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Employability Skills Framework for Mechanical Engineering

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***Abstract*—Industrial Revolution 4.0 is an age of digitalization in the production process using digital system. The figure of an ideal mechanical engineering of the industry 4.0 should be able to response all the changing needs of the employability skills according to the market power of the manufacturing industry. Employability skills could be identified as a necessity of graduates in order to compete of competition in the era of the industrial revolution 4.0. The purpose of this study is exploring employability skills from an industry that is considered as the most appropriate for graduates of engineering. Every graduate should have the feasibility of work to identify the concept of theoretical and feasibility models of work, minimizing the skills gap by academics. The literature review found out that the manufacturing industry requires employability skills that suitable for mechanical engineering graduates, including technical skills and generic skills. Technical skills included: mechanical engineering drawing, conventional machining, computer numerical controlled, metal fabrication and welding. Generic skills are: social skills, teamwork, communication, critical thinking, ICT skills, and self-management. The implications of this study is helping mechanical engineering graduates for standardizing and improving their skills by industry and academics.**

Keywords—employability skills; mechanical engineering; manufacturing industry

I. INTRODUCTION

The emergence of the 4.0 has created changes from the skin, face to face towards the touch screen, screen to screen, the relationship of virtual with a wide range of window dressing which is run automatically and robotics. Communication that is becomes easiest allows company's manufacturing to exploit the potential of digitalization in production. The success of the implementation of the 4.0 require the ability of engineering and IT, by expanding competitiveness in order to create the chains of digitalization in industrial engineering [1].

The skills needed by the manufacturing industry are changing faster and impacting changes of employability skills. The changes happened in this world needs a framework to be updated as needed in the working space. Because of that, orientation of vocational education's graduates is not just limited by the development of knowledge, but directly develop learners by developing their knowledge, skills, attitudes, and value through simulations of how the real world's work [2].

Education has a roles of increasing the quality and productivity of the students as a form of investment to responds the needs in manufacturing industry [3]. In this case vocational education as the supplier of employees, has a big role to ensure that everybody could learn and develop their employability skills [4].

The ideal figure of a mechanical engineering graduate should be able to responds to any changes in labor skills in according to the global manufacturing industry. A graduate of the engineering should have understand enough about the industry and also convenience of working with computers because most of time is spent to design, simulate, and producting [5].

In fact, there so many prospective workers who lack the employability skills needed in the era of the industrial revolution 4.0 to minimize the mismatch of the industry. Consequently, lead to the feasibility of work of every graduate to have the new skills to minimize the employability skills expected by industry.

Employability skills rather considered to be very important, because the employability skills is the most needed skills in addition to the mechanical engineering, which is the skills to compete to get a job and maintain a job in the global market of industry [6]. Employability skills is the skills needed by workers or prospective workers to be updated in every time [7].

Employability skills of a labor should not be specific, but more oriented to a higher social skills [8]. and competence isn't always static, but must follow the guidance of the work process, it means that these changes are not always through an education or training but change through independent study [9]. It indicates that any employability skills that need to be equipped to support the change in labor skills that constantly changing to follow the development of times.

As a basis, the development of skills needed a framework to support the hard skills of engineering graduates in the industrial revolution 4.0 era. One of the development of a framework for the employability skills in order to create a quality network between users that graduates from vocational education and education providers that are visible from the quality, relevance and the postgraduate study.

A. Employability Skills

Employability skills is not something new, the concept of employability skills have been developed in 1950 and up to now this concept has undergone many changes of focus, ranging from the focus employability skills rather to the potential of individuals attitude changing of workers, a career up to the changing of working skills [10]. One of the term employability skills have been introduced with the concept that was developed in the United States and its objective is to identify the difference between the people that deserve to employed and cannot be employed [11].

There is a lot of the different ways that used to describe employability skills. For example, in the country that call such a generic skill, employability skills, key skills, core skills and others, but essentially the same by the ability that tends to the skills that is absolutely non technique.

Employability skills is a series of attributes, skills and knowledge to the workforce to make sure that they have the ability to be effective in the workplace that they are interest of their own, industry and economy to be wider [12]. Employability skills also guide to get a job that has the skills professionally qualified so that explicitly increase the attractiveness to be recruited [13,14]. It indicates that employability skills include all the possibilities for someone to be successful in a variety of jobs in the market situation and looking at a person's capability to develop. Therefore, the employability skills are considered as a basic of their fundamental because it will provide mastery of technological change [15].

Rather identified and validate the seven skills that are deemed important by the industry, namely the basic skills of foundation skills rather: (basic skills, thinking skills, personal qualities) and competence in the workplace workplace competencies: (resources, interpersonal, information, system, and technology) [16]. It is in tune with the employability skills includes a set of achievements that consists of; skills, understanding and the private and make the individuals who are successful in his choice, as well as the work of providing benefits for himself, labor, community and economic [17].

Employability skills rather as one of a necessary tool to increase mobility and income a person [7]. Mobilitas and income is received after the man if you have employability skills rather good in his work. However, if a person is not have employability skills yet rather less well would be difficult to follow the movement of its mobility, such as communicating with both of which made him a top choice that will lift him to a career high and the impact of the earn extra income.

B. Mechanical Engineering Framework

The concept of the competence framework of technical skills rather to be essential and raw, it is important to be formulated. The framework developed with the qualifications in order granting recognition of work according to the level of competence, making it easier in formulating standards setting of a framework that most important considered by the manufacturing industry.

Analyze the qualifications framework and the experience of the developments in European countries and other countries of the world is concerned, it is very influenced by their purpose [18]. Indonesia has their own standards, it is KKNI standard (The Framework of National Indonesia). Those standards are to be a reference for education in analyse the achievement of graduates and absorption capacity as well as the standards of qualifications. By that framework and the skills of employment, conceptualization to build the framework of the match formed.

The standard of indonesia level is the most widely with the qualifications of the countries in ASEAN, at least indonesia should refers to AQF (ASEAN qualification framework). The framework of the qualifications of a comprehensive understood as a framework for integrated, including the qualifications of all types, obtained by means of formal, non-formal education and informal and needed to work [19].

Graduates of mechanical engineering that come from middle school and higher education should be reconstructed on the achievement of its graduates. All students and graduates are prepared to be the personalities of a reliable, that can compete in the modern era. So, the graduates in Higher Education does not mean education just a transfer of knowledge but also has improved value that should be able to integrate their good employability skills. The strategy developed by; the profile of the graduates, the determination of graduates competence, the determination of graduates/achieving competence of learning and the establishment of the college/activity [19].

Employability skills have a role that crucial to the graduates of engineering and manufacturing industry that needs to be applied by giving the charge of learning. Employability skills is the skills needed to deal with the transition from the industrialized economies to economic knowledge shown by changes in skills. Employability skills is necessary in the field of work. Integration of this value can be developed through a learning experience in a sustainable and programmed since new students enrolled in college until they graduate. Such a conclusion can be achieved through the eyes of the college in the actual curriculum, in hidden curriculum, recognition, training, the strengthening, development and practice. In order to implement it, then there needs to be a commitment from the institutions, there is a statement of a clear values and beliefs are developed, there are activities undertaken in order to facilitate the needs of students.

II. METHOD

The purpose of the study of literature is to explore the skills required the industry as well as increased the feasibility of the graduates of engineering and employees mainly focusing on engineering or the manufacturing industry. The concept of theoretical models and feasibility work explored deeply to review the gap between the feasibility of work for between knowledge and skills provided by academics or educational institutions, as well as knowledge and skills are considered important by the industry when recruiting.

The study reviewed approximately 120 papers with details of the articles covering topics employability skills, the industrial revolution 4.0, manufacturing industry and

engineering. The search process of the literature done of the journal reputable and indexed Scopus through science journalists, taylor and Francis, sage journals and springer. Articles of the analysis, the key words of the concept of the review and the findings of analysing data to the purposes of research [20]. Then the articles used to identify keywords associated patterns, the selection of specific and is clustered into a sub-theme [21]. Compounding keywords collected and analysed, then the same one is classified and combine.

III. Results and Discussion

The review of literature can be presented for discussion and study of a mechanical engineering graduate for an ideal profile. Seeing the future is something that is not easy to do and in the results of the study in a short discussion, employability skills rather seeks to provide views based on experiences in managing the standard qualification profile of Engineering Deck.

The literature in the paper suggests that employability skills rather not just be a complementary, but a support that must be a profile of mechanical engineering. The academic need to integrate any learning with the ethos of the employability skills significantly. Therefore it is very important to anticipate the skills over the needs of a constantly changing in the market work.

Many manufacturing industry who recruits workers from a mechanical engineering graduate that selected from the basic skills such as: the power of mathematics, English and analytical skills. That is a recommendation from the users of mechanical engineering in order to prepare its graduates to have basic skills.

Employability skills that is considered important by the industry as the ability to communicate is so important because a mechanical engineering graduate of the more often interact with machines, which is it's dead, so when communicate and present work tend to trouble and haven't got it. It indicates the ability to communicate to the important mechanical engineering.

Graduates of mechanical engineering as well as the basic of scientific applications in integration to the ability of critical thinking is needed in the world of work today, because later workers will be faced with the problems happen that requires problem solving ability in order to solve it. Then these capabilities needs to be supported by the management of personal, because every individual is live to work. Management personal is the process of how we are going to organize and arrange what to do to get the achievement as the purpose of life. Therefore, the ability of management personal every individual must be improved. With that, a mechanical engineering graduate should able to keep his job and improve it to reach the top level of his job.

The fact is, a graduate engineering required to work in the multicultural and multinational workplace, and those should have attributes and professional competencies. Most graduates of engineering works in the field of the manufacturing industry which requires workers have the ability to use computer in the highest classified levels of computing and programming. This skill should have as a solid foundation because production in the machine has been a lot of changed with the advent of the CAM (Computer Aided Manufacturing) technology. The process of production in the manufacturing industry to mobility quickly so that consumers, the production process and supply chains will become more efficient, with the advancements in productivity and the huge savings in materials and energy. These tools have been popping up to support the use of mechanical engineering in the software to draw CAD, inventors or catia. The use of the software used to the analysis method the mechanics and materials. Automation the product of a mechanic has been running for a long time with the advent of technology mechatronic and robotics. It is in harmony that mathematics is an essential element to support practice of its duty especially the work of the work involved the technological tools like a machine that tend to wear the strong basic math.

Skills for mechanical engineering in the future is a person who has the competence of the work is in accordance with the qualifications of national, regional and international. For that they must have the technical skills and the ability of the generic as supporting a packed into a unified whole is employability skills framework for engineering that applied to apply to all levels of competence. The generic reference to the engineering is skills of a generic ones that are important is represented by the analytical, skills communication, teamwork and skills to lead. The following is the authentic result related to the literature study of employability skills and attribute graduates mentioned in Table 1 and Table 2 in Appendix.

IV. Conclusion

The literature helps in adopting a list of employability skills according to engineering. The opinion experts have been taken to make verification and further use in developing the skills of a comprehensive with the help of some statistical techniques. The implication of research is helpful in guiding the industry and academics or educational institutions in incorporating and improve the skills of a more professionals. In the future, there should be standard models and the ability to work, in determining the curriculum, to bridge the gap between skills that are owned and the skills required in industry, so there is the right solution can be given to industry and academics.

Indicators is outlined can be a reference, so it can restore the framework of mechanical engineering to produce graduates who are productive, creative, professional and able to develop themselves in order to fill workforce needs in the industrial sector of manufacturing and all sectors. The relationship of mechanical engineering with the industry should have been centered on the hard competency that graduates are produced can contribute in the field of the profession.

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APPENDIX

TABLE I. SUMMARY OF REVIEWED STUDIES (EMPLOYABILITY SKILLS)

Schallock (2018)	**Ismail (2015)**	**Jackson (2014)**	**Ashleih (2017)**	**Knox & Stone (2018)**	**Sisodia (2017)**	**Misra (2017)**
Technical skill	Problem olving and adaptability skills	Working effectively with other	Business and custumer awarens	Numerically and IT	Communication	Technical skill:
Transformation skills	Professionalim	Communicating effectively	Self-mangement	Self-management	Information communication & technology	Higher order thingking skill
Social skills	Lifelong learning	Self awarenss	Team working	Professional context skills	Work psyclogy	Personal skills
	Teamwork skills	Thingking critically	Problem solving	Flexbility, adaptability. Resilience	Teamwork	People/ social skills
	Communication skills	Analysing data and using technology	Commication and literacy	Communication	Interpersonal	Generic skills
	Information communication technology and computer skills	Problem solving	Application of numeracy	Team working	Critical thingking & problem solving	Self-perceived employability skills
	Initiative and enterprise skills	Developing initiative and enterprise	Ethic and moral	Problem solving	Self-management	
	Leadership skills	Self-management	Aplication of IT	Leadership	Planning & organizing	

TABLE II. SUMMARY OF REVIEWED STUDIES (SKILLS AND ATRIBUTE OF THE GRADUATE MECHANICAL ENGINEERING)

Markes, (2006)	**Henning, et.al (2010)**	**Chishom, (1906)**	**Street & City, n.d.)**	**Amin (2012)**	**Tryggvason & Thouless, (2001)**	**Fernandes (2007)**	**Tenaga, Dan, & Republik,**
Operation CNC Mchine	Production engineering: manufacturing	Material removal: machining procces	Engineering design	Thermodyn amics	CAD	Calculus	Assembly
Computer Aided design (CAD)	Design engineering and development	Material forming	Principles of engineering	Fluid mechanics	Statistic	Mechanical mettalurgy	Cating and moulding
Computer Aided manufacture (CAM)	Chemical enginnering:	Casting	Computer intergrated manufacturing	Heat transfer	Solid mechanics	CAD	Drawing, design and drafting
Computer Aided Engineering (CAE)	Plastics and textile technology	Welding	Engineering design and development	,	Dynamic	Mechanic material	Fabrication
	Transportation engineering	Heat treatment			Electronics	Automation and control	Forging
	Fundamental of mechanical engineering	Assembly			Thermodinamics	Numerical method	Machine and procces operation

		Material handling			Engineering material	Fluid mechanics	Maintenance and diagnostic
		Metrology			Mechanical design	Mnufacturing	Material handling