Minimize the competence gap between ferrous foundry small firms and vocational high school in Indonesia readiness industry 4.0

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Abstract. The purpose of this paper is to identify the Competence that should be taught in Vocational High School which still takes care of the skills needed for the future. The research method used is descriptive qualitative. To get the required Competence of metal Ferro casting industry from Vocational High School students through two sides. The first side is observation and interviewing in the ferrous foundry to get the required Competence. The next side is by way of interviews and observations at Vocational High School to know the difference Competence is taught. Competences that should be taught are provide material on the foundations of metal casting, pattern-making techniques and power points or Prezi, engineering drawings and AutoCAD, manual and modern casting technique, Solidwork and the solid cast, mold making techniques and core, and Ferro metal casting techniques with industry.

1. Introduction

Politics, economics, education, culture and social change drastically due to the development of technology and information. The development of technology and information has an impact on the political policies of the government [6]. The economy shifts from a door-to-door marketing system to Start-Up marketing [5]. The curriculum, learning subjects, learning environment, teachers and students must follow the development of this technology [10]. Culture and social change follow the existing environment due to the changing environment due to the development of technology and information [4].

Indonesia faces the challenge of setting up industry and workforce in accordance with industry 4.0 caused by the development of this technology and information. Preparation for Indonesia to face this 4.0 industry revolution is Indonesia to make a roadmap to industry 4.0. one of the roadmaps to industry 4.0 that Indonesia set 10 national priorities. Indonesia will encourage 10 national priorities in "Making Indonesia 4.0” initiatives: 1) improving the flow of goods and materials, 2) Re-design of industrial zones 3) Accommodating sustainability standards 4) Empowering SMEs 5) Building a national digital infrastructure 6) Attracting foreign investment 7) Improving the quality of human resources 8) Development of innovation ecosystem 9) Incentives for technology investment 10) Harmonization of rules and policies [6].

There are 2 national priorities that are concentrated in this paper that empower the Micro and SMEs industry as well as improving the quality of human resources. Micro industries and SMEs are
empowered because 62% of Indonesian workers work on micro and SMEs with low productivity. [6] Micro and SMEs productivity are still low due to the lack of applied technology, poorly trained workers, poor production management, low demand for goods, poor marketing, product results that are still inferior to foreign products and raw materials which is expensive. Micro industries and SMEs can be empowered through financial incentives, technical assistance, employee HR improvement, product standardization, management standardization, product development and product marketing. One of the things that can improve workers' human resources, standardization product, and product development is through teaching factory. [12][13].

Teaching factory is a concept that integrates between corporate or industry environment with class. Teaching factory was originally derived from the concept of medical science and specifically. Between schools and hospitals walk parallel and go hand in hand. The purpose of walking parallel and coherent is to integrate learning and work environments. Once the integration between the learning and work environment occurs when the real and relevant learning experience increases [12].

Teaching factory is growing rapidly in companies and industry in America. Computer hardware and software companies use this teaching factory concept. Then progressed to the manufacturing company. Students are involved in designing and developing new products needed by the market in this manufacturing company [12]. Manufacturing industry that includes the process of machining, joining, forming and casting [3]. Metal casting is a manufacturing process that produces a very complex form [1]. This Focus paper is the process of manufacture metal casting. Metal casting is divided into two branches namely ferrous and non-ferrous metal casting. This focus paper is ferrous metal casting. The micro and small-scale ferrous metal foundry industry in Indonesia is spread and concentrated in Klaten area.

Teaching factory will be able to run well if ferrous foundry cooperation of micro and small enterprises with vocational high school competence of metal casting technique skill go hand in hand. Vocational high school competence of metal casting technique expertise in central Java is SMK N 2 Klaten and SMK Batur Jaya Ceper 1 Klaten. The concept of learning model is taken in Klaten area because Klaten is a district in central java which become center of the industry of Ferro foundry micro and SMEs.

So the purpose of this paper is to identify the Competence that should be taught in Vocational High School which still takes care of the skills needed for the future. Competence should be able to help and improve the good cooperation between school and ferrous foundry.

2. Method

The research method used is descriptive qualitative. To get the required Competence of metal Ferro casting industry from Vocational High School students through two sides. The first side is observation and interviewing in the ferrous foundry to get the required Competence. The next side is by way of interviews and observations at Vocational High School to know the difference Competence is taught.

3. Result and Discussion

3.1 Ferrous Foundry analysis

3.1.1 Tacit knowledge

Knowledge is divided into 2 namely tacit knowledge and explicit knowledge [14][15]. Explicit knowledge is the knowledge that can be explained through sentences, can be described with pictures and writing. While tacit knowledge is action, work procedure, work routine, commitment from the worker, worker idealism and worker emotion that can not be explained by the worker [9]. Tacit knowledge can be shared through interviews with someone who can be trusted by the worker itself [14][17]. therefore, to conduct interviews should build trust first with workers, through frequent
meetings and indirect talks about the work of the workers. Once the workers begin to believe situational interviews are conducted to obtain valid data.

3.1.2 Foundry worker analysis
To be able to find out the Competence that the industry needs today, so it can be applied in Vocational High School, people skilled at casting Ferro in the ferrous metal casting industry area of Klaten are interviewed. 10 people in the micro and small-scale Ferro metal casting industry were interviewed. The research used qualitative research type. Situational interviews [8][11][16][18] and observations were used to obtain data. Based on the observations and transcripts analysis required by industry of vocational high school graduation are furnaceman, caster and molder, fattier, pattern maker, core maker, material handler, and spectrograph operator. (Table 1)

Table 1. Competence foundry worker and gap competence student

| No | Foundry worker | Competence | Gap Competence Student |
|----|----------------|------------|------------------------|
| 1  | Furnaceman     | Furnace maintenance (Knocking out of the furnace and ladle linings, Relining the furnace or ladles, turn on and off furnace suitable SOP), charging, melting, removal of slag, refining, and tapping | No furnace |
| 2  | Caster and molder | Pouring and cooling, Shakeout or knockout, Sand casting by cup and drug | Pouring and cooling, Shakeout or knockout, Sand casting by cup and drug but the cast and mold aluminum molten |
| 3  | fattier        | Hand Grinding, welding, shot blasting, heat treatment | Hand Grinding, welding, shot blasting, heat treatment but aluminum |
| 4  | Patternmaker   | 2D and 3D CAD, Solid Casting or other application and making, assembly and storage of patterns | not teach and train |
| 5  | Core maker     | making, assembly, and storage of core, core molding, shell core making, core painting | Mostly Fulfilling demand |
| 6  | Material Handler | Crane and hoist operator, manual material handling, AGV, monorail | not teach and train |
| 7  | Spectrograph operator | Operating spectrograph and maintenance spectrograph | not teach and train |

3.2 Vocational high school analysis
Based on KKNI (qualification framework of Indonesia) Vocational High School entry at level 2 that is (1) Be able to perform a specific task, using commonly used tools, and information, and work procedures, and demonstrate performance with measurable quality, under the direct supervision of their superiors. (2) Have basic operational knowledge and factual knowledge of specific work areas, so as to be able to choose the available solutions to common problems. (3) Responsible for the work itself and can be given the responsibility of guiding others.

Based on the depth interview that has been done in Vocational high school. Learning that has been done in Vocational high school is to use project-based learning. However, learning only uses
aluminum materials. So the furnaces used in the Ferro metal foundry industry are completely different from those in the school. The consideration is the furnace for Ferro metal casting requires more electrical energy, of course, will cause a high cost for practice. Therefore, schools only rely on the job training (OJT). Though OJT usually cannot be used to teach Ferro metal casting. Because industry only focuses on production, so the students tend to only help the existing jobs in the industry.

Based on the existing national curriculum, vocational high school competence of metal casting technology expertise. There are 4 main subjects namely pattern making techniques, mold making techniques and core, manual casting techniques and casting techniques with the machine. Of the four subjects that really can be taught by the school is the technique of pattern making, mold making techniques and core and manual casting techniques.

Techniques of pattern-making are still taught manually. The pattern-making technique is more likely to produce wood patterns and resins. Though small firms foundry industry that is in Klaten, already using the aluminum pattern to facilitate the pattern of sand casting. This means that there is a gap here in terms of the use of pattern materials used in schools with those in the industry. In addition, the foundry industry needs people who are able to communicate with customers. However, in school children have not been taught to communicate well. Schools are also still not implementing computer programs that can help in planning the pattern and gating system good foundry.

Molding and core making techniques are still taught manually. The molding technique is still using manual cup and drag by hand. The mold making technique is in accordance with the existing in metal casting industry Ferro small firms in Klaten. However, schools must also develop competencies to try to adapt sophisticated foundry industries. Students should be familiar with material handling conveyors, monorail, crane and hoist and Automated Guided Vehicles. The core manufacturing technique is still taught manually. The making of the core in schools with existing in the small firms metal casting industry in Klaten is appropriate.

Core manufacture still uses heat from gas fuel to condense the core sand to be used. However, schools should also try to start teaching children about core making using CNC machines. Means that students should be familiar with CNC machines.

Manual casting technique taught school is sand casting technique. Manual casting techniques in schools still use a crucible furnace that can only heat aluminum. So, students only get non-ferrous metal competence. Competence of ferrous metal casting has not been taught due to the absence of furnace that suits small metal firms foundry industry in Klaten.

4. Teaching Factories to Minimize GAP Competence Between Vocational High School and Ferrous Foundry Small Firms in Klaten

Between vocational high school and metal Ferro metal casting industry firm in Klaten must cooperate to develop industry and vocational high school competence of metal casting techniques. Micro and SMEs Foundry in Klaten usually only try to increase production and improve marketing. Therefore, to start cooperation. Vocational high school should start to establish good cooperation with equally profitable industries. Cooperation must be built based on competence to be improved. (Figure 1)
Figure 1. Collaboration win-win solution

Vocational high school in Indonesia is implemented for 3 years. The first year the school should prepare is to provide material on the foundations of metal casting, pattern-making techniques and power points or basic Prezi, engineering drawings and AutoCAD [12]. The second year is a simple manual casting technique, powerpoint or Prezi professional, AutoCAD 3D and the solid cast. So the mold making techniques and core are taught all on the subjects of manual casting techniques. The third year of vocational high school teaches Ferro metal casting techniques with industry.

The learning method used is the method of learning research. The first step is the school has established cooperation with partner industry. After the school works with the foundry industry, the next step is the students get a picture of the workpiece that will be developed through discussion between teacher and industry party. The teacher then gives an overview of the workpiece to be made. Students design 3D work drawings with AutoCAD [20] then moved to SolidCast [2] to be used for planning the patterns to be created and the gating system used. Then students make a good prototype of aluminum, then make a powerpoint or Prezi that will be presented to the industry. Once the industry approves products that are likely to be developed, then students are invited to the ferrous metal casting industry.

After students are in the shop floor of ferrous metal casting industry, students then make molds and gating systems that have been planned before. students then pay attention to iron smelting process directly from Furnace maintenance process (Knocking out of the furnace and ladle linings, Relining the furnace or ladles, turn on and off furnace according to SOP), charging, melting, removal of slag, refining, and tapping. After the smelting process is complete the next step students move the molten metal ferrous from the ladle to mold. After cool, the next step is to disassemble the mold in accordance with the Competence that is often done by workers. After the workpiece is complete the next step is to check the casting results visually and spectrograph. After the analysis is complete then make a presentation to be presented to the industry the results that have been done.
5. Conclusion

Competence that should be taught in Vocational High School are provide material on the foundations of metal casting, pattern-making techniques and power points or basic Prezi, engineering drawings and AutoCAD, manual casting technique, powerpoint or Prezi professional to presentation with industry, Solidwork and the solid cast, mold making techniques and core, and Ferro metal casting techniques with industry

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