need for competency and work skills. Looking at the 4.0 industrial revolution, it began to be identified that a frog jump was needed in preparing the workforce skills to follow the revolutionary changes in industry 4.0. The vocational education curriculum can no longer be linear monodisciplinary. An open, multidisciplinary, transdisciplinary curriculum of various skills is needed. It is estimated that the vocational education approach based on the study program is no longer relevant to the need to fulfill the development of disrupted era work skills. Study program boundaries increasingly need to be eliminated.

The application of CPPS to the industry 4.0 totally changes the system and the way our industry works towards smart industries in producing smart, fast, careful and satisfying products and services. This change has a direct impact on our vocational education system. The role of vocational education in the 4.0 industrial era can be seen from the basic functions of Vocational Education itself. In the Technical and Vocational Education and Training (TVET) literature, we find that traditionally the main goal of Vocational Education is to prepare graduates to work. Work preparation is the main goal of Vocational Education. In order for graduates of Vocational Education to be ready to work, the Vocational Education Curriculum must contain special training that tends to be creative-reproductive according to the needs of the industry. Vocational Education Learning includes providing learning experiences and training in designing something, producing something or doing services that give added value. The motivation for organizing vocational education is economic benefit in the future. Competency based. The training process takes place under the supervision and instruction of the teacher or instructor focusing on the development of industry needs and the needs of the workforce.

Changes in the production system in industry 4.0 that apply CPPS are an important point on how the content of vocational education curriculum is adjusted again. Industrial automation uses machines and intelligent robots and 3D printers that are able to learn to solve production and service problems changing the demands of workers' competency needs. Workers in the Industrial 4.0 era are required to have reliable competence in AI, IoT, IoS, VR, AR, sensor applications, transducers, 3D printers, and intelligent control systems. The training provided for vocational education contains special skills in terms of the application of CPPS. The hope after undergoing training related to the application of CPPS Vocational Education graduates can work productively and provide economic benefits. The main motivation of vocational education lies in economic benefits for the future in a sustainable manner.

The main role of VE in industrial automation 4.0 is as a provider of skills workers in the implementation of CPPS in accordance with the concept of matching men and jobs as the basis for developing vocational education programs. The role of VE in industrial automation 4.0 includes:

- As a provider of competency education and training programs in the field of AI, intelligent control, VR, AR, IoT, IoS, Robotic for young children.
- As a provider of skill training programs the use of 3D printers, sensors and transducers.
- As a provider of retraining programs for workers requires increased competence in the areas of AI, VR, AR, IoT, IoS, and Robotic
- As the executor of the competency certification program in the fields of AI, VR, AR, IoT, IoS, Robotic.
- As the center of design and engineering for the application of AI, VR, AR, IoT, IoS, Robotic.

4. Conclusion

The role of vocational education as a provider of skilled labor and training centers and retraining skills in the fields of AI, VR, AR, IoT, IoS, and Robotic greatly supports the need for industrial automation 4.0. In order for the role of vocational education to be more effective in supporting the development needs of industrial automation 4.0, it requires a frog leap in curriculum development, learning, program management through a multi and transdisciplinary approach across study programs. Vocational education is truly link and match with super large changes in industry 4.0.

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