

Implementation Concept of Industry 4.0 to Manufacturing

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Implementation Concept of Industry 4.0 to Manufacturing Industry in Indonesia in Order to Optimize Supply Chain Management

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Abstract. Common manufacturing Industries in Indonesia are labour intensive industry, paper-based information flow thus un-well recorded. This behaviour can't give real time and accurate information from shop floor which is important to make an effective production planned. This paper presents an approach to change the current behaviour by adding digital factor into the production process. The process to change the production process behaviour will be minor and focusing on the information flow. The process will be called digitalization process in this paper. The digitalization process can be categorized as an implementation of industry 4.0 concept. Information flow in digital based form will be easy to be distributed accurately and in real time. By knowing accurate information from shop floor in real time, a production process can be managed effectively in general and especially to optimize the supply chain management.

Introduction

The concept of Industry 4.0 was introduced for the first time in Germany during Hannover Fair event on 2011 which symbolises the beginning of the fourth industrial revolution [1]. The fourth industrial revolution is a continuous revolution after the 1st, 2nd, and 3rd industrial revolution and it is described as "smart factories" that creates a world in which virtual and physical systems of manufacturing cooperate with each other globally in a flexible way. Rapid changing of Information and Communication Technology (ICT) which create development in Big Data, Cloud Computing, Cyber Physical System (CPS), Internet of Things (IOT) are factors that support this possibility of smart factory [2]. This concept had been widely used to improve manufacturing process more effectively. Many ways to improve effectivity of manufacturing process depend on the current business process. This research will be developed to improve the effectivity of manufacturing process in common manufacture industry in Indonesia.

The most typical industries in Indonesia as a developing country are labor-intensive industries where the production process involves a non-automated machine and a lot of workers. Coordination between manual machine and human usually by paper-based which can be difficult to maintain the record. Production schedule usually using push system where the operator is targetted with certain amount to produce every day without considering the market. This behaviour could cause a lot of waste from overproduction, inventory, motion and so on. Waste means extra cost and needs to be minimized. The way to change the behaviour is by changing the information flow from paper-based into digital based [3]. This will be called the digitalization process. By doing this, all event in the production floor can be captured and all waste can be monitored and minimized. The digitalization process, in general, is to develop a monitoring system which will supply the information flow in real time.

This research focuses in development of production monitoring system for capturing real time operation data directly from the shop floor. By monitoring the actual event of the shop floor, the real time material storage can be determined. The supply chain management can then estimate the next

purchase order by considering the lead time of certain material. The development system will tell when the material will be used and how many required. With good recording, the supply chain management can make better evaluation and decision of all supplier for current and next project.

The concept of Industry 4.0 will be implemented to develop digitalization process of the monitoring system [4] [5]. By incorporating Internet of Thing, Cloud Computing, Big Data, and Cyber Physical System, this research develops an architecture of monitoring system that suits common manufacturing industry in Indonesia. On the digitalization process, the physical system will be modelled as a virtual system. This virtual system will be the system to be monitored. The next chapter will explain about the development of the system.

Model of Monitoring System

To develop the digital monitoring system, a virtual system needs to be modeled. The virtual system is digital based which is mapped from actual physical system. For modeling the virtual system, the shop floor will be treated as a black box, a single system which is separated from supplier and customer system. The shop floor consists of several workshop. The blackbox also can be rescaled to lower level as a workshop. Supplier and customer from a workshop could be another workshop from the same shop floor. The relation between workshop, supplier, and customer system is shown in figure 1. The dashed arrows are information flow which is also treated as order lines. The solid lines are material flow. Supplier, workshop, and customer are considered as three different systems. This research will focus on workshop system only. Material flow and information flow from supplier and customer will be treated as input to the workshop system.



Fig. 1. Relation of material and information flow

A workshop consists of several elements. In this research, the elements to be monitored are operator, material, and operation which is activity to increase material added value. A workshop also has several workstations forming a certain production line which is a material flow sequence from one workstation to another. Each workstation has a specific operation. The sequence of material flow can be seen in figure 2. The dashed line is for the material flow, and the solid line is for the operator movement. An operator can be dedicated to a certain workstation or can work on several workstations, thus the operator is made in and out to/from the workshop. The abbreviation “ws” means workstation and “Op” means an operation in each workstation.

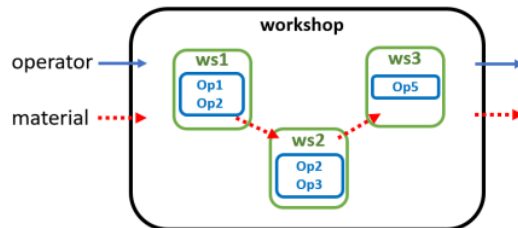


Fig. 2. Material flow in a production line

To generate an operation for each product, a certain process for each material flow should be input to the system library. Another information which is required is the material type before and after the process, this will be saved as product structure as input to the system library. This product structure then connects to material library to call the material type. Certain process only can be done

in certain workstation, thus workstation library will be required. An operator library is also required and connected to the virtual system. All these libraries supply the attribute information to the operation table in database.

The order from the customer system will inform the workshop system that certain model of product with certain amount and due date is needed. This information is a trigger to generate all operation that is required to form products and will activate works in the workshop. It means the workshop will produce products only by customer order and will generate order to supplier. The information flow of the virtual system can be seen in figure 3. Operation will have all information that can be connected to each element of workshop, customer and supplier system.

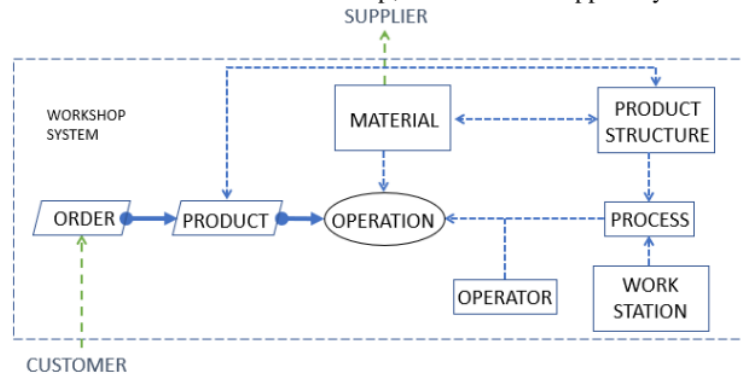


Fig. 3. Information flow in virtual system

Digitalization Process

Digitalization process will use Cyber Physical System concept from Industry 4.0 to bridge between the virtual and physical system [6]. Each element that need to be monitored in figure 2 will be mapped one by one to the virtual system. Operator will be equipped with RFID card which contains the operator ID. Operator need to tap the RFID card to RFID reader when go into or out from workstation, so that operator attendance can be monitored frequently. Material will be equipped with barcode sticker which contains the material serial number. Materials can be defined as raw material that comes from supplier as a solid component or bulk to be processed or a product after passing certain operation in each workstation. Material as a product will also have a barcode which contains its product ID. The barcode will also need to be scanned through the barcode scanner when enter to or leaving out from workstation so the material position can be monitored in real time. Actual operation will be monitored from start to finish through the LCD touchscreen monitor so that the real time operation and the duration can be determined. The physical devices will be connected to controller to be processed then the data will be sent to cloud server via Wi-Fi. The connection between workstation and server is established using the internet network. The schematic of how physical devices being connected is shown in figure 4.

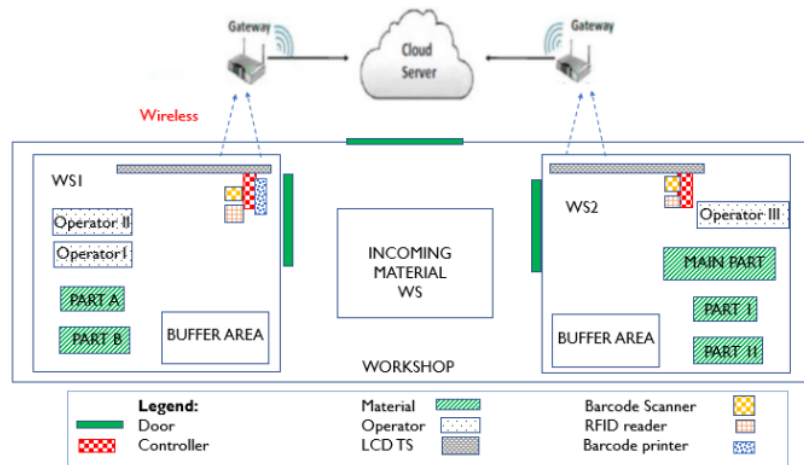


Fig. 4. Schematic of physical devices to digitalize the production element into virtual system

Figure 4 shows an example of mapping physical system to virtual system which consist of two workstations. Both workstations have physical devices which almost similar except one has barcode printer and the other does not. Barcode printer is required to print new barcode after certain operation is finished, but not all operation require new barcode after finish. It means the product ID will use the previous product ID, usually from the main component. In this development phase, each workstation is not communicating directly. Information among each workstation is sent to a cloud server which can be a local or centralized server depend on the internet connection coverage. The operation schedule are generated from this local server to each controller in each workstation if there is an order. However, the actual operation needs to be triggered to the system so that the actual condition of the physical system can be updated to virtual system regularly.

When an actual operation is started, an operator needs to press the start operation button triggered event on the interface through LCD touchscreen which will inform the virtual system to be updated. The database in the virtual system will update the material stock by reduce the stock from amount of material needed for the certain operation. This concept will update the material stock regularly so that the actual stock can be monitored in real time. After the actual operation is finished, operator also needs to press the finish operation button triggered event on LCD touchscreen to update the virtual system. When the system recognize that an operation is finished, it will update the product finishing progress status and jump to the next operation to finish that product. The system also will also inform what materials required for the operation in advance so that the warehouse can send the materials in time which means reduce waste of waiting.

Shortly, mapping the physical system into virtual system in digital based will not change the current production system significantly. Several physical devices might need to be added as little as possible without disturbing the current production system in shop floor. The physical devices consist of several sensor to authenticate or recognize the production element into virtual system such as material and operator. Actual operation from the physical system will be mapped into the virtual system through button triggered event on the LCD touchscreen.

The virtual system consists of database which can be processed further to gather useful information which required to improve the effectivity of current production process. Information about the material history from raw until becoming a product will be a benefit to improve the supply chain management. Next chapter will explain about how the information from virtual database can optimize the supply chain management.

Optimize Supply Chain Management

Current monitoring system was developed for workshop system only. However, information gathered from the activity of the workshop in real time can be used to optimize the supply chain management. For example, once customer order had been made the system will inform if there is in need to request new purchase order. Table 1 shows an example of material request based on order needed.

Table 1. Purchase order that autogenerate once there is customer order coming

	Materialtypecode	Onstock	needed	status	purchaseOrder	unit
1	A04CU0635	60	75	need order	15	METER
2	B51VA0195	1	20	need order	19	EA
3	B52TH0249	5	20	need order	15	EA
4	B52TH0654	9	20	need order	11	EA
5	B52TH0773	5	10	need order	5	EA
6	B40AK0001	2	20	need order	18	EA
7	B40AK0002	2	10	need order	8	EA
8	B50AK0002	3	5	need order	2	EA

All information within the system are supplied in real time. A strategy can then be developed so each material will be treated efficiently and minimize waste. It will reduce burden in stock cost. Each material and product finishing progress also can be monitored. Figure 5 shows how stock and position of certain material can be monitored accurately and in real time. This information will help supply chain management to develop strategy to ensure correct amount of stock is sufficient without causing excessive stock.

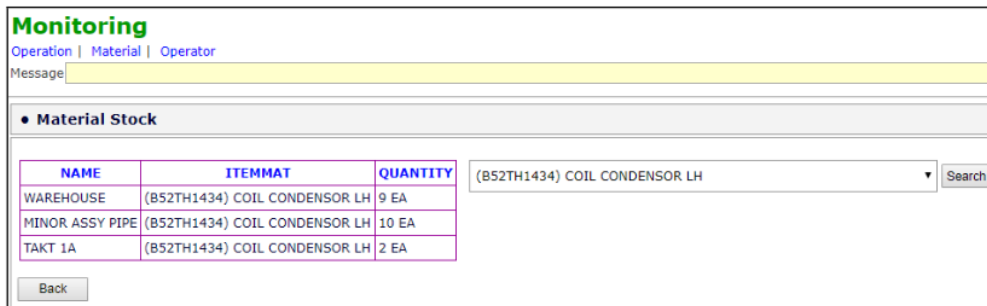


Fig. 5. Display stock information of certain material

With the new development system in place, information needed to manage the supply chain management will be more accurate and in real time. There will no need for excessive stock just to meet an unpredictable order. Once each material had been recognized with barcode and all activity in the shop floor also continuously monitored, the forecast will be predictable. By evaluating the actual production process for certain time, the minimum stock for each material can be predicted to reduce the stock cost. Supplier performance also can be evaluated to negotiate current or future contract.

Conclusions

This research explains about the implementation of Industry 4.0 in manufacturing industry and the beneficial from the supply chain management side. The main influence of implementation of Industry 4.0 technology is the digitalization process that change the behaviour of information flow from paper based to digital based. The digitalization process target is to develop a monitoring system which will supply the information flow in real time.

Many information can be gathered from this development system. By knowing the real time condition on the shop floor, operation schedule can be managed accordingly to improve productivity and effectivity of the production. Materials do not need to be stocked excessively anymore when the actual stocks are monitored transparently. Production forecast can be predicted from operation history which is recorded in database at all time. Minimize the material in stock will reduce the burden from stock cost that can optimize the supply chain management.

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