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Examining Career Development of Informatics Engineering Vocational Education Students in the Industrial Revolution 4.0

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This article aims to examine the career development of informatics engineering vocational education students in industrial revolution 4.0. The graduates are demanded to possess the necessary qualification and competence to compete and survive in this tumultuous era. Adjustment is definitely needed between vocational curriculum, industrial revolution 4.0 development and career opportunity. In addition, educational institutions can provide career counselling and service for students to plan and decide desired careers. Development opportunity of student careers must be tailored to their competence. The graduates of vocational education are at level, while bachelor graduates are at level 6 and the curriculum structure is tailored to learning outcome in each subject. The career opportunity of informatics engineering vocational education is oriented to the occupational guideline in National Qualification Framework in the field of Informatics and Communication Technology.

Key words: *Vocational career development, Informatics engineering, employment opportunity.*

Introduction

Vocational education in tertiary education fundamentally prioritize the nurture of work-ready graduates. In turn, this requires to adapt swiftly to changes. Joblessness of vocational

graduates is something to be anticipated by every educational institution. One way to overcome it is to establish relevance between education and ever-changing working world condition. The demand for relevance between education world and the working world implies the need for mastery of several applicable competencies in the workplace. However, this relevance issue is far from being solved (Daniel and Kathleen, 2005). Studies found that people choose their careers based on competences. According to Bhattacharyya (2018), to be ready to work, various attributes and skills considered essential for the industrial revolution 4.0 are needed. Some of the skills are adaptability, critical and innovative entrepreneurial mindset, accountability, motivation and passion (Osman & Kamis, 2019).

According to Ngakan Timur Antara, the Head of Industry Research and Development Agency (2019), to improve human resource quality to realise Making Indonesia 4.0, one of the necessary steps is to redesign the education curriculum, conforming to industry 4.0. As most students have their dream career, that is careful and well-thought-out it makes career plans needed. Career planning should be viewed as a structured process where one makes decisions and plans for a future career (Li et al., 2011; Belser et al., 2018). Building a career in a profession is necessary since it is associated with the position during their working cycle. Critical in career building is a career path and it differs greatly between companies and fields. In order to be the desired individual, one may need to make a career plan, explore job options, follow study path, and solve problems in working life (Hao &Yen, 2015).

When a career is established, it should be improved following career development indicators, which include, according to Handoko (2010), work achievement, exposure, organisational equality, mentor and sponsor, opportunity to grow and management support. Proactive personally and career management behaviours are all positively correlated with career satisfaction and career management behaviours that mediate the relationship between proactive personality and career satisfaction (Belinda Renee Barnett, Lisa Bradley, 2007). In addition, the relationship between expectations and career development and showered is an important thing to note because people experience differently at different career stages, resulting in different approaches (Hirsch, 2014). According to Mondy (1993), career development principals include activities that set someone off on a path of planned career improvement.

The world is currently undergoing significant changes with equally big impacts, which are the results of the industrial revolution 4.0 (Verawardina and Jama, 2018; Rukun et al., 2015; Huda, 2017). Industry 4.0 is a term used to refer to the era where technology coalesces in an extensive way, blurring the barriers between physical, biological, and digital dimensions (Scawab, 2016). Innovation leap and industry 4.0 advancement are stimulated by various fields such as artificial intelligence, robotics, internet of things, autonomous vehicles,

biotechnology, nanotechnology, 3D printing, material science, quantum computing, and energy storage (Ratna Wardani, 2018).

It's undeniable that in this industrial revolution 4.0, the education sphere in Indonesia needs digital transformation on a massive scale (Hendriyani & Amrizal, 2019). Technological advancement has sure opened the access to career services and information for the wider public, however, much workshop work is still needed to assess the development of the changes (Chope, 2008). Industrial revolution 4.0 also affects labour needs, particularly concerning vocational education as a producer of work-ready graduates. Due to industry 4.0, vocational education is required to revise its curriculum, learning media, facilities and infrastructures, learning system and teacher roles. The biggest challenge in industry 4.0 is how to bring vocational education close to current and future employment condition. Labour needs in the industrial setting is influenced by demographic challenges and technological advancement (Wolf et al., 2018). According to Chope (2008), in career development, creativity and innovation are needed to ensure that the career and counselling discipline continues to grow and to prepare individuals to face ever-changing career paradigm and the working world. Therefore, the education system and curriculum need to evolve in line with the needs of the business and the industrial world in the era of the industrial revolution 4.0.

Discussion

Curriculum in Vocational Study

The curriculum conceived in connection with the results of competence achievement of a graduate is also related to the learning outcome produced by vocational education, so it is necessary to study the appropriate curriculum in vocational education so that the graduates produced will be able to compete and be absorbed in the workforce as needed. The current curriculum development process has been in line National Competency Standard (SKKNI). National competency maps out work qualifications that pair, equalise, integrate education and training sector and work experience.

The curriculum must have: 1) conformity with the demands, needs, conditions, and development of the community, 2) compatibility between curriculum components, such as contents with goals, processes with contents and objectives, evaluation with process, contents and objectives (Sukmadinata, 2008:2012). The vocational education curriculum contains program guidelines for the development of graduate work competencies that are in line with global work standards (Sudira, 2018; Wardina, Jalinus and Asnur, 2018). The Technical and Vocational Education and Training (TVET) curriculum as a whole and complete learning program contains the program's philosophical foundation, graduate competency profile, graduate competency standards, learning outcomes, subject structure, syllabus description,

learning implementation plan, learning modules, lab sheets, worksheets, assessment tools, competency tests and competency certification.

In vocational training, the development and implementation of education integrate curricula from elementary, middle and high levels to prepare competitive specialists in professional activities. Implementation of a skilled workforce uses modern equipment for technological processes that are being developed (Akhmetov et al., 2016). According to Adebayo (2018), curriculum development also requires the provision of textbooks, workforce development and so on. The central role of the teacher is to collaborate with companies and other institutions, building training plans that are compatible with the school curriculum (Gentili, 2017). In this regard, stakeholders involved in education must also take strategic steps to face the challenges of industrial revolution 4.0.

The curriculum clearly cannot stand on its own because curriculum development and planning is closely related to learning. According to Cheng (2005), the curriculum aims to nurture students in accordance with technological developments, economic, social, political, cultural, and learning aspects. The aim of the vocational education curriculum is to create an authentic learning environment through the systematic social implementation and cultural development projects, and utilising schools as the dominant cultural institution (Tyson, 2016).

Demanding the curriculum to evolve to keep up with the industrial revolution 4.0 in order to stay relevant can be met, among others, by doing curriculum reconstruction that provides: 1) new broader skills such as coding, big data, artificial intelligence, 2) introduction of new learning formats such as the combination of face-to-face and online learning (blended learning), offline face-to-face or online with full online learning (Nasir, 2018). Meanwhile, according to the Director-General of Belmawa Kemenristekdikti (2018), mastery of competence 4.0 requires literacy movements such as data literacy, technological literacy and human literacy.

Vocational Career Development

In the era of the industrial revolution 4.0, higher education is demanded to be able to overcome the turmoil of changes that occur due to digital transformation. One component that can overcome the turmoil is human resources available in tertiary institutions, in this case, lecturers (teaching staff). Graduates in the industrial era are required to have competitive qualifications and competencies to survive the industrial 4.0 (Wardina, Jalinus and Asnur, 2018). Likewise, in career development, students of vocational education in informatics must be able to deal with developments in industrial revolution 4.0 which contains technology-based learning (Dony Novaliendry et al., 2015).

In anticipation of the industrial revolution 4.0, the Indonesian government is increasingly promoting vocational education improvement. One of the improvements in vocational quality in the face of the industrial revolution 4.0 is the certificate of graduates of PT Vokasi (Muhamad Nasir). According to Rivai and Sagala (2009: 274), career development is the process of improving individual work skills achieved in order to achieve the desired career. Therefore, there needs to be a planning step in career development that pays attention to the indicators of career development undertaken such as self-assessment, setting career goals, planning, and plan execution (Rivai and Sagala, 2009:274).

Career management is needed (Tanuja Agarwala, 2008), specifically, career management among information technology (IT) professionals (Patrick, 2002), as well as career control (Monique, Judith, Tinka van Vuuren, 2016). Provision of career facilities helps students in planning and determining his career; therefore, institutions, as providers of education, should provide career services and career guidance. Career consultation can create different career transition strategies (Emilie, Bérangère, and Nouchka, 2017) and develop careers for students (Yehuda Baruch, Nóra Szűcs, Hugh Gunz, 2015).

The types of services that can be used in career counselling/guidance in vocational are: (1) orientation services in which students can be introduced to the work environment by making visits to the business and industrial world, (2) employment-related information services in accordance with the department students major in, (3) places and personnel who can help career planning, (4) hands-on experience and work visits, (5) self-understanding to establish job choices in accordance with students' nature, (6) knowledge and skills about the labour market, and (7) flexible college planning assistance in choosing several different jobs (Yusuf, 2006).

Student Career Development in the Curriculum of Vocational Education of Informatics Engineering in Industrial Revolution 4.0

The curriculum in higher education refers to KKNI which is a framework for the qualification of work that pairs, equalises, integrates, the education and training sector as well as work experience in the context of providing work competency recognition in accordance with work positions in various sectors. The embodiment of the quality and identity of the Indonesian people is related to the education and training system and the national human resource development program. Universities must also have a quality assurance system based on the IQF. BSNP prepares National Education Standards for achieving qualifications in KKNI.

Vocational education students of informatics engineering have a graduate-level of higher education which is level 6 (source: KKNI). They have:

a. Ability in the field of work: able to apply their expertise and utilise science and technology in their fields in solving problems and able to adapt to the situation at hand.
b. Knowledge mastery: mastering the theoretical concepts of a particular field of knowledge in general and the theoretical concepts of particular area in that field of knowledge in-depth, as well as being able to formulate procedural problem-solving.
c. Managerial abilities: able to take appropriate decisions based on analysis of information and data and able to provide guidance in choosing various alternative solutions independently and in groups. Responsible for one's work and can be given responsibility for the achievement of the work of the organisation.

a. The Competency of Vocational Education Graduates of Informatics Engineering in Achieving Career As:

1) Teachers in the field of Software Engineering, Computer Engineering and Network, Multimedia.
2) Teachers (Instructors/Civil Workers/Trainers) in industrial seminar and education institution in the field of Computer and Informatics Engineering.
3) Professional Staff in the field of Information Technology as a Programmer, System Analyst, Network Administrator or Multimedia/Visual Designer in the Information Technology companies (software house) or Production House with entrepreneurship soul and IT counsellor.
4) Teachers (Head of the computer laboratory/Lab Manager).

b. Learning Outcome

In the explanation of KKNI, learning outcomes of the study program curriculum and learning outcomes of in course learning are contained.

Knowledge Mastery
a. Mastering concepts of pedagogy and didactic in planning learning media to carry out education in vocational education. b. Mastering concepts, theories and application in the field of computer and informatics engineering taught in vocational education. c. Mastering assessment method and learning evaluation and learning outcome as well as using evaluation results for the improvement of learning quality. d. Mastering the principals and innovative learning model issue.
Special Skills
a. Possessing the ability to plan, implement and evaluate learning. b. Able to establish a conducive learning environment by utilising the latest information technology. c. Able to prepare learning media in accordance with curriculum needs in schools and educational institutions in the fields of informatics and computer engineering. d. Possessing the ability to implement creative and innovative learning models in learning management in the classroom. e. Able to carry out assessment and evaluation of processes and learning outcomes and using evaluation results to improve the quality of learning. f. Able to apply mathematics, science, and engineering principles to solve complex engineering problems in informatics and computer engineering. g. Able to find sources of engineering problems in software systems, computer networks and multimedia. h. Able to conduct research that includes identification, formulation and analysis of engineering problems in informatics and computer engineering. i. Able to design programs according to customer requests with appropriate algorithms and program development opportunities. j. Able to make multimedia and graphic products. k. Able to design computer networks of small and wide scale along with all network security needs in accordance with various developing network technology models and network development opportunities.
General Skills
a. Applying logical, critical, systematic, and innovative thinking in the context of developing or implementing science and/or technology in accordance with the ICT field. b. Assessing the implications of developing or implementing science, technology or art in accordance with the fields of information and computer engineering expertise based on rules, procedures and scientific ethics to produce solutions, ideas, designs, or art criticisms and compiling scientific descriptions of the results of their studies in the form of thesis or final project report. c. Making appropriate decisions in the context of problem-solving in the field of computer and informatics engineering based on the results of the analysis of information and data.

The qualification level, which consists of 9 (nine) levels, is following KKNI, as seen on the left side of the vertical on the map - which is divided into three groups, namely Experts, Technicians/Analysts, and Operators. In addition, terminology for strata of position often used in industry and government circles was also added. For level 6, graduates are grouped into technical or analyst positions according to occupation within the Indonesian National Qualification Framework in Information and Communication Technology.

Curriculum structures with learning outcome of career opportunity of vocational students of informatics engineering according to occupations in National Qualification Framework in Information and Communication Technology are as follows:

Course	**Learning outcome 1**	**Learning outcome 2**	**Learning outcome 3**	**Career Opportunity**
Introduction to Information Technology	Able to establish a conducive learning environment by utilizing the latest information technology.	Applying logical, critical, systematic, and innovative thinking in the context of developing or implementing science and/or technology in accordance with the ICT field.		• Career opportunity as teachers in the fields of Software Engineering, Computer and Network Engineering and Multimedia. Career path as a SMK teacher and career path as PNS (SMK teachers) class IIIA-IVD.
Programming	Able to design programs according to customer requests with appropriate algorithms and program development opportunities.	Applying logical, critical, systematic, and innovative thinking in the context of developing or implementing science and/or technology in accordance with the ICT field.		• Programmer as database programmer supervisor (database programmer supervisor), junior programmer, object programmer, Junior web programmer.

Digital Engineering	Able to establish a conducive learning environment by utilizing the latest information technology.	Able to make multimedia and graphic products.		• Visual/multimedia designer as intermediate multimedia designer, intermediate animator, techniciaforms and graphics designer, audio visual technicianforms.
Computer Assembly and Installation	Applying logical, critical, systematic, and innovative thinking in the context of developing or implementing science and/or technology in accordance with the ICT field.	Able to conduct research that includes identification, formulation and analysis of engineering problems in informatics and computer engineering.		• IT jobs in structured industry organization bachelor graduates as a Supervisor and manager up to top career as GM/plan manajer.
Computer Network	Able to find sources of engineering problems in software systems, computer networks and multimedia.	Able to design computer networks of small and wide scale along with all network security needs in accordance with various developing network technology models and network development opportunities.		• Career opportunity as teachers in the fields of Software Engineering, Computer and Network Engineering and Multimedia. Career path as a SMK teacher and career path as PNS (SMK teachers) class IIIA-IVD. • Network Administrator as junior network administrator, wireless coordinator, voice communications coordinator, voice wireless communications coordinator.

Web Programming	Able to apply mathematics, science, and engineering principles to solve complex engineering problems in informatics and computer engineering.			• Programmers as database programmer supervisor (database programmer supervisor), junior programmer, object programmer, Junior web programmer.
Pedagogy	Mastering assessment method and learning evaluation and learning outcome as well as using evaluation results for the improvement of learning quality.	Mastering the principals and innovative learning model issue.	Possessing the ability to implement creative and innovative learning models in the learning management in the classroom.	• Career opportunity as teachers in the fields of Software Engineering, Computer and Network Engineering and Multimedia. Career path as a SMK teacher and career path as PNS (SMK teachers) class IIIA-IVD. • Career opportunity as Teachers (Instructor/Civil Worker/Trainer) in industrial seminar and education institution in the field of Computer and Informatics Engineering. Career path as Widyaiswara Pertama-III/a. Up to Junior Level and Intermediate Level.

Digital Media	Able to make multimedia and graphic products.	Able to establish a conducive learning environment by utilising the latest information technology.		• IT Consultant/Vocational Counselor. As digital enterpreneur supervisor and as consultancy supervisor technology.
Software Engineering	Able to conduct research that includes identification, formulation and analysis of engineering problems in informatics and computer engineering.	Able to apply mathematics, science, and engineering principles to solve complex engineering problems in informatics and computer engineering.	Able to find sources of engineering problems in software systems, computer networks and multimedia.	• Career opportunity as teachers in the fields of Software Engineering, Computer and Network Engineering and Multimedia. Career path as a SMK teacher and career path as PNS (SMK teachers) class IIIA-IV. • Career opportunity as a Teacher (Head of Computer Laboratory/Laboratory Manager). PLP requirement for S1 path: Tingkat Ahli Pertama IIIa - IIIb. Muda IIIc - IIId . Madya IVa – Ivc.

Decision Support System	Making appropriate decisions in the context of problem solving in the field of computer and informatics engineering based on the results of analysis of information and data.			• System analysis as data entry coordinator business
Educational Games Visual Communication Design	Able to make multimedia and graphic products.	Applying logical, critical, systematic, and innovative thinking in the context of developing or implementing science and/or technology in accordance with the ICT field.	Possessing the ability to implement creative and innovative learning models in the learning management in the classroom.	• Career opportunity as teachers in the fields of Software Engineering, Computer and Network Engineering and Multimedia. Career path as a SMK teacher and career path as PNS (SMK teachers) class IIIA-IVD. • Visual/Multimedia Designer as intermediate multimedia designer, intermediate animator, technicianforms and graphics designer, audio visual technicianforms .

Multimedia-Based Learning	Mastering the principals and innovative learning model issue.	Possessing the ability to implement creative and innovative learning models in the learning management in the classroom.		• Career opportunity as teachers in the fields of Software Engineering, Computer and Network Engineering and Multimedia. Career path as a SMK teacher and career path as PNS (SMK teachers) class IIIA-IVD. • Career opportunity as Teachers (Instructor/Civil Worker/Trainer) pada in industrial seminar and education institution in the field of Computer and Informatics Engineering. Career path as Widyaiswara Pertama-III/a. Up to Junior Level and Intermediate Level.
Vocational Curriculum and Learning	Mastering concepts of pedagogy and didactic in planning learning media to carry out education in vocational education.	Able to prepare learning media in accordance with curriculum needs in schools and educational institutions in the fields of informatics and computer engineering.		• Career opportunity as teachers in the fields of Software Engineering, Computer and Network Engineering and Multimedia. Career path as a SMK teacher and career path as PNS (SMK teachers) class IIIA-IVD.

Mobile Application Development	Able to apply mathematics, science, and engineering principles to solve complex engineering problems in informatics and computer engineering.	Program developer		• Career opportunity as teachers in the fields of Software Engineering, Computer and Network Engineering and Multimedia. Career path as a SMK teacher and career path as PNS (SMK teachers) class IIIA-IVD. • Programmers as database programmer supervisor (database programmer supervisor), junior programmer, object programmer, Junior web programmer.

Wireless Communication	Able to find sources of engineering problems in software systems, computer networks and multimedia.	Able to design computer networks of small and wide scale along with all network security needs in accordance with various developing network technology models and network development opportunities.		• Career opportunity as teachers in the fields of Software Engineering, Computer and Network Engineering and Multimedia. Career path as a SMK teacher and career path as PNS (SMK teachers) class IIIA-IVD. • Career opportunity as Teachers (Instructor/Civil Worker/Trainer) in industrial seminar and education institution in the field of Computer and Informatics Engineering. Career path as Widyaiswara Pertama-III/a. Up to Junior Level and Intermediate Level. • Network Administrator as junior network administrator, wireless coordinator, voice communications coordinator, voice wireless communications coordinator.

Vocational Learning Strategy	Mastering concepts of pedagogy and didactic in planning learning media to carry out education in vocational education.	Mastering assessment method and learning evaluation and learning outcome as well as using evaluation results for the improvement of learning quality.	Possessing the ability to implement creative and innovative learning models in the learning management in the classroom.	• Career opportunity as teachers in the fields of Software Engineering, Computer and Network Engineering and Multimedia. Career path as a SMK teacher and career path as PNS (SMK teachers) class IIIA-IVD. • Career opportunity as Teachers (Instructor/Civil Worker/Trainer) in industrial seminar and education institution in the field of Computer and Informatics Engineering. Career path as Widyaiswara Pertama-III/a. Up to Junior Level and Intermediate Level.
Vocational Learning Assessment	Mastering assessment method and learning evaluation and learning outcome as well as using evaluation results for the improvement of learning quality.	Possessing the ability to plan, implement and evaluate learning.		• Career opportunity as teachers in the fields of Software Engineering, Computer and Network Engineering and Multimedia. Career path as a SMK teacher and career path as PNS (SMK teachers) class IIIA-IVD.

Educational Research Methodology	Mastering the principals and innovative learning model issue.	Assessing the implications of developing or implementing science, technology or art in accordance with the fields of information and computer engineering expertise based on rules, procedures and scientific ethics to produce solutions, ideas, designs, or art criticisms and compiling scientific descriptions of the results of their studies in the form of thesis or final project report.		• Career opportunity as teachers in the fields of Software Engineering, Computer and Network Engineering and Multimedia. Career path as a SMK teacher and career path as PNS (SMK teachers) class IIIA-IVD.
Vocational and Technological Education	Mastering concepts of pedagogy and didactic in planning learning media to carry out education in vocational education.	Mastering concepts, theories and application in the field of computer and informatics engineering taught in vocational education.		• Career opportunity as teachers in the fields of Software Engineering, Computer and Network Engineering and Multimedia. Career path as a SMK teacher and career path as PNS (SMK teachers) class IIIA-IVD.

Industrial Practice Educational Internship				• Career opportunity as teachers in the fields of Software Engineering, Computer and Network Engineering and Multimedia. Career path as a SMK teacher and career path as PNS (SMK teachers) class IIIA-IVD. • Career opportunity as Teachers (Instructor/Civil Worker/Trainer) in industrial seminar and education institution in the field of Computer and Informatics Engineering. Career path as Widyaiswara Pertama-III/a. Up to Junior Level and Intermediate Level. • Career opportunity as professional staff in the field of information technology. • Career opportunity as a Teacher (Head of Computer Laboratory/Laboratory Manager). PLP requirement for S1 path: Tingkat Ahli Pertama IIIa - IIIb. Muda IIIc - IIId . Madya IVa - IVc

(**Source:** KKNI Curriculum, Vocational Curriculum and Occupation, TIK KOMINFO)

Conclusions

It was concluded that educational institutions, in this case, is the career development of students in the field of vocational informatics education, must be able to deal with the marching of industrial revolution 4.0. Graduates are also required to have the qualifications and competencies to compete and survive in the turmoil of this era. In addition, educational institutions can provide career counselling and services for students to plan and determine their career to be achieved. Career development opportunities for students must be tailored to their competencies.

Students of vocational education of informatics engineering are at higher education graduate level, equal to bachelor, which is level 6. Vocational education graduates have competencies for 1) Teachers in software engineering, computer and network engineering, and multimedia, 2) Teachers (Instructor/Civil Worker/Trainer) at industrial seminars or educational institutions in ICT, 3) Professional staff in Information Technology as programmers, system analysts, network administrators or visual/multimedia designer in IT companies (software house) or production house with entrepreneurship soul, and IT counsellor, and 4) Teachers (head of computer laboratory/lab manager). Then, the curriculum structure was developed based on the learning outcome of career opportunities for vocational education students of Informatics Engineering according to occupation in the Indonesian National Qualification Framework in the field of information and communication technology.

Suggestions

A curriculum that has been included in courses can be integrated more specifically for the sake of relevancy with future careers. Students should also have started career guidance and career planning so that they are ready to build the career they want. In order to face the industrial revolution 4.0, students of Informatics Engineering Vocational Education must improve their skills in the field of technology, because future career opportunities will undoubtedly revolve around the field of technology.

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