A Preliminary Study of IoT in Smart Manufacturing Management and Product Integration Services

Yao-Chin Lin, Ching-Chuan Yeh, and Wei-Hung Chen

***Abstract*—This study is to improve the management of smart manufacturing process in industry 4.0, and to development smart products in the IoT series of connected factories. After the customer places an order, cooperate with the design department to package the advanced application of the package, so that customers, companies and third parties can pass the company's current design of the organization and components has been completed. And the collaborative design mechanism is used to confirm the customer at the same time. The IoT real-time monitoring function allows the customer to know the current status of the product at any time. On the other hand, IoT can also assist the company's manufacturing department to control the product immediately. The purpose of this study is to explore the application of the IoT in the integration of factory smart manufacturing management and product integration services.**

This study used a case study method to explore the impact of the implement of IoT from the Solen Company's factory. The results of the study, after implementing of the IoT in the case of intelligent manufacturing which is the most important impact on product integration services is "real-time", and the impact of product integration services through the "process change" was improved. Therefore, this study proposes "product integration services 2.0 model". Finally, the theoretical and practical implications are discussed, in the future research recommendations are proposed.

***Index Terms*—IoT, smart manufacturing, product integration services.**

I. Introduction

This study is based on the company's research, the main purpose is to enhance the company's intelligent manufacturing process management in the industry 4.0, the intelligent manufacturing of the Internet of Things (IoT) tandem factory. According to the product integration services model [1], after the customer orders. The design department's turnkey service advanced application enables customers, companies and third parties to use the company's current design of the organization and components. Then through the collaborative design mechanism to confirm with customers at the same time, with the IoT real-time monitoring function to customers can always know the current status of the product. On the other hand, IoT can also help the company's manufacturing department to instantly control the quantity, quality and other information of the product. The latest "IoT equipment" from the company has this part. The monitoring function, together with the Taoyuan Government's plan to build the "motor professional park", introduces the latest equipment, and enabling the application of the IoT in the factory smart manufacturing management and product integration service model.

According to the above, after the smart manufacturing management mechanism, the company has two major benefits. First, in the process management: it can increase the company's performance in e-commerce, develop the effectiveness of IoT, and the advanced application of the product integration service. Second, in the decision support area: the company's headquarters that is the core of the operation headquarters. The decision-making function is enhanced through the information system function and the smart manufacturing mechanism. Third, in terms of production incentives: the intelligent evaluation of different production lines can be enhanced to benefit the company and economic decision-making reference. Research questions are as follows:

1. What does it affect product integration services after implementing IoT in the case of smart manufacturing?
2. What is the impact of the product integration services process after the IoT implementing?

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II. Literature Review

A. IoT and Smart Manufacturing Management

In terms of smart connectivity, it combines Cyber-physical systems (CPS), Internet of Things, big data, cloud computing, and intelligent management which is including Enterprise Resource Planning, Supply Chain Management, Customer Relationship Management and other systems, as well as smart integration of vertical integration and horizontal integration.

In addition, the research proposes a smart service development framework, which is a smart service application based on web networking. Through IoT technology, it can operate and remote fault tracking, show customers the requirements of machine productivity, save time and sustainable resource optimization and other functions [2].

The Internet of Things means no infrastructure communication, devices are ubiquitous, smart, powerful, connectable, smaller, cheaper, and easier to deploy and install. This opens up a new future direction for the information and communication technology (ICT) community. Today, the Internet of Things, defined early as machine-to-machine (M2M) communication, has become a key issue in the ICT world and research [3]. The study pointed to three IoT categories that enhance customers' enterprise applications: monitoring and control, big data and business analytics and information sharing and collaboration. Five IoT technologies

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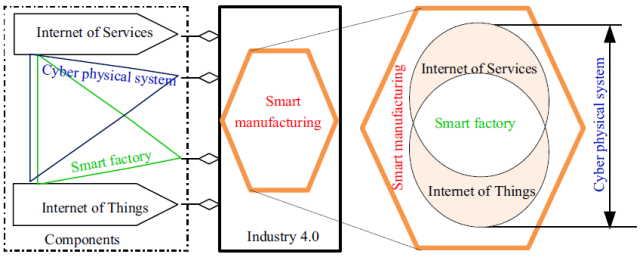
and management challenges: data management challenge, data mining challenge, privacy challenge, security challenge and chaos challenge [4].

CPS are receiving more and more attention in integrating the network technology into the physical process, and the huge potential of the next generation intelligent system. CPS did not launch any smart factories or smart manufacturing. Instead, smart factories introduced IoT in manufacturing and later became a key part of Industry 4.0. Details are shown in Fig. 1 [5], including internet of services, smart factory and internet of things.



(a) Four key components of Industry 4.0 **(b)** Smart manufacturing in Industry 4.0

Fig. 1. Key factors of smart manufacturing [5]. This study uses the intelligent manufacturing system architecture, taking Solen Company as an example. In the "motor professional park", the company's motor production line uses IoT equipment technology to achieve the application example of the IoT in the factory.

B. Product Integration Services

Mastering management activities in the product development process is considered a key competency. Research findings indicate that some management practices can be improved in new product development, for example, using marketers with prior knowledge and experience to gain weight from R&D activities. Level product manager solves problems with syncing product and technology development [6].

The Fig. 2 show the product integration service model [1]. The product integration service model is: A. Master the customer's needs, and the company is responsible for the opening, verification, mold opening, procurement, sample and packaging activities of the finished product. It coordinating the localization specifications of the customer's marketing base after the listing. B. Effectively reduce the communication and agency costs of the client. Information integration service model is: A. Shorten the time and cost of customer information integration. B. The single window service mechanism allows the customer's information to be managed and saved by the existing system.

In the consumer products package service, Solen service center will use web base application as the main structure, to provide product procurement and support demand management module functions for suppliers/collaborative factories for manufacturers to make parts or mold specifications, resume documents, etc. Electronic management, can return to the progress of participating projects at any time, and connected to the product service model of consumer finished brand customers, that can inquire online of the company's service products online. It propose service requirements, when the project starts progress of the project can also be grasped by the information provided by the supplier or the company. In the framework of the model, including collaborative design service system and information integrated value added service system.

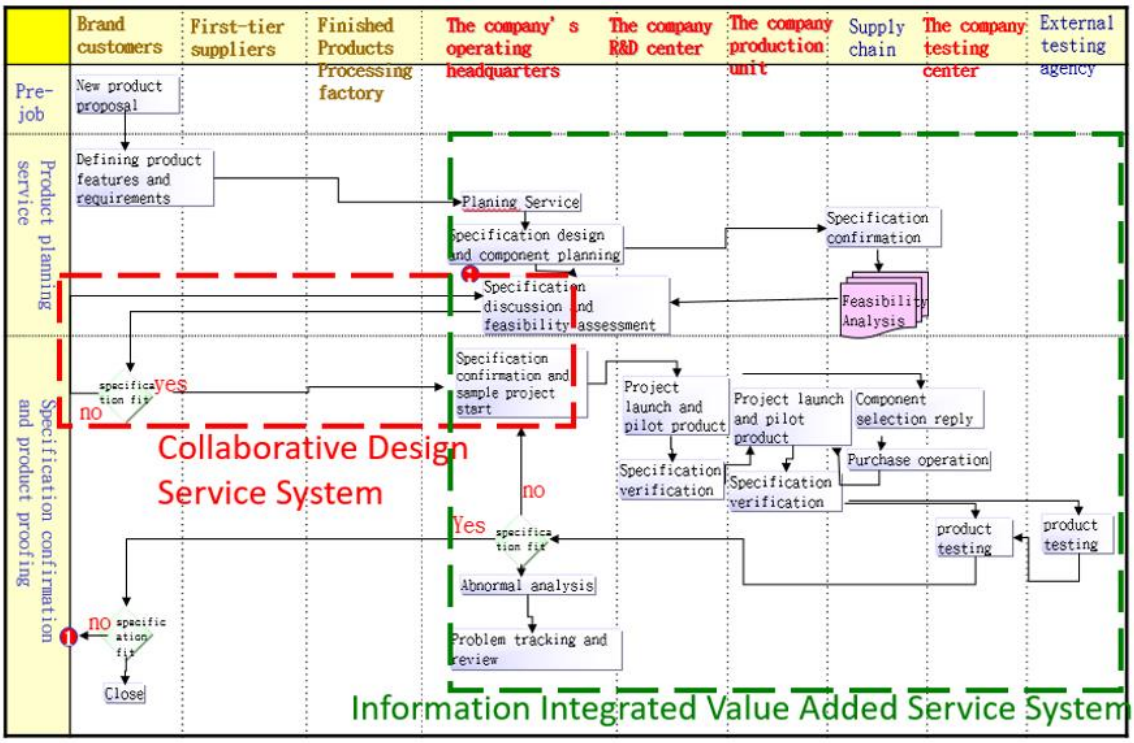


Fig. 2. Process of product integration services [1].

Germany, titled "Industry 4.0" explores the changing process of production work under the conditions of intelligent production systems. These are technical concepts for new industrial automation that have been discussed and debated in innovation policy or engineering science. Its core feature is integration through CPS. CPS-based production systems and

technology components should be configurable, tuned and optimized to respond to external requirements autonomously. These technical concepts can be seen as process innovation. It is assumed that the intelligent production system represents a disruptive structural change process innovation. These innovations are viable, organizations and people who promote development and innovation in these processes [7]. In many industries, companies are looking to incorporate concepts into customer development time, improve quality, reduce new product costs, and promote the smooth launch of new products. Previous research has shown that integrating material suppliers into the new product development cycle can bring substantial benefits to achieving these goals. Such participation may include simple negotiations with suppliers on design concepts and suppliers responsible for designing the components or systems. In addition, suppliers may be involved in different stages of the new product development process. Early involvement in the supply chain is a key coordination process for supply chain design, product design and process design. There are still no answers to several important questions about suppliers participating in new product development. Specifically, it will examine the issue of how management practices affect the efficiency of new product development teams when suppliers are involved [8].

One study shows the relationship between complementary product integration and the initial technology strategy of high-tech new companies. Because customers place great emphasis on cross-product integration, the success of a new business depends to a large extent on the integration of its products with related complementary products, as well as the core product features themselves. Three types of complementary product integration are proposed: value-added internals, add-on modules and data interfaces. Providing high-tech new companies requires a clear complementary product focus during initial product design [9].

Research indicates that the cost and technical barriers for industrialists using emerging technologies (ex: IoT) are high. Second, there are a large number of IoT devices in smart factories, warehouses and offices. The vast scope of data exchange and communication, management, monitoring and control of IoT devices. The establishment and maintenance of reliable cloud platforms are expensive. Hong Kong's Industrial Internet of Things (IIoT) suite has been re-industrialized for industrial upgrading and transformation [10].

IoT combined with cloud manufacturing can leverage its key technologies of intelligent awareness and access (i.e., hard manufacturing resources, computational resources and intellectual resources) [11]. That study showed the advantages of its real-time monitoring. In addition to smart manufacturing, IoT combined logistics is one of the entire real-time systems, especially for a highly service-driven manufacturing which supports to respond to the real-time dynamics captured from the IoT-enabled execution hierarchy. Empirical evidence from the results of this paper [12].

The old model is that the brand manufacturer designs the finished product specifications, the main and auxiliary materials, and assembles the test by itself (subcontract). After the sale, if the single part does not meet the market expectations, it is necessary to contact the manufacturer to replace the parts (components), and the communication cost is too high. The product integration services model proposed in this study refers to the Solen Company responsible for product specification opening, verification, mold opening, procurement, sample and packaging activities. After the overall listing, in response to the adjustment of the localization specifications in the customer marketing base. It can effectively reduce the communication and agency costs of the client.

III. Research Design

A. Instrument

This study used a case study method to explore the impact of the introduction and IoT from the Solen Company's factory, from client and manufacture respectively. Client: customer and order, manufacture: receive order, IoT equipment and product integration services model which is the most important influencing factors in the introduction of IoT is real-time. As shown in Fig. 3.

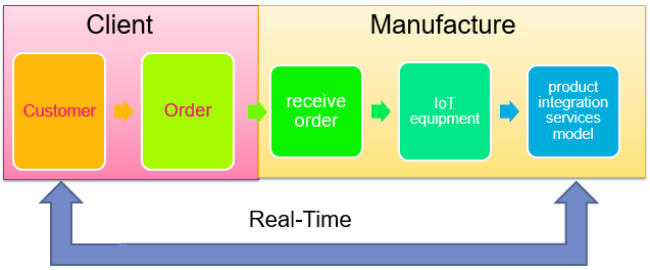


Fig. 3. Research model.

B. Data Analysis

The data analysis uses the comparison method and the inductive reasoning method. Firstly, the IoT case is introduced and described in Table I. Secondly, the shadows before and after the introduction are compared. Finally, the important influencing factors of IoT are summarized.

This study is jointly evaluated and analyzed by 3-5 experts and company managers. Define the problem and impact through group discussion, termed expert assessment and evaluation.

IV. Finding

A. Case Description

Solen Company specializes in the production of solenoids, motors and valves for the development including medical, healthcare, entertainment, automation, household appliances, POS, HVAS applications. Solen Company's main products: AC electromagnetic solenoid, DC electromagnetic solenoid, electromagnet, electromagnet and its components, coils, transformers, fly back transformers, relays, stepper motors, servo manufacturing, processing and trading of motors, AC and DC motors. Taiwan's largest and the world top three water valve and electromagnetic solenoid design manufacturers. Taiwan's only manufacturer certified by

world-class customers GE, HITACHI, FUJI and XEROX. Based on the concept of collaborative design, this study adopts the product integration service model, based on the existing design knowledge, combined with Taiwan supply chain members, develops a product integration service model. It leads the design, develops the production, packaging and transportation of finished products, that makes the brand owners can focus on marketing campaigns. Then increase customer conversion costs and build the company's ability to create its own finished brand. The company has developed the product integration services model since 2013 [1].

B. Compare Before and After Implement IoT

Table I analyzes the differences between the various items in the factory before and after the introduction of IoT equipment.

TABLE I: ANALYSIS OF BEFORE AND AFTER IMPLEMENT IOT

Dimension	Item	Before	After
Client	Customer	The customer cannot know the status of the product in any way before placing the order	The customer can know the manufacturing status or capacity of the product through IoT before placing the order
	Order	The customer can use the phone, fax or directly to the company to place an order	In addition to the above order method, customers can use the internet to place orders
Manufacture	Receive order	Manufacturing side: the company receives orders by phone, fax or directly	In addition to the above order method, can also receive orders via the Internet
	IoT equipment	-	Real-time feedback after importing IoT, and information about product manufacturing through the Internet
	Product integration services model	Information can't be feedback instantly, but it can be collaboratively designed in a relevant way	Collaborative design through IoT, information can be instantly feedback

1.Customer: Before the order is placed, the customer cannot understand the status of the product in any way. After importing the IoT, the customer can know the manufacturing status or capacity of the product through the IoT before placing the order. 2.Order/Receive order: Customers can use the phone, fax or order directly to the company. After importing the IoT, in addition to the above ordering method, customer can use the internet to place an order and directly link to the production line. 3.IoT equipment: real-time feedback after importing IoT, and information about product manufacturing through the Internet. 4.Product integration services model: Information can't be feedback immediately, but it can be collaboratively designed in a related way. After IoT is imported, it can be collaboratively designed through the Internet of Things, and information can be immediately feedback.

V. DISCUSSION AND CONCLUSIONS

A. Conclusions

According to the findings, after implementing the IoT in the case of smart manufacturing, the most important impact on product integration services is "real-time". Because the core of IoT technology is real-time monitoring through the Internet. Under product integration services model, although there have been many innovative practices, after joining IoT, the last mile is completed and is integrated into the manufacturing side.

Therefore, after the implementation of IoT, the impact of the product integration service was improved by "process change". In the analysis table of this study, there are 5 items that will change the process. The changes of these 5 items can enhance the functions of customer service and collaborative design.

B. Theoretical Implications

The theoretical contribution of this study is to increase the introduction of IoT between original product integration services model [1]. IoT technology can make up for the shortcomings of the original model, and create a "product integration services 2.0 model" through the analysis of this study. Through the analysis of the new product development process in [8], the research "product integration services 2.0 model" integrates the supply chain and client. It increases the contribution to the theoretical model and the practice of collaborative design.

Three IoT categories for enterprise applications: monitoring and control, big data and business analytics, information sharing and collaboration. It can be developed to increase customer value [4]. The results of this study are consistent with several projects: monitoring and control, information sharing and collaboration. Data and business analysis require future efforts.

Information sharing and collaboration in the IoT can occur between people and things. Perceive pre-defined events, usually the first step in information sharing and collaboration. In the supply chain, information sharing and collaboration can increase situational awareness to avoid information delays or distortions [4]. This study proposes the "real-time" approach based on the above theory.

C. Practical Implications

In practice, the biggest contribution is the serial connection between the client and the manufacture side. Although the past model also links customers and manufacturing, it can't achieve real-time monitoring. Then customers can't know the process and quality of the product. Otherwise, "product

integration services 2.0 model" is the best pattern of becoming a practical operation.

D. Recommendations for Future Research

This study uses case study to show the factors affecting the introduction of IoT into manufacturing factory. It is recommended that future research can apply "product integration services 2.0 model" to a variety of different manufacturing plants to increase the number of samples in multiple case studies to obtain generalized inferences. Otherwise, it can also try to use quantitative research to verify whether the "product integration services 2.0 model" dimensions are significant.

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