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What Industry Needs of Vocational School Graduate Competence in the Era of Industrial Revolution 4.0

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Abstract

This study aims to formulate the competencies of vocational school (VS) graduates required by industries in the Industrial Revolution 4.0 (IR 4.0) era. This case study was conducted by involving business owners and industry practitioners with over 15-years of experience in managing human resources in the industry. Open-ended questionnaire and focus group discussion questions were two instruments validated by expert judgment, while the research data were analyzed by means of qualitative descriptive techniques. The results show that the main competencies of VS graduates expected by industries in the IR 4.0 era cover the aspects of hard skills including highly technical competencies, foreign languages skills, and information technology skills, as well as soft skill aspects especially honesty, discipline, responsibility, health, collaboration, communication, creativity and innovativeness, and problem-solving. The expected Vocational School learning processes are those that strengthen competency-certified technical skills integrated with soft skills according to industry needs supported by competent teachers and synergistic collaboration with the industrial world.

Keywords: Vocational school, competency, Industrial Revolution, 21st Century.

1. Introduction

The world has undeniably entered the 21st-century which accelerates disruptively with the presence of Industrial Revolution 4.0. (IR 4.0). "Developments in genetics, artificial intelligence, robotics, nanotechnology, 3D printing, and biotechnology, to name just a few, are all building on and amplifying one another [1]." In the context of human resource development, this era has an impact on the emergence of new employment maps as quoted by the World Economic Forum that "current trends could lead to a net employment impact of more than 5.1 million jobs lost to disruptive labor market changes over the period 2015–2020, with a total loss of 7.1 million jobs— two-thirds of which are concentrated in the Office and Administrative job family—and a total gain of 2 million jobs, in several smaller job families [2]." The impact of technological, demographic, and socioeconomic disruption on business models will be felt in transformations to the employment landscape and skills requirements, resulting in substantial challenges for recruiting, training and managing talent.

The new world of work requires new ways and conditions of work so as to bring about the consequences of the needs for new competencies that may be far different from the competencies predicted so far. Various studies were conducted to formulate new competencies in anticipation of the development of the situation [3][4][2][5][6][7].

Wagner [8] proposes the seven survival skills for careers, college, and citizenship including critical thinking and problem-solving; collaboration across networks and leading by influence; agility and adaptability; initiative and entrepreneurialism; effective oral and written communication; accessing and analyzing information; and curiosity and imagination. While Trilling and Fadel [9] suggest three categories of skills, namely learning and innovation skills (critical thinking and problem solving, communication and collaboration, creativity and innovation); digital literacy skills (information literacy, media literacy, information and communication technology literacy); and career and life skills (flexibility and adaptability, initiative and self-direction, social and cross-cultural interaction, productivity and accountability, leadership and responsibility). These various formulations agree that the future working world requires workforces who have both general and specific competencies inherent in their respective fields.

Accelerating changes at the global level consequently may require a change in approach to education in general and vocational education specifically. Research shows that countries with a stable vocational system have proven capable of overcoming various employment challenges, especially in overcoming youth unemployment even in crisis conditions [4]. This is in line with Thompson's opinion [10] stating that "vocational education is any education that provides experiences, visual stimuli, affective awareness, cognitive information, or psychomotor skills and that enhances the vocational development process of exploring, establishing, and maintaining one self in the world of work." Vocational education can also be interpreted as education for occupations [11][12], education for direct preparation for work [13], education to provide careers [14] or concerned with the acquisition of knowledge and skills for the world of work [15]. The success of vocational education, in short, maybe judged by how many graduates can play their roles consistent with the needs of employment or industry.

In this 21st century and IR 4.0 era where technology is fast changing and expectation from industry is high, Technical Vocational Education and Training (TVET) graduates must be prepared with the appropriate knowledge, skills, and attitude to enter the labor market [5]. This is in line with Rojewsky's enlightenment [16] arguing that vocational education is particularly challenged to develop, adapt, or redesign strategies to address the needs of workers and society. Thus, vocational education should formulate and re-evaluate learning models and approaches currently being applied in a time of increasing complexity, interdependence, and unpredictable world.

Concerning this, Indonesia has a strong commitment to advancing vocational education especially through Vocational High Schools (VHSs) or Vocational Schools (VSs). Presidential Instruction No. 9 of 2016 on The Revitalization of Vocational High School to improve the quality and competitiveness of Indonesia's human resources strongly instructs 12 Ministries, the Head of the National Professional Certification Agency and 34 governors throughout Indonesia to (1) take steps needed to revitalize VSs to improve the quality and competitiveness of Indonesian human resources and (2) compile a map of labor needs by referring to the road map to developing VSs [17]. Various policies contained in the Vocational Education Revitalization framework are explicitly outlined in the 2020-2024 National Medium-Term Development Plan [18] as one of the main directions of human resource development.

It is realized that Indonesia's progress will possibly be largely determined by its success in preparing vocational education through VSs. However, the mismatch has been a major problem faced by VSs. The high open unemployment rate of VS graduates [19] and the lack of their optimal management [20] [21] are some evidence of the mismatches in organizing education in VSs. The main source of mismatch can be the incompatibility of competencies produced with the needs of the workforce or industry. Wagner [8] mentions this as the global achievement gap, which is the gap between what is taught and tested in schools with the skills needed by careers, college, and citizenship in the 21st century. Symptoms of economics irrelevance of training include the mismatch between

supply and demand, employers' complaints, and low employment rates for graduates. The causes include lack of information about demand, lack of employer involvement in the various phases of training from policy development to delivery, and rigid supply responses by public training providers [6].

There are still too few practitioners and managers of vocational learning today who understand well the development of 21st-century jobs and IR 4.0 and know what jobs are becoming less required, what new jobs will develop, how innovations of working grow and develop in society, what changes happen in the manufacturing sector, and what changes occur in the information industry sector [22]. These altogether add to the severity of the mismatch that occurs in the world of vocational education. Therefore, fundamental efforts to formulate the competencies of Vocational School graduates looked-for by the industrial world are urgent to do.

Concerning this, there seem to be two big challenges for VSs, namely (1) how to formulate the competencies of VS graduates in accordance with the real needs in the world of work or industry, and (2) how to prepare educational programs in VSs that are in line with the demands of the world of work or industry. The program in question means that VSs not only prepare graduates who possess the quality to enter the work market but also equip themselves with the capacity to learn and mature themselves at work. This study aims to formulate the competencies of VS graduates required by industry based on real conditions in the field. By obtaining the competency formulation, curriculum, plans, and learning strategies, learning management and assessment that can be developed following the needs of the industrial world are in line with the demands of the 21st century and IR 4.0.

Competency is a keyword in today's world of education [23]. Competence is a characteristic of individual potential related to work performing, including but not limited to knowledge, skills, and character. In a high dependency situation, competence also relates to the difference between good performance and general performance [24]. Competency is the profound and lasting personal characteristic that stimulates individuals toward actively performing well at work, including, but not limited to, professional knowledge, professional spirit, abilities, analytical thinking, values, and so on. These qualities act on and affect one another. [25]. Various studies [26][27][28][29][30][31][32] reach the agreement that competence is related to aspects of knowledge, skills, and attitude needed to do a particular job. These three aspects can be categorized as hard skills closely related to technical skills or field-specific competencies [33][34][35] and soft skills or employability skills associated with behaviors, personalities, and self-development abilities in the workplace [36][37][38][39][40][57]. Thus, competence in this study can be interpreted as knowledge, skills, and attitudes that must be possessed by someone to enter the workforce, maintain work, and develop in the workplace.

2. Methodology

This is a case study research with a qualitative approach that aims to formulate the competencies of VS graduates required by the industrial world. Case studies are used to find out more information about subjects through research [41]. According to Isaac and Michael [42], it aims to study intensively the background, current status, and environmental interaction of a given social unit: an individual, institutional, or community. Respondents in this study were owners and practitioners of VS graduates from various fields of businesses, including manufacturing, fabrication, automotive, design, aviation, maintenance services, hospitality, fashion, services, and agro-industry. The number of respondents, 15 people, was determined purposively provided that they were owners or practitioners of the industry with more than 15 years of experience in human resources development. Data in this study, as proposed by Cresswell [43], were collected by using open entries and in-depth discussions through focus group discussions

(FGD). The instrument was in the form of an open-ended questionnaire containing 3 questions as follows.

2.1. What are the main competencies of Vocational School graduates required by industry?

2.2. What are the weaknesses of the current Vocational School graduates to enter the industry?

2.3. How is learning in Vocational School to be able to equip graduates with the skills needed by industry?

FDG questions were organized according to the research objectives and were used to strengthen and deepen the findings of the research results. The instrument was validated by rational judgment, while data were analyzed by qualitative descriptive. Besides, all collected data were validated with a triangulation technique.

3. Results and Discussion

3.1. Results

3.1.1. Main Competencies of Vocational School Graduates Required by Industry

Based on an open questionnaire given to 15 practitioners from the industry about the main competencies that should be possessed by Vocational School graduates, a variation of thirty main competencies should be possessed by Vocational School graduates. An overview of the main competencies that Vocational School graduates should have based on their importance is presented in Table 1.

Table 1. Main Competencies of Vocational Graduates Required by Industries

No	Competency	Aspect	No	Competency	Aspect
1	Mastering the field of expertise/technical skills	Hard Skills	16	Adaptability	Soft Skills
2	Honesty	Soft Skills	17	Willingness to learn	Soft Skills
3	Discipline	Soft Skills	18	Flexibility	Soft Skills
4	Work ethic	Soft Skills	19	Productiveness	Soft Skills
5	Responsibility	Soft Skills	20	Politeness	Soft Skills
6	Health	Soft Skills	21	Appearance	Soft Skills
7	Collaboration	Soft Skills	22	Self-confidence	Soft Skills
8	Creativity	Soft Skills	23	Work Spirit	Soft Skills
9	Communication	Soft Skills	24	Innovativeness	Soft Skills
10	Information Technology Skills	Hard Skills	25	Loyalty	Soft Skills
11	Experience	Soft Skills	26	Daringness	Soft Skills
12	Foreign Language Skills	Hard Skills	27	Working fast	Soft Skills
13	Smartness	Soft Skills	28	Initiative	Soft Skills
14	Problem Solving	Soft Skills	29	Self-development	Soft Skills
15	Working Under	Soft Skills	30	Perseverance	Soft Skills

	Pressure				

Based on the data in Table 1, it can be clearly seen that mastery of the field of expertise ranks first in the competencies required by the industrial world. It includes in the category of hard skills along with information technology skills in the 10th place and foreign language skills in the 12th place. It can also be observed that soft skills are the dominant competencies required by industries. Of the thirty competency items, there are twenty-seven competency items in the soft skills category (90%) and three competency items (10%) in the hard skills. Competencies in the soft skills category are mainly related to honesty, discipline, work ethic, responsibility, health, collaboration, creativeness, and communication.

The results of the FGD with the industry strengthen the main competencies of VS graduates needed by the industry as found in the open-ended questionnaire. All respondents agree that VS graduate competencies required by industrial sectors in the 21st century and IR 4.0 concern with both hard and soft skills. There seems to be an interesting discussion regarding the relationship between both types of skills. Some respondents argue that soft skills are the main and most important aspects that must be mastered by VS graduates.

Attitude or soft skills must be possessed (by workers), especially discipline and safety in working, whilst the mastery of the field of expertise, of course, can be improved as long as the person concerned dares work and wants to learn (Res_IND-05).

Attitude or skills for self-development are mandatory. While abilities can be assessed from the initial portfolio ... (Resp_IND-07).

In the field of services, the main competency that is central is the ability to provide excellent services, empathy, punctuality, friendliness to customers (Resp_IND-04).

However, some respondents stated the opposite, that hard skills are basic prerequisites that should be non-negotiable qualities.

In the field of hospitality, initial and basic skills in the field of study are very important as basic assets for VS graduates to start a new job. This is not negotiable and if worker basic skills are low, it would be very busy to develop them (Res_IND-15).

Foreign language mastery is very important because in aviation the ability to translate instructions in English is vital. Other aspects required are analytical skills and the ability to work under pressure (Res_IND-08).

Some respondents likewise see that industries need a workforce with a balance in both hard and soft skills.

... what really matters is the balance between hard skills and soft skills in career development (Res_IND-01).

Based on these data, chiefly hard skills in the form of highly-technical skills are basic competencies and prerequisites that must be possessed by VS graduates to enter the labor market. Nonetheless, without being supplemented by soft skills, these graduates will have difficulties in developing in the workplace. Therefore, highly-technical skills or hard skills must be supported by soft skills. Hard skills and soft skills are interdependent and

mutually reinforcing and do not negate each other. The efforts to strengthen hard skills and soft skills, therefore, can be carried out in an integrative manner.

3.1.2. Weaknesses of Vocational School Graduates in Entering the Industrial Undertakings

Based on the open-ended questionnaires distributed to 15 practitioners from various industries, the weaknesses of VS graduates face in recent days cover fifteen aspects. The list of these weaknesses is presented in Table 2.

Table 2. Weaknesses of Vocational School Graduates in Entering the Industries

No	Competency	Aspect
1	Low the field of expertise or technical skills because it is influenced by curriculum structure and learning facilities	Hard Skills
2	Lack of tenacity	Soft Skills
3	Lack of self-autonomy	Soft Skills
4	Lack of foreign language skills	Hard Skills
5	Lack of communication skills	Soft Skills
6	Lack of self-confidence	Soft Skills
7	Low motivation to learn	Soft Skills
8	Lack of cross-field capability	Hard Skills
9	Low desire to progress	Soft Skills
10	Low work ethic	Soft Skills
11	Low discipline	Soft Skills
12	Lack of logical thinking ability	Soft Skills
13	Lack of social sensitivity	Soft Skills

Based on the data in Table 2, it is apparent that the weaknesses of VS graduates in entering the industry include three hard skills and ten soft skills. Competencies in the hard skills category that are still low include mastery of the field of expertise or technical skills, foreign language skills, and cross-field capability. While the soft skills that are felt to be lacking mainly include the lack of tenacity, self-autonomy, communication, self-confidence, motivation to learn, and the desire to progress.

The results of the FGD with industry corroborate the data obtained from these questionnaires. All respondents agree that the main weaknesses of VS graduates comprise aspects of mastery of the field of expertise as well as various aspects of soft skills.

Some Vocational School graduates are still very far from the basic skills expected possibly because of the lack of teacher creativity (Resp_IND-12).

The graduates' foreign language skills still need to be greatly improved (Resp_IND-10).

The weaknesses of the current Vocational School graduates are discipline, safety, and low basic math skills (Resp_IND-13).

Discipline is still low, punctuality, self-confident … (Resp_IND-04).

Problem-solving skills really need to be improved (Resp-08).

Based on the FGD results, it can be rearticulated that VS graduates still need to increase their abilities in the area of expertise. The soft skills, similarly, need to be improved, especially discipline, safety, self-confidence, and problem-solving skills. These qualities can be improved along with work experience in their workplace.

3.1.3. Vocational School Learning to Equip Graduates with Skills Needed by the Industry

Based on the questionnaires involving 15 industry practitioners, the formulation of learning characteristics at VSs to produce work-ready graduates includes the following items.

o Curriculum adapted to the needs of the working filed
o Expanding work-specific knowledge (productive portion)
o Learning adapted to the conditions and needs of the working world
o Competency certification
o Foreign language training
o Communication skill development
o Soft skill learning (honesty, discipline and work ethic, and teamwork)
o Improving productive teachers' competencies
o Opportunity to create a job under students' fields
o Enhancing collaboration with industries

Besides, the results of the FGD with industry corroborate the suggestions of the open questionnaires. All respondents agree that learning that should be applied at VSs should be driven synergistically by schools and industries.

The ideal learning is to place Vocational Schools as a replica of the industry, and teaching materials are updated according to the latest developments (Resp_IND-01).

Learning at Vocational Schools needs to present figures of successful people as models for students (Resp_IND-15).

The apprenticeship system is ideal learning, companies can use Corporate Social Responsibility to serve the world of education (Resp_IND-03).

Learning in Vocational Schools needs to be enhanced by field practice, so collaboration with industries is the key (Resp_IND-04).

As proposed, VS learning formulas based on the input from the industry can basically be categorized into aspects of graduate competencies, curriculum, learning, assessment, teacher, and learning management. In the aspect of graduate competencies, the industry suggests that graduates must be equipped with the skills in the field of expertise (certified competency) supported by communication skills and mastery of foreign languages, as well as being equipped with strong soft skills. In the aspect of the curriculum, the industry suggests that the curriculum is designed to meet the needs of the industrial world. The learning applied is the one that is adapted to the conditions and climate of the industry. The assessment is done authentically based on performance by giving opportunities to students to create innovative work. Besides, teachers should have sufficient competencies

and industry experience, and in the aspect of managing learning, collaboration with industry is inevitable.

3.2. Discussion

This study found that basically the competencies needed by industry include two aspects, namely technical skills or hard skills, and soft skills or employability skills. The ability to master the fields, mastery of information technology, and foreign language skills are the main aspects that must be possessed by VS graduates supported by other abilities that are dominated by employability skills. In this case, the relationship between hard skills and soft skills becomes interesting and is very central to formulate. In the context of global changes in the 21st century and the IR 4.0 era, VSs need to more clearly define the broader concept of skills development, for both hard skills and soft skills. In this case, paradigm and mindset changes are needed in that vocational schools should design education to respond to the needs of the industrial world, and at the same time also prepare graduates to have the ability to develop their careers and lifelong learning.

Novel skills largely demanded by rapid technological change upsurge in the need for higher-level technical skills at all levels of work. A very good relationship between hard skills and soft skills is recommended by the World Economic Forum [2016] as follows.

> *"Overall, social skills—such as persuasion, emotional intelligence and teaching others—will be in higher demand across industries than narrow technical skills, such as programming or equipment operation and control. In essence, technical skills will need to be supplemented with strong social and collaboration skills".*

The balance between hard skills and soft skills is important to formulate. The third International Congress on Technical and Vocational Education and Training [44] recommend a proper balance between generic learning and social skills, and specific vocational skills. Indeed, an increasingly important task for TVET is preparing students to learn how to learn and how to adapt, rather than simply preparing for specific occupations. Given the need for hard and soft skills foe a sustainable future, this is in line with Carnevale's formula [7] that in the era of flexible production and service delivery systems and more rapid economic changes, workers not only need better technical preparation but also require sufficiently robust skills to adapt to changing requirements on the job. The demand for specific academic and vocational skills has been augmented with a growing need for general skills, including learning, reasoning, communicating, general problem-solving skills and behavioral skills.

The findings of this study are in line with OECD recommendations [4] about the importance of changing vocational education policies to provide the right mix of skills for the labor market. Through VET systems, providing young people with generic, transferable skills to support occupational mobility and lifelong learning, and with occupationally specific skills that meet employers' immediate needs will be possible. All students in vocational programs can have adequate numeracy and literacy skills to support lifelong learning and career development, as well as to identify and tackle weaknesses in this era. In the 21st century, those entering the labor market need immediate job skills and career and cognitive competencies to handle different jobs and sustain their learning capacity.

Besides, clarity of implementation guidelines is an important part of the success of strengthening hard skills and soft skills for VS students. Research conducted by Paryono [37] in the context of soft skills or transferrable skills found that all respondents agree that these skills are important and that there should be clear guidelines for teacher training both at national and at school levels. Guidelines on transferrable skills has been used as references by teachers in terms of rationale, definitions, frameworks, list of transferrable

skills component, staff development, integration in the course content, as well as monitoring and verifying transferrable skills.

This study found that one aspect of hard skills that is very important to be mastered by Vocational School graduates is information technology skills (ICT skills). ICT is the technology that has the greatest influence on the pattern and order of social, cultural, economic, political, and technological life in society [45]. ICT changes the way people complete their work, communicate, interact, transact, give orders, assign, report work, monitor and evaluate programs, document data and more. Consequently, vocational education needs to advance the students 'capacity to become lifelong learners who continuously progressively explore technology and science so that they know, understand, apply, discover new technologies, and carry out new social engineering. Students must be technology literate, have the capacity, be creative and be critical in applying technology and be subject to technology. Changes in attitude are needed starting from technological awareness to technological literacy, then becoming a capacity or having good technological capacity and ready to apply digital technology creatively. All of these stages must be based on the willingness and decision-making ability (technological criticism) about what technology will be used, how the model of its application, and why the technology is chosen and used. This capacity is very important to have in the digital age.

This study also found the importance of problem-solving skills for VS graduates. When related to 21st-century skills, creative problem-solving is essentially the culmination of learning intelligence skills in the XXI Century [45]. In this case, creative problem-solving requires learning and innovation skills '5C' as expressed by Wagner [8] including creativity, critical thinking, communication, collaboration, and celebration. Therefore, vocational learning in VSs is expected to improve the ability to solve problems creatively in a variety of contexts in both pursuing, developing, and caring for careers. Future problems are no longer routine and linear but are dynamic, unstructured and even disruptive. To face these issues, VS graduates should be born as people who can deal with problems using ways of thinking and working creatively and innovatively.

The quality of the vocational education implementation, including that of VS graduates, cannot be unglued from the reputation of its teachers. Teachers are the most influential and instrumental input for the excellence of educational processes [46][47][48][49]. A meta-analysis conducted on more than 800 studies [50] later upgraded with a meta-analysis of 1200 research results [51] shows that of the various determinants of student learning outcomes, teachers were the main determinants. In the context of vocational education, the commitment to organize quality vocational education must be supported by competent and experienced teachers. Besides, an important facet emerging includes the importance of teachers having experience in the industry. Industry experience is an absolute quality for teachers. In line with OECD recommendations [4], teachers and trainers should be well prepared with industrial experience. Recruiting sufficient teachers and trainers for TVET institutions and ensuring this workforce is well-acquainted with the needs of the modern industry have become a couple of central agendas. In short, TVET systems have to reassure trainers in TVET institutions to devote some of their time working in the industry.

Moreover, this study reveals that the main aspects of learning at VSs as suggested by the industry are linked with the relevance of curriculum, learning, and assessment which are adjusted to the characteristics of the world of work or industry in the 21st century and IR 4.0. This is in line with Howell & Donell [52] that the goal of future learning is to prepare students to succeed in the learning process, driven by globally connected technology for developing their skills, competencies, and knowledge. Besides, future learning is associated with three main things, namely learning for work, learning about work, and understanding the nature of work [53] as TVET is always going to have the additional challenge of operating across the two contexts - learning and learning [34]. The Teaching and Learning Research Program [35] likewise recommends that vocational

pedagogy must be catered for teaching and learning issues specific to the vocational context, for example, the need to balance formal knowledge and knowledge of workforce procedures and practice, the need to develop generic pedagogic skills that are common across different vocational areas, co-ordination of learning that takes place in more than a few contexts. The best vocational education learning is broadly hands-on, practical, experiential, real-world as well as, and often at the same time as something which involves feedback, questioning, application and reflection and, when required, theoretical models and explanations [30].

The education process at VSs, therefore, should match with the reality in the industry. This is in line with various studies [54][4][55][56] which impulse the importance of collaboration between vocational education and industry. Collaboration between education and industry becomes a must. Blending school and workplace learning together will be powerful and effective methods for developing many soft skills, preparing young people for jobs, and smoothing initial transitions into the labor market [4]. Industrial knowledge has a crucial role in national, regional, and international coordination and cooperation amongst partners. In this case, vocational schools and industries can synergistically conduct dialogues for curriculum development, program design, learning process, assessment, recruitment, and governance as needed.

4. Conclusions

Vocational school graduate competencies required by the industry include two aspects, namely technical skills or hard skills, and soft skills or employability skills. The relationship between both skills is interdependent and mutually reinforcing and does not negate each other. Vocational School orientations is to provide graduates with the occupational-specific skills that meet employers' immediate needs and generic-transferrable skills to support occupational mobility and lifelong learning. Weaknesses of vocational school graduates in mastering the aspects of the field of study and soft skills, especially discipline, safety, self-confidence, and problem-solving skills, therefore, need serious attention from both parties. Learning at the vocational schools as suggested by the industry is mainly related to the relevance of curriculum, learning implementation, and assessment all of which are attuned to the characteristics of the world of work or industry in the 21st century and IR 4.0.

Acknowledgments

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