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Integrating Blockchain Technology for Air Purifier Production System at FIM Learning Factory

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Abstract

This paper focuses on the use of blockchain technology in the production process of the air purifier through a learning factory collaboration concept, which emphasizes more on the academic and industrial liaisons for innovation and development among partners. The partners agreed to use learning factory concepts through collaboration between academia and industry for the production planning and design, plant automation, execution, maintenance, services, and quality enhancement. Moreover, it has also described the rationale for using blockchain technology for the production of air purifiers and the strategies of the supply chain activities incumbent for the manufacturing processes of the air purifier. Furthermore, for supply chain activities were integrated with the blockchain technology in order to identify the blocks and data during the process flow. This paper also explains a synchronization process flow and integration for the smoother operation of the manufacturing processes of the Air purifier using blockchain technology. Potential industrial challenges of the Air purifier construction and development have been highlighted. The review results indicate the significance of using blockchain technology to meet energy needs around the globe; it will give new directions and philosophies to the industrial processes of manufacturing high-quality cost-effective Air purifiers efficiently and effectively, fulfilling the needs and expectations of the customers.

Keywords: *Blockchain Technology, Learning Factory, Air Purifier*

1. Introduction

Most of the companies in the world are using computerized enterprise resource planning (ERP) technique to be connected with the latest operational strategies (Andrianto, 2019; Ashraf, 2019). Computerised techniques are used to track the products right from its origin till the waste generated. Despite of huge investment in the technological infrastructure by the companies, still there is lack of insight and visibility on tracking of the product at the right time. The main reason, in such cases, are the analog gaps that exist between systems within enterprises and across enterprise boundaries (Berić, Stefanović, Lalić, & Ćosić, 2018; Ashraf, 2019). This problem can be tackled via the use of the blockchain technology, which offers both socio and technical aspects of human-machine interaction.

It has become increasingly recognized within the manufacturing sector that there has been a shift towards collaborative partnerships in order to enable organizations to remain at the forefront of their industry (Terminanto & Hidayanto, 2018; Ally & Wark, 2018). Digital innovations with increased connectivity can be generated through new advanced technologies and strategies that changes the customer demands with more collaborative models. As a result, the traditional linear contracts individually linking participants in the supply chain are reducing, making way for more flexible multi-party behavioral contracts

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to account for new co-operative commercial relationships. The shift towards collaboration in manufacturing is a major development for the sector and one which requires organizations to place greater consideration on how the changes affect their business (Prieto, et al., 2019). In the same way, the educational industry has turned the biggest dynamic service industry around the globe; therefore, it is expected to fulfill the needs of the dynamic challenges and provide possibilities to their valued stakeholders. Stilled and traditional labs have been transformed with their latest processes, models, methods, and techniques to qualify the customers and stakeholder's requirements and expectations using the concept of a learning factory. It provides hands-on experiences to the graduates to tackle real-world challenges and provide better insight for their solutions. The learning factory combines manufacturing concepts and processes, simulation software, virtual and augmented realities, and prototyping, which equip the learner to better comprehend the concepts and industrial processes. Students get hands-on experience on different industrial models, methods and processes after comprehending theoretical concepts in the classrooms. Apart from that, students get access to industrial machinery and processes to input new ideas using blockchain technology and supply chain management processes. Besides this, the learning factory also helps to increase the employability of the graduates, commercialization, industrial liaisons, and university earnings.

Industrial liaisons can also be increased among academia and industry. Similarly, one module of the learning factory is blockchain technologies which have proven records in sustainable supply chain management and smart manufacturing processes (Ashraf, 2019; Andrianto, 2019). In the meantime, a new paradigm of sustainable or green manufacturing emphasizes that all the aspects of manufacturing processes should address the triple bottom line of sustainability (Waris et al., 2019). Blockchain technology is used for sharing information with project groups because industry 4.0 may not work without information sharing. The student is also taught to use initiatives from blockchain to get an order from the customer, get helps from the historical benchmarked data, process, models and methods to deliver good quality-tested products. For these reasons, this paper proposes a learning factory for air purifier manufacturing using blockchain technology for smoother and smarter production processes and smart manufacturing. Learning factory and blockchain technology have the capacities and capabilities to comprehend the production and smart manufacturing processes within the learning organization among the learning partners.

2. Air Purifier Production Process

The flow of the production process of the Air purifier is provided in Figure. 1. The production of Air purifier in the learning factory of Universiti Malaysia Pahang (UMP) was initiated by product design, product planning, and control. This process includes the design of the product, market study, and capacity planning. Once the product design has been finalized, the materials were sourced through warehousing with quality control. In this process, material storage and supply to production quality-tested followed using the Kaizen model. The next step is the production of the material as planned in line with quality assurance. After the production process has been initiated from Workstation 1 (WS1) till WS9, the quality control personnel conduct the testing on the finished product to ensure compliance with quality requirements before been sent to the customers.

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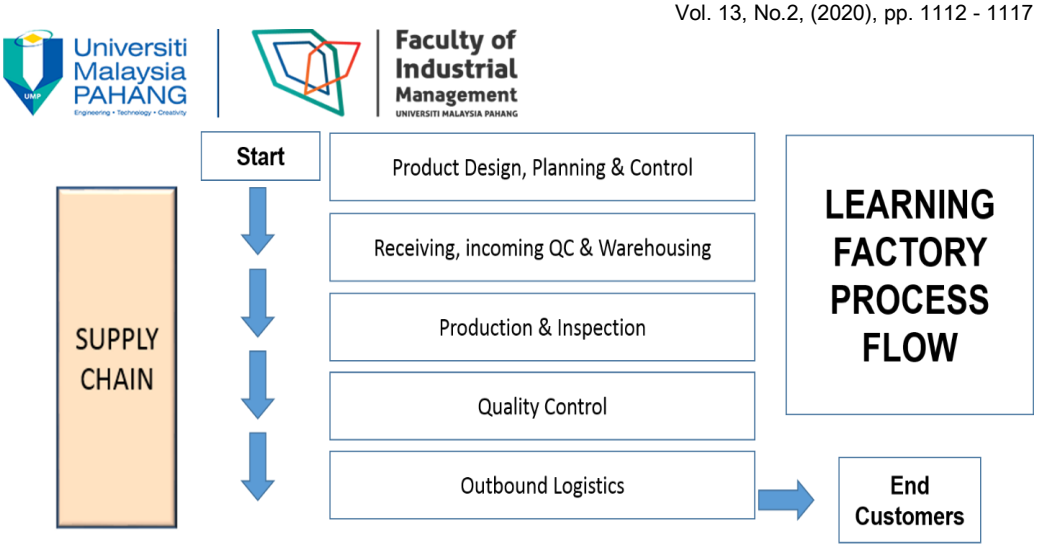

Fig. 1. Learning factory process flow at UMP

After the check for quality, the finished goods are stored and packed before shipping to the customers. The final stage of the supply chain is the outbound logistics that focuses on arranging for the transportation of the products to the customers, as well as preparing the necessary documentation declarations. The whole production process of the Air purifier was conducted by university students based on assignments given in the learning factory.

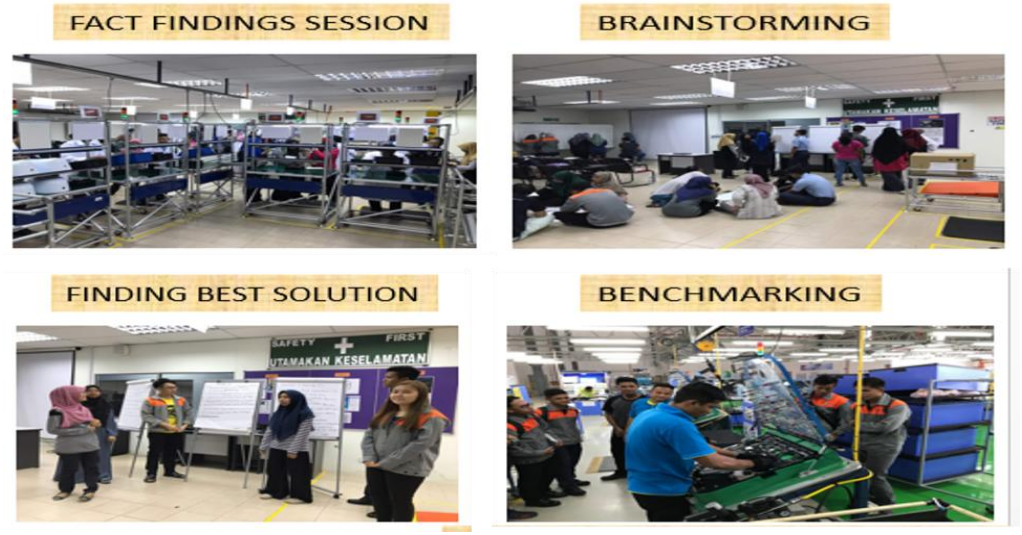

Fig. 2. Students demonstrating real Air Purifier assembly in the UMP learning factory

Figure 2 demonstrates the teaching-learning processes as used in the UMP learning factory. The students are exposed to different tools and processes in the learning factory; they do the fact-finding sessions, brainstorming, devise different solutions to product development, select the best feasible, optimal, and viable method among alternatives, and compete for the product development, testing, and delivery.

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The students are provided with industrial learning concepts in the classrooms to fill the learning gaps. They are taught gorgons, graphs, and processes that will be applied in the learning factory. The students were enabled to use the learning factory as a platform to play around with the machine and note the cycle processes, as well as to apply their experiences and tacit knowledge to learn more out of the box. The students were evaluated by assigning them with different projects on product development which they are expected to break down and calculate the cycle times.

3. Integrating supply chain with blockchain process flow for Air Purifier manufacturing

The integration of supply chain with blockchain was opted for the smart manufacturing processes by the learning factories of the partner organizations. Blockchain technology has proved its utility in data management, record-keeping, ledger, and supply chain management in Industry 4.0 Standards. Process flow using blockchain forms a natural foundation for the manufacturing and supply chain activities. As shown in figure 3, each supply chain process for air purifier manufacturing are integrated with the blockchain technology to trace the independent blocks and data. However, there is challenge to integrate blockchain with supply chain processes. There can exists ethical issues and can also be vulnerable while integrating supply chain with blockchain. Publicly accessibility of the data might not be desirable for the manufacturing processes. This blockchain network can smoothly handle the production processes of the air purifier and other smart manufacturing devices and can remove the design, manufacturing, supply chain, and assembling processes through the sharing of expertise and specialties.

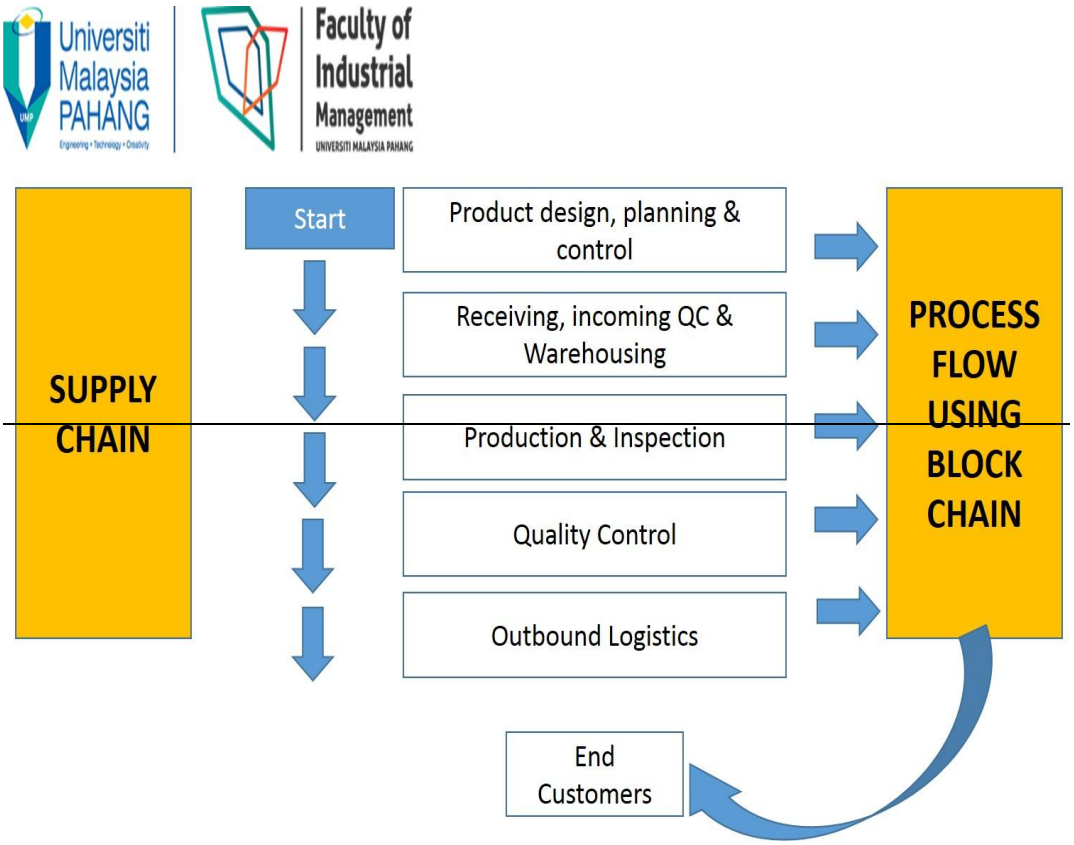

Fig. 3. Integrating supply chain with Blockchain technology for air purifier manufacturing in FIM learning factory

4. Blockchain Technology in the Learning Factory: Challenges and Opportunities

Blockchain technology can help in effective collaboration and enhancement of the efficiency of learning factories as it is distributed, immutable, transparent, and trustworthy databases shared by a community; it can also influence sustainable supply chain networks. The learning factory can be used as a base for the supply chain using blockchain technology. Students gain knowledge on how different materials are processed into polished products; they use software for making prototypes and develop Standard Operating Procedure (SOPs) to maintain product uniformity, retain products, and repair them as well. They also gain knowledge about the procurement, storing, and assembling processes. Through these processes, students can develop new ideas and design new products using 3D printers. For product planning and control, case studies are given and based on that, they are expected to focus on the development of the product. For instance, a transparent record of product history assures buyers that goods being purchased are supplied and manufactured from sources that have been verified as being ethically sound (Andrianto, 2019). Smart contracts may be required for tracking and controlling sustainable terms and regulatory policies autonomously, as well as for enforcing or governing appropriate corrections. Openness, transparency, neutrality, reliability, and security for all supply chain agents and stakeholders can exist in this technological context which can serve as the platform for the effective functioning of the learning factory (Ally & Wark, 2018).

We have encountered many issues pertaining to the adoption of blockchain technology in the learning factory. First and foremost, the integration posed some hurdles because such production has never been executed using blockchain technology. Technical specifications, such as the speed of processes, scalability, coding, and efficiency of the existing materials need to be considered for an effective blockchain technology adoption in the manufacturing process.

5. Conclusion

In this paper, we have presented a framework that identified the importance of learning factories to bridge the gap between industry and academia. By implementing blockchain technology in the learning factory for the manufacturing of Air Purifier via the integration of supply chain activities, the skills of the students can be enhanced through industrial collaborations. The industry will get skilled workers in the field by the time such students graduate. Industrial collaboration and a proper system are needed to start a learning factory concept. Some of the procedures discussed in this paper include the processes, facilities, and curriculum. The importance of the learning factory and the overall world was also discussed. Although blockchain technology has great potentials as modern technology in the manufacturing process, there are technical challenges like scalability and security issues related to it. Large blockchain means more storage space that leads to centralization; thus, strong optimization and redesigning of blockchain have been proposed to solve the scalability issue of blockchain. Though there are tremendous benefits of learning factory, its implementation and processing are a complicated process. It not only involves great human effort but also requires high investment; but being a future investment, it is expected to pay back more than expected. The key issue is to deal with the financial resources and management of student mobility which will also involve travel expenses. Likewise, projects may also involve living expenditures; hence, we must properly set credit hours, equipment, systems, and diversity. There are different levels of this system as well; therefore, academia must identify the level of students and the project complexity as a mismatch between these will bring drastic results.

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