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Design Training Kits CPI for Vocational Learning in Industry 4.0

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Abstract: Cyber Physical Infrastructure (CPI) is one of eight supporting technology infrastructures of Industry 4.0. CPI is built from several technologies including RFID, RTLS, sensors, wireless sensors, actuators, processors, controllers, and data communication network systems. This paper presents the design of vocational learning training kits for CPI competencies in industry 4.0. CPI training kits for developing industry competency 4.0 are designed using the waterfall life-cycle method. Design analysis, design systems, part production, assembling processing, firmware production, systems evaluation, and test used interactively to produce the final product. Industrial 4.0 CPI training kits design includes: (1) PLC processor systems, mini PC, Arduino mega2560; (2) a timer counter controller with a PID systems; (3) RFID and RTLS identifiers; (4) proximity sensor, magnetic sensor, inductive sensor, capacitive sensor, photoelectric sensor, humadity sensor, thermocouple, thermostat, thermistor, opto coupler, limit switch, push button, analog V, ultrasonic, pressure sensor, speed sensor; (5) AC motor actuators, servo motors, stepper motors, valves, pneumatic-hydraulic cylinders, lamps, heaters, relays, SSR, 24V-5V converters; (6) LCD, LED monitor display; (7) data communication between controllers, (8) data communication modules to the internet; (9) user manual and job sheet. The test results show: content experts have given a score of 76.7 from a scale of 100, media experts have given a score of 88.6 from a scale of 100 and users have given a score of 85.4 from a scale of 100. Field trials through training show results can improve competencies in industry 4.0. CPI training kits strongly support the education and training needs of various competencies to develop the capacity of workers in industry 4.0. CPI training kits can be used in schools, universities, and training centers for industrial technology 4.0.

Keywords: Training kits, CPI, Industry 4.0

I. INTRODUCTION

Industry 4.0 is a smart, effective and efficient industry with flexible production capabilities, customized mass production, higher production speeds, and able to increase efficiency [22],[21],[11],[5]. Industry 4.0 is called an intelligent and efficient industry because it implements Artificial Intelligence (AI), Adaptive Robots, 3D Printers, Virtualization Technologies (Virtual Reality, Augmented Reality), Cyber Physical Infrastructure (CPI), Internet Industrial of Things (IIoT), Big Data Analysis, Cloud Computing, Simulator, Additive Manufacturing [23],[4],[5],[6],[11]. Industry 4.0 works with real time monitoring and diagnosis systems, information transparency, integrated business processes, using networks (interconnection), fast and precise, interactive, service oriented business [21],[22]. Industry 4.0 gives a lot of added value [2]. The concept and design of industry 4.0 then becomes the choice of the industry in the future.

Cyber Physical Infrastructure (CPI) or Cyber Physical Systems (CPS) is a physical infrastructure as a backbone of Industry 4.0 [4],[27]. CPI/CPS is one of the supporting technologies for smart factories, smart cities, smart homes, smart washing machines, smart campus, smart class rooms, smart cars, smart devices, smart gardens, etc. [4],[5],[1],[3],[20]. CPI/CPS is increasingly being utilized in industry 4.0 and is increasingly being applied to smart systems because these systems are cheaper, build new capabilities, and are more efficiently used [24],[25],[4],[11]. CPI is very important to be continuously studied and developed.

CPI/CPS is built from embedded systems. CPI/CPS works to organize and coordinate physical infrastructure with cyber infrastructure in order to have communication, computing and control capabilities [25],[26],[7]. Physical infrastructure consists of physical systems and sensor-actuator systems. In the physical systems there is a network of machines, conveyors, production lines, 3D printers that work in manufacturing and assembling. In the sensor-actuator systems there is a sensor-actuator network systems that functions and works to perform special sensing and acting functions.

Sensors, actuators, controllers, processors, data communication networks are the main components of CPI's physical infrastructure [5],[3],[4],[17]. The sensor works to convert physical, mechanical, optical, magnetic and thermal quantities into voltage or current quantities. The results of the conversion can be in the form of electrical quantities either analog or digital. If it is in the form of an analog scale, a data converter is needed commonly known as Analog-to-Digital Converter (ADC).

Sensors are very widely used in the industry 4.0 [14],[18],[26],[27]. Various types, characteristics, and sizes of sensors are installed in industry 4.0 systems. Sensors are installed to measure, monitor the process and results of production and the performance of machines.

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Whereas the actuator works turns electrical and fluid energy into mechanical energy in the form of motion, sound, heat, rotation, and so on. Sensors and actuators are an important part of CPI.

Cyber infrastructure works in computing, controlling and communicating functions [25],[11],[26]. The CPI strictly measures data on the physical part then computes, builds abstractions and models for systems work. Cyber infrastructure facilitates the fusion process and analysis of data received from various sources and then makes decisions. Cyber infrastructure simultaneously works sensing data from physical infrastructure and carries out control commands to the physical infrastructure. CPI/CPS works as a supporter of intelligent network systems with real-time data processing [4],[10],[21]. This is the main function of CPI which is very important in the production process in industry 4.0.

Industry 4.0 applies physical systems and software systems in an integrated, coordinated and communicating manner [1],[5],[27]. Physical systems include production machines, production lines, sensors, actuators, processors, signal conditioners and data communication network systems. Software systems include digital-based data management systems, production process information systems, machine maintenance and repair information systems, machine work monitoring systems, order reception and handling systems, data security systems, artificial intelligence (AI), actuator sensor work control software and decision-making control systems [25],[5].

The advantages of CPI/CPS make it widely used in intelligent production systems. The application of CPS in a production systems is called the Cyber Physical Production Systems (CPPS) [4]. CPPS provides communication services between humans, machines and products [4],[25]. CPPS is designed to be able to get and process data and can control itself according to its tasks and interact with humans through the systems interface. One of the main objectives is to achieve optimal conditions of the process and production line. The machine has the intelligence and ability to pay attention to the conditions themselves, do reconfiguration to adapt to the entire state of the production process and communicate with each other in depth.

The industry revolution 4.0 provides opportunities and threats of losing jobs for unskilled workers by 46%, skilled workers 45.4%, master craftsmen 33.4%, and professional workers 18.8%. It turns out, this challenge is very broad not only threaten 1.6 million jobs will be forfeited but also 3 million new jobs will emerge. The new jobs that will emerge are all related to industry 4.0 competencies (Training Innovative Teaching and Learning for Industrial changes due to industry 4.0 Forum from Regional Cooperation Programme for TVET ASEAN and GIZ on 5-16 August 2019 in Bangkok Thailand).

Changes in job platforms caused by the industrial revolution 4.0 require accelerated technological awareness, technological literacy, technological capability, technological creativity, and technological critism [13],[28],[8]. Creativities in technology 4.0 can be built if people have the capability, literacy, and awareness of technology 4.0. Increased technological awareness, technological literacy, technological capability, technological creativity, and technological critism can be done through vocational learning and training at education and training centers. Vocational learning is an important part and is one of the characteristics of CPI, namely human in the loop. CPI positions humans as a very important component and determinants of the systems operation in process of production.

Vocational learning as a capacity building process in the CPI field requires training kits as a complete curriculum for training programs. Training kits are used as learning units and practice various competencies in the CPI/CPS field. The availability of training kits supports the effectiveness of learning. CPI training kits can be used to improve awareness, literacy, capability, and creativity. Vocational learning and training is held to build work competencies in the field of CPI/CPS. Training kits provide training material for mastering theoretical and practical concepts about CPI/CPS. Training kits can be used to demonstrate the work processes of Industry 4.0. What is the design of CPI training kits for vocational learning needs in Industry 4.0 is important to be developed. How physical systems and cyber systems are designed in training kits to have the capabilities of communication, computing and control functions. How the performance, features, reliability, durability, serviceability, and aesthetics of CPI / CPS training kits are discussed in this paper. Then as a training media, are CPI training kits easy to use, how well are they in building insight into industry 4.0 and what about technical reliability.

II. CONCEPT OF TRAINING KITS CPI

A. Cyber Physical Infrastructure

Cyber Physical Infrastructure (CPI) is an infrastructure that integrates physical components and cyber components in production processes, and services with computing, controlling, communicating elements to strengthen a deeper knowledge of the environment so that it can act accurately [4],[25]. Lie et al in [25] stated that CPI is an embedded computer and network monitoring that works to control physical processes including a feedback loop where physical processes affect computing processes and vice versa computing processes affect physical processes. Computers, software and networks systems works systematically and dynamically. CPI systemsivally works to combine cyber capabilities with physical systems in solving various problems [25].

The term "Cyber Physical Systems" according to [25] was introduced in 2006 in the United States by Hellen Gill. Cyber Physical Systems comes from the same vein, "Cybermetics". The CPS term is increasingly popular in line with the launch of the industrial revolution 4.0 in Germany. CPS then becomes the basic infrastructure or industry backbone 4.0. Then the term Cyber Physical Infrastructure (CPI) appeared. The CPS term is more academic in nuance whereas the CPI term is practical. Cyber means infrastructure that is capable of performing computation, communication, and control functions in a discrete, logical, and switching environment with full-duplex communication. Figure 1 shows the three main functions of CPI.

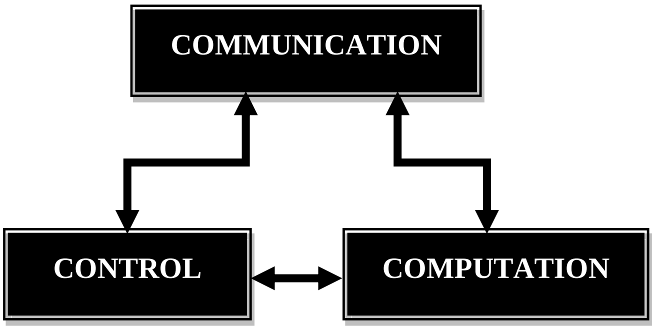

Figure 1. Basic Requirements CPI
Source: [25]

CPI has 31 main characteristics viz: (1) human in the loop, (2) feedback systems, (3) intelligent systems, (4) tight integration, (5) communication networks, (6) networked control, (7) wireless sensing and actuation, (8) adaptif and predictive, (9) non-functional requirements, (10) high safety requirements, (11) dependability, (12) distributed structure, (13) diterminism, (14) real-time and time-awareness, (15) interoperabilty, (16) interfacing with legacy systems, (17) modularity and composability, (18) cyber security, (19) malicious attacks, (20) resilience, (21) privacy, (22) confidentialy, (23) intrusion detection, (24) heterogeneity, (25) multiform time, (26) model of computation, (27) continuous and discrete, (28) concurrency, (29) scalability and complexity management, (30) validation and verification, (31) simulation [25]. CPI block diagram can be illustrated as shown in Figure 2 below.

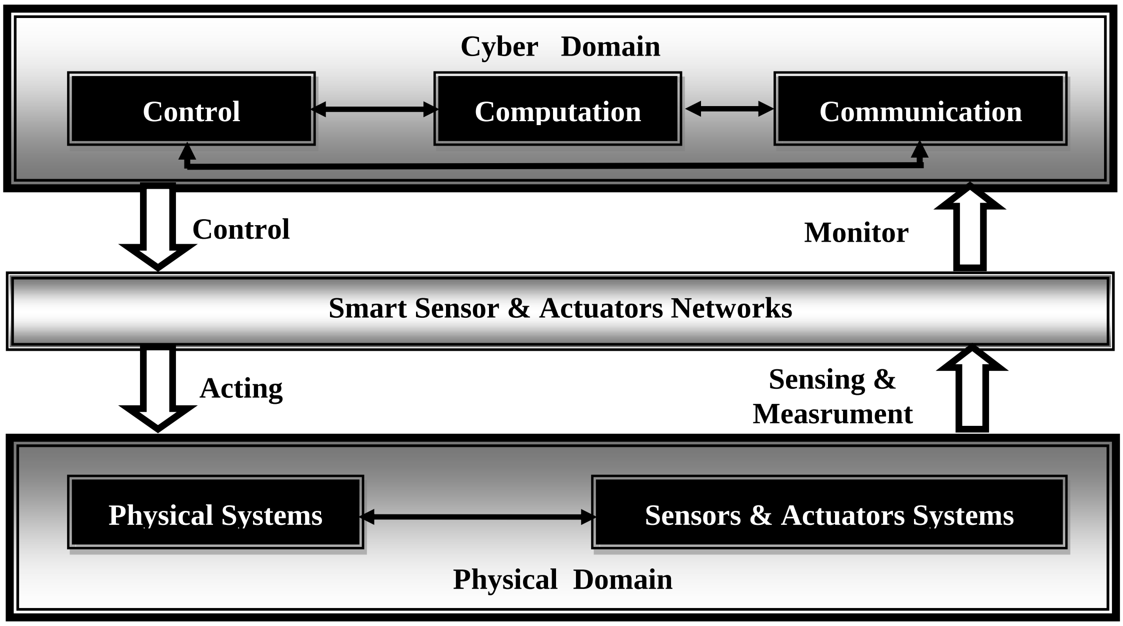

Figure 2. Diagram Block CPI/CPS
Source: [25]

The cyber component works in the process of computing, communicating and controlling of data that is monitored from smart sensors & actuators networks. Computational results are used to control and communicate with physical systems. Sensors are installed to detect and measure physical parameters into digital signals that are ready to be processed by cyber systems. On the other hand the actuator is installed to carry out actions to the physical systems. Cyber systems share information from sensor networks and access available data and connect to digital networks, which became known as the Industrial Internet of Things (IIoT). Reference [4] show “cyber physical systems through technology based on the integration of wireless systems, wireless control systems, machine learning, and production-based sensors”. CPI or CPS has become an industrial backbone with a new platform from the era of industry 4.0.

CPI integrates embedded systems that work in real time based on knowledge, artificial intelligence, IIoT [4],[1],[5],[6]. CPI works to connect, communicate and interact autonomous and cooperative elements in real time in every situation, at all levels of production, machinery, manufacturing processes and logistics networks. CPI later became an important part of the Cyber Physical Production Systems (CPPS) used in industry 4.0. In industry 4.0, manufacturing systems can monitor all physical processes known as "digital twins" or "cyber twins" from the physical world. CPI can make smart decisions through real-time communication and cooperation with humans, machines, sensors, actuators and industrial internet networks [5]. CPI is a digital infrastructure and intelligent factory.

Embedded systems in the form of small computers commonly called microcontrollers are assembled in a printed circuit board. Many embedded systems are equipped with wireless communication technologies such as Bluetooth, Infrared, Wi-Fi, ZigBee, Z-wave, Lo-RA, Radio Frequency Identification (RFID), Real Time Location Systems (RTLS) and others [16].

Sensors that are widely used include proximity sensors, magnets, inductive, capacitive, thermocouples, thermostats, thermistors, optocoupler, limit switches, push buttons, analog V, ultrasonic, pressure sensors, speed sensors, humidity sensor etc.

B. Training Kits

The conventional theory of learning facilities states "Effective vocational training can only be given where the training jobs are carried on in the same way, with the same operations, the same tools, and the same machines as in the occupation itself" (Prosser Theorema). This theory confirms that vocational training requires training kits tools. A CPI training kits contains all CPI components and CPI training instructions. Training jobs must be compatible with CPI operations so that the effectiveness of vocational training is achieved.

Training kits are needed according to training needs. Gradually the needs of a training kits can be directed starting from the fulfillment of technological awareness, technological literacy, technological capability, technological creativity, and technological critism of technology 4.0. Vocational training must provide adaptation power to the new technologies. This is in line with the basic tradition of vocational training is to develop an understanding of new industries.

A good training kits can be assessed from several aspects, namely performance, engagement, interactivity, conceptual change, content, adaptability, technical reliability, serviceability, and learner navigation. CPI training kits need to be assessed in terms of their performance as learning kits, work stability (reliability), durability, durability, serviceability, conformance, conformity, features, features, neatness, satisfaction, and users received quality.

CPI training kits are composed of hardware and software as well as job learning devices. Job learning can be assessed from the clarity and organization of the contents of the material, the suitability or relevance of the content with the learning objectives, increasing insight, understanding and ease of use in practice.

C. Vocational Learning

Vocational learning is an important aspect in the use of CPI training kits. Vocational learning is related to work learning, acquisition of work skills and the development of creativity. *Vocational learning as any activities and experiences that lead to understandings of and/or skills relevant to a range of (voluntary and paid) work environments* [29],[28]. Experience needs to be gained through work activities in the appropriate work environment. Vocational learning is learning related to the world of work (work-related learning), related to produktivities and the future career skills. Vocational learning encompasses a variety of training and re-training as a process of finding work experience and mastery of work competencies for various types of jobs in industry 4.0 [29],[30],[31].

The development of vocational learning in the XXI Century needs to pay attention [13],[28],[31]:

1. What types of jobs are available;
2. incubation period for each type of work;
3. the capacity of the availability of job vacancies;
4. distribution of areas of employment needs;
5. how anyone can participate in the work;
6. how future career opportunities are possible;
7. what competencies (skills) are needed in work and career;
8. do they workers participate well in the work;
9. whether workers receive protection for security, health, education and welfare.

These are important things that need attention for job seekers and how they should learn to prepare themselves through Technical and Vocational Education and Training (TVET) at work. Changes in the types of jobs available, the distribution of job locations, and the accessibility of paid work also change. Job availability both type and location distribution becomes an important variable in the development of TVET. Industry 4.0 creates great opportunities for new jobs. New jobs require new competencies. In order to access new jobs, capacity building is a necessity. Autonomous in learning is an important key in the vocational learning process.

Work competencies training is important. Work competencies training is carried out to improve competency in adapting to new technologies so that they become more productive in work [13], [28]. Mastery of competence determines the continuity of one's job title. Job competency training aims to develop an understanding of the technology used in industry, work tasks in industry. So the competency training material is specific [30]. Competencies training will be effective if it is appropriate to the type of work to be performed. Job competency training develops one's personal capabilities with special skills according to job titles. Industrial workers are required to carry out self-transformation through training so that the skills possessed match the needs of the work [31], [30]. Competency training for industry 4.0 requires appropriate training kits. Competency training will be effective if the equipment used to practice is the same as the tools and machines used at work.

III. METHOD

This research is research by project. This research used the research and development model of the waterfall life-cycle 7 steps. The final product of CPI training kits is researched and designed using seven steps viz: (1) infrastructure preparation, (2) design analysis, (3) systems design, (4) parts production, (5) assembling processing, (6) firmware production, (7) systems evaluation. Figure 3 shows the waterfall life-cycle procedure model. These seven procedures contain design detailing, debug processing, and testing.

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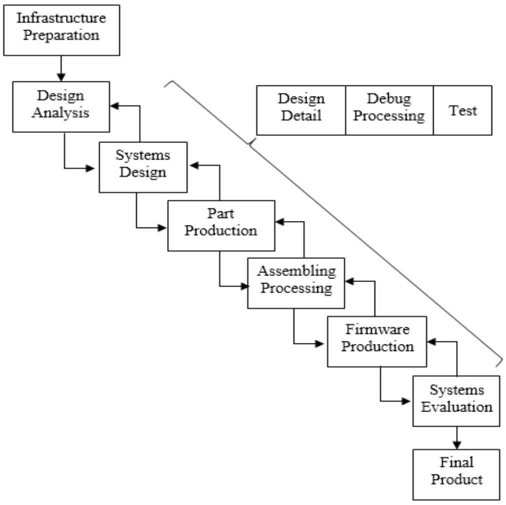


Figure 3. Model of Waterfall life-cycle Training Kits Design
Source: [32]

The final product trial uses three stages: (1) media and material expert test, (2) small group test to 10 students, (3) field test to one class of 27 students. Data collection uses industry surveys, questionnaires, documents, and questionnaires. The quality of the final product is measured using criteria 8 namely: Performance, Feature, Reliability, Conformance, Durability, Serviceability, Aesthetics, Preceived quality.

The quality of CPI training kits content is assessed from the content of the material, the consistency of the material with the learning objectives, describing the real and complete needs of the CPI, expediency. While in terms of learning media the quality of early CPI training kits; from attractiveness, ease of understanding, growth of motivation, interactivity, stimulation, technical reliability. Data were analyzed using percentages by criteria as table 1 below.

Table 1. Criteria of Qualification Product

Number	Grade (%)	Qualification
1.	76 - 100	Good
2.	51 - 75	Fair
3.	26 - 50	Poor
4.	0 - 25	Very Poor

IV. RESULT AND DISCUSSION

A. Design Training Kits CPI

The design infrastructure used in designing CPI training kits is twofold: Isis Proteus Professional and Corel Draw. Survey data from 15 industries found 62% of industries use robotic production systems, mini PCs, PLCs, sensor systems, sliders, hydraulics, pneumatics, RFID, RTLS, and people as operator. Whereas 56% of industries use AC motors both 1 phase and 3 phase and display systems. Analysis of CPI training kits needs to conclude the need for systems builders, among others: (1) the processor systems model PLC, mini PC, and microcontroller; (2) a timer-counter controller with PID; (3) sensor systems; (4) AC, Servo, Stepper, Cylinder, Palve, motor actuators; (5) monitor display; (6) RFID and RTLS; (7) data communication systems; (8) internet.

Combining the elements of CPI training kits is done by breaking down from existing elements into real parts on the market. This is so that the parts in the training kits resemble or are the same as the parts used in Industry 4.0. Table 2 shows parts for CPI training kits in Industry 4.0.

Table 2. Elements and Parts of Design Training Kits CPI for Industry 4.0.

Element	Part
Processor	PLC, Timer, Counter, Arduino mega2560
Sensors	Proximity, Magnet, Thermocouple, Thermostat, Thermistor, Optocoupler, Limit Switch, Push Button, V Analog, Ultrasonic, Pressure Sensor, Speed Sensor, humidity sesnsor, RFID, RTLS
Actuators	Motors, Lamp, Heater, Relay, SSR, Driver motor, Converter 24V-5V
Display	LCD, LED, Lamp indicator
Communication Modules	Ethernet, Bluetooth, Max232, Max485, SD Card, Access Point

All parts summarized in Table 2 are constructed into a CPI Training Kits board as shown in Figure 4. The board construction uses the principle of adjacent stacking as related parts, is easy to operate, works stable, sturdy and strong, is aesthetically pleasing and safe to use.

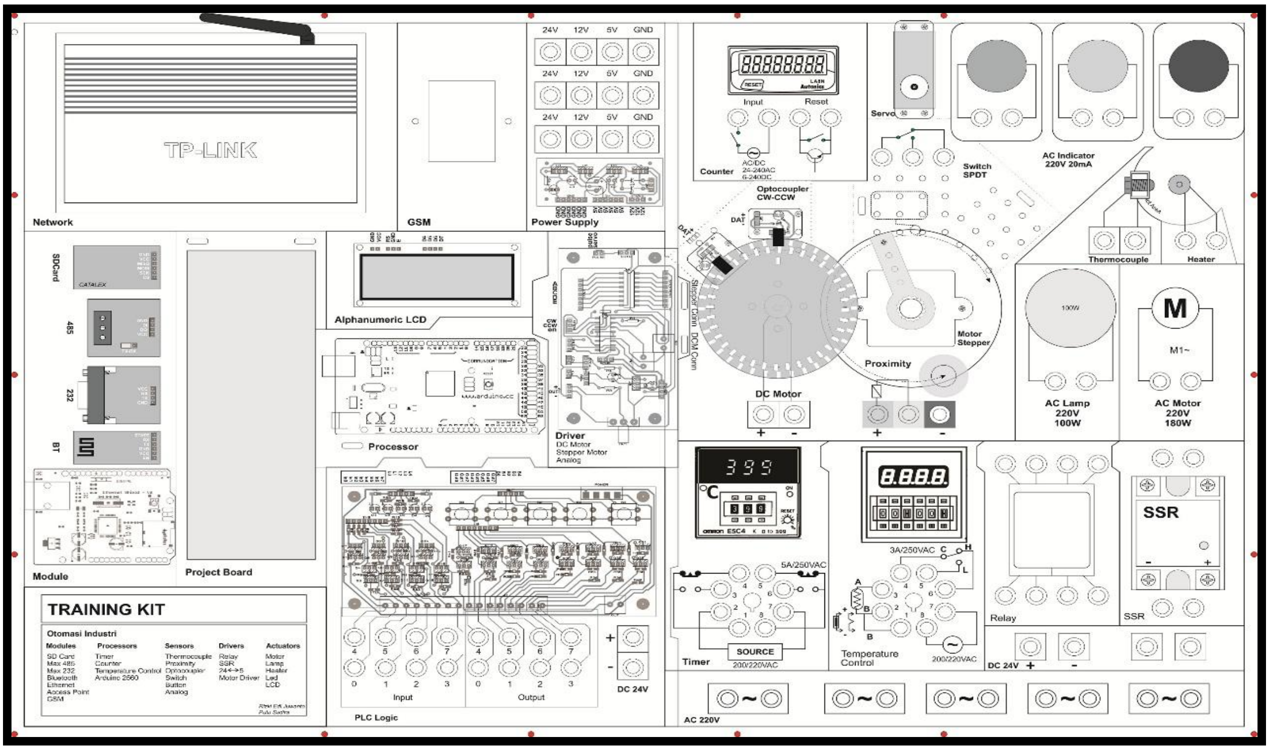


Figure 4. Design Board of Training Kits CPI
Source: personal document

Part training kits are made of acrylic according to design, label, frame. The part assembly process starts from attaching labels to the acrylic, mounting it to the frame, arranging all parts into one CPI training kits unit. The next step is making firmware. Firmware is made to run part functions in training kits using the processor as a controller. Firmware made include: (1) AC Motor Speed Controller; (2) DC Motor Speed Controller; (3) RPM meter; (4) RS232 / 485 & LCD; (5) Stepper & Proximity; (6) Servo & Bluetooth; (7) Web Controller; (8) Data Logger.

B. Performance Test

The test of CPI training kits design is done by testing the performance of each part in the form of measurements and simple experiments. Timer on delay testing is done by comparing the results of the time calculation on the timer part with a stopwatch as shown in Figure 5. The test results show the timer and lamp indicator are functioning well.

Figure 5. Timer on Delay Testing
Source: personal document

Temperature control, thermocouple, relay and heater tests are carried out by activating the heater controller where the set point temperature is determined. When the temperature is below or equal to the set point, the heater is on and if the temperature is above the set point, the heater is off. Figure 6 shows the testing of temperature control, thermocouple, relay and heater that has worked well.

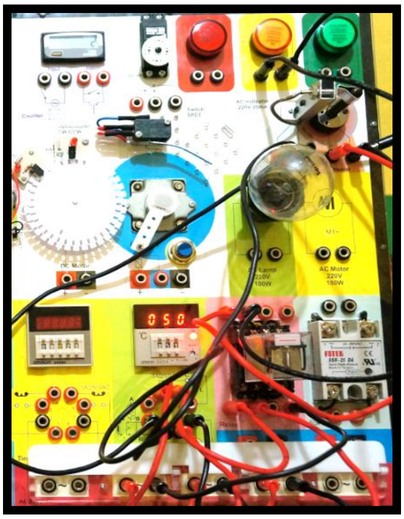


Figure 6. Temperature Control, Thermocouple, Relay, and Heater Testing
Source: personal document

Counter and Push Button is tested through the reset button pressing so that the counter counts the number 0 and after the counter is released, the counter works to count or count the numbers. Figure 7 shows the counter testing model in the CPI training kits.

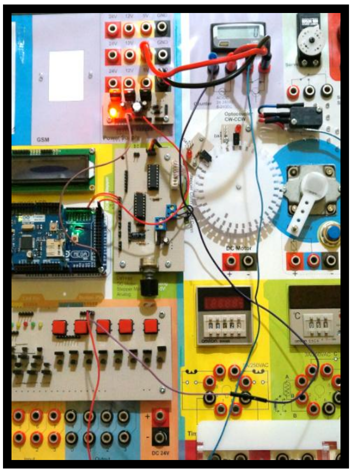


Figure 7. Counter and Push Button Testing
Source: personal document

Arduino, Analog Input, Solid State Relay (SSR) and AC Motor testing are done by programming Arduino as an analog voltage reader and output voltage regulator in PWM. Analog input is used as a reference PWM pulse width regulator. PWM signals are used to trigger SSR. SSR output is used to cut off power lines on the AC motor. So that when the analog input is turned on, there will be a change in the speed of the AC motor. Based on the results of Arduino experiments, Analog Input, Solid State Relay (SSR) and AC Motor can work well. The speed of the motor can change based on the rotation of the analog input potentiometer and the SSR indicator can light up while the SSR is working. Figure 8 below show the testing of Arduino, Analog Input, Solid State Relay (SSR) and AC Motor.

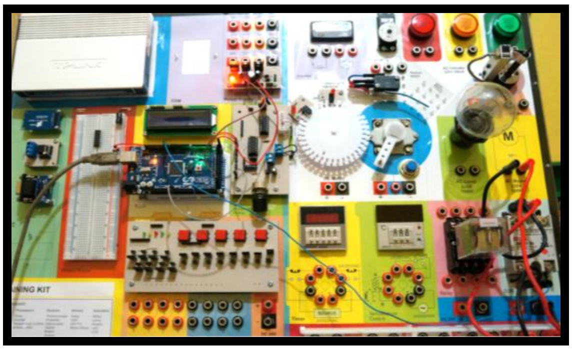


Figure 8. Arduino, Input Analog, SSR, and Motor AC Testing
Source: personal document

RS 232, 485 and LCD Module testing is done by setting Arduino as the sender and receiver using the RS232 line and 485 results are displayed on the LCD. This test was tested to communicate with computer devices. Data of sending and receiving is displayed in the serial monitor. Based on the results of testing the RS232 and 485 modules can work well. All are able to send data precisely. Figure 9 below is a series of tests and test results for RS232 485 and LCD modules.

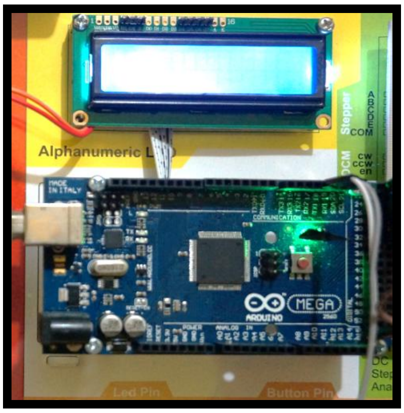
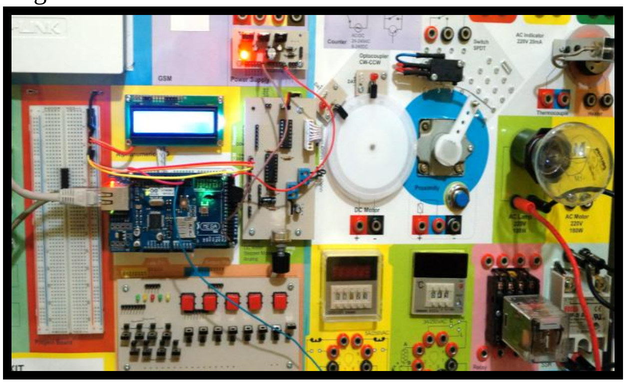


Figure 9. Modul RS 232 and LCD Testing
Source: personal document

Arduino Ethernet module testing is done by functioning as a server and used to control several sensor-actuators. Control of existing devices using the browser application by pointing to the server IP. Based on the results of testing the Ethernet module can work well, which can receive commands from the browser and display displays. Figure 10 below shows the testing model of the Arduino Ethernet Module.



Pigure 10. Ethernet Modul Testing
Source: personal document

The level of feasibility of the industrial automation training kits is tested through an evaluation process as a learning medium. The evaluation process is carried out in 3 main stages, namely evaluation by experts (expert judgment), small group evaluation and field testing. In each evaluation other than the field test revisions were made to the training kits based on expert input and limited test input. This revision was made with the intention that the training kits that was built becomes more perfect so that the value of the quality of the training kits can increase. The revision of the training kits is done repeatedly to get the best shape. Agreement on the form and structure with the expert becomes the design evaluation standard.

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The results of the evaluation of the test data showed that from the aspect of the content of CPI training kits included in both categories with a score of 76.7%. Even though the score of 76.7% is in the good category, it still requires the development of content to reach a score of more than 90. The processor, sensor, actuator, cyber systems still need to be upgraded. More content development needs to be considered is controller, sensor, actuator, computational model, control model and communication model.

CPI training kits are designed in a panel board consisting of processor elements, sensors, actuators, monitor displays and communication modules that meet basic needs as a training media. This is according to the score data from the media expert giving 85.4. The use of CPI training kits for training meets the criteria of the field test so that it is appropriate to use.

The design of this training kit is appropriate and meets the structure of a CPI consisting of cyber components and physical components [4], [25]. The processor element uses PLC, timer, counter, and Arduino mega2560 functions as a cyber component that works to perform communication, computation and control tasks. Physical elements are composed of Proximity, Magnet, Thermocouple, Thermostat, Thermistor, Optocoupler sensors, Limit Switch, Push Button, Analog V, Ultrasonic, Pressure Sensor, Speed Sensor, RFID, RTLS. Then actuator AC Motor, Stepper Motor, Servo Motor, Lamp, Heater, Relay, SSR, Motor Driver, 24V-5V Converter. Physical elements are also equipped with data communication modules such as Ethernet, Bluetooth, Max232, Max485, SD Card, Access Point. The CPI training kit design contains two main elements, namely the cyber element and the physical element. The CPI training kits design fulfills the main functions and meets the requirements stated in the studies [25], [4], [19].

Communication, computation and control capability according to opinion [25], [26], [4], [7] is the basic capacity of a CPI. The application of processors, sensors, actuators, displays and communication modules in a systems is a requirement of a CPI. The types of processors used in a CPI training kits can be selected and developed according to training needs and pay attention to suitability in use in related industries. PLC, mini PC, microcontroller capacity can be chosen as needed. Likewise, sensors and actuators can be adjusted as needed.

The arrangement of the processor, sensor, actuator, display and data communication module elements is arranged and arranged using its convenience approach to be assembled, tested, and observed. High safety requirements, dependability, distributed structure, interfacing with legacy systems, modularity and composability, validation and verification as stated in [25] are important to consider in the design of CPI training kits.

CPI training kits are effectively used as a training unit if they contain the same tools as the tools used in industry 4.0. Elements of a CPI training kit are in accordance with industry elements 4.0.

The training job sheet is also important to pay attention to its suitability with work tasks in industry 4.0. A CPI training kits is designed to build technology awareness, technological literacy, technological capability, technological creativity and technological critism [13],[28].

Awareness of industry 4.0 is related to understanding industry 4.0, which is having knowledge about industry 4.0. Furthermore literacy about industry 4.0 deals with comprehension on various technologies used in industry 4.0 [8]. Literation about industry 4.0 requires deepening through training on industrial technology 4.0. The use of CPI training kits is very urgent in the industry 4.0 literacy process. The design of CPI for industry 4.0 training kits strongly supports the process of vocational learning in industrial technology training centers. Through good literacy then one can have capabilities and be able to apply CPI technology in industry 4.0 [15].

Based on the characteristics of industry 4.0 where humanity in the loop of cyber physical production systems as one of the characteristics, the capability of humans as workers in Industry 4 is important to be developed through training [9]. CPI training kits strongly support these needs. CPI training is carried out through effective vocational learning. Workers or prospective workers are quickly able to adapt to new technology. Without increasing capabilities, workers in CPI technology will threaten the achievement of the new vision of industry 4.0 [12]. Specific training must be given to workers and prospective workers so that awareness, literacy, and capability are owned and can be utilized to work in an industrial 4.0 environment.

Performance, features, reliability of a CPI training kits are important to consider in making a design. CPI performance training kits have been tested by material experts, instructional media experts and potential users. This means that CPI training kits are suitable for use as training tools for developing competencies in the CPI field. A training kits in the training process does not stand alone. CPI training kits are used by instructors in the training process. So before using a CPI training kits must be trained in advance to prospective instructors. The instructors practice mastering the CPI content and then practice the pedagogical process to be able to convey effectively in a training process.

Performance, features, reliability and aesthetics of CPI training kits have been tested, but the durability and serviceability of CPI have not been tested because it takes a long time for this to be further tested. The ease of use has been tested and gives a good insight about Industry 4.0. Another thing that needs to be developed is the transfer of learning from CPI. The selection of strategies, methods, models and learning media that is appropriate to the CPI training kits is important to review next.

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V. CONCLUSION

The design of CPI training kits meets the technical and conceptual requirements of technology and vocational learning for Cyber Physical Systems competencies. CPI training kits are suitable for use in vocational education institutions and vocational training centers as learning tools and training tools in the field of CPS. CPI training kits can be used to practice: (1) operation of sensors, (2) sensor reading, (3) physical device monitoring, (4) actuator controlling and regulating, (5) programming control model, (6) data computing, data collecting from sensors, (7) data communicating through the internet network. The use of CPI traning kits supports the effectiveness of vocational learning in the development of community capacity, so that they aware with the development of industry 4.0, literacy towards industry 4.0, and then have the capacity and creativity to develop CPS technology for industry 4.0. CPI is the basic infrastructure as backbone industry 4.0 which is very important to learn with proper and good training kits.

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