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Social informatics of Intelligent Manufacturing Ecosystems: A Case Study of KuteSmart

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Abstract

Intelligent manufacturing involves developing a vertically and horizontally connected manufacturing system that allows efficient mass customization. Research has mainly focused on connections between information technology and manufacturing equipment in a cyber-physical system. This case study analyzes major changes in the development of an intelligent manufacturing ecosystem by a traditional manufacturer that connects customers to manufactories for the mass customization of suits. Findings highlight the importance of social informatics, that is, connections that involve technology, as well as people, organizations, and their activities, and show how they are enabled by experience-based knowledge. They indicate key connections accounting for social and institutional milieus that should be studied in further research, for a more complete understanding of the successful implementation of intelligent manufacturing.

Keywords: Intelligent manufacturing; Social informatics; Digital Ecosystem; Case study

1. Introduction

Intelligent manufacturing draws upon the concept of Internet of Things and other related information technology to develop a vertically and horizontally connected manufacturing system of enhanced productivity (Pan, Pan, & Lim, 2015; Thoben, Wiesner, & Wuest, 2017). The connected system is expected to improve production efficiency, product quality, and more importantly, product customization. Unlike traditional manufacturing based on mechanization, mass production, or automation, intelligent manufacturing can fulfill individual customer requirements with product variants in a very small lot size, down to one-off items.

Although connections are central to intelligent manufacturing, research has thus far focused on technological connections and our understanding of their social and institutional milieus remains limited. Most prior studies have either identified applications of intelligent technology in manufacturing or proposed solutions for connecting technological elements such as data, sensors, microprocessors, and telematics with physical elements such as machines, storage systems, and utilities in a cyber-physical system that shares information and acts autonomously (Thoben et al., 2017). Since the system operates in the physical world, it is imperative to extend our understanding of connections in intelligent manufacturing by accounting for intelligent technology, as well as people, organizations, and their activities. This case study seeks to address the gap.

This case analysis unveils connections that account for social and institutional milieus in the development of an intelligent management ecosystem (IME), by analyzing the major changes during the development of KuteSmart's IME for manufacturing business suits. KuteSmart has become a "poster child" of IME in China, the world's largest manufacturing country (Yu et al., 2015). It has provided consulting services to about 100 organizations in 30 industries varying from jewelry makers to machine manufacturers, and hosted study tours for companies such as Procter & Gamble and Cerruti 1881. From the year 2012 to 2016, KuteSmart's annual profit doubled, despite a 3.6-percent dip in the industry's average profit. We combined the case study approach (Pan & Tan, 2011) with the social informatics perspective (Kling, Rosenbaum, & Hert, 1998) to examine the connections. We found that the development of IME involves connections, disconnections, and reconnections among intelligent technology, as well as people, organizations, and activities. These connections and reconnections manifest in value chain and organizational structure and are enabled by experience-based knowledge.

2. Case background

KuteSmart IME started as an initiative to address business challenges facing the Red Collar Group (RCG), a business suit maker in Qingdao, China. RCG was established in 1995 as an original equipment manufacturer for foreign as well as domestic brands. RCG also operated tailor outlets under its own brand. In 2000, RCG saw a shrinking profit margin due to increasing costs of supplies, inventory, and distribution. The founder and chairman of RCG noted:

> *"Low cost and low price is not the way to go for manufacturers. The traditional model would not be sustainable. Profit is necessary for driving and providing resources for innovation, and realizing continuous growth."*

To improve profitability, RCG sought to differentiate itself from competitors by creating unique value for customers. Based on the understanding that many customers desire a custom-made suit but it is often considered a luxury, RCG began to explore mass customization of suits and rethink its manufacturing business as one that is customer driven rather than product driven. To better connect customers to its manufactories, several major changes were necessary, as described in the next section. A recurring theme underlying these changes is connection – the development of IME and use of intelligent technology involve connections that are social and institutional in nature, as well as disconnections or reconnections, which are enabled by experience-based knowledge. Lessons learned with regard to these connections will be discussed later.

3. Major changes during the development of KuteSmart IME

RCG changed its business model from that of manufacture-to-stock to manufacture-to-order, driven by customer demand. Customers are now more directly connected to RCG's manufactories through the Internet. To create a seamless customer-to-manufactory connection, RCG had to change its organizational structure from tall to flat. The platform's success attracted the interest of manufacturers in related industries, which catalyzed the platform's transformation into a digital ecosystem comprising manufacturers in complementary industries.

3.1 From manufacture-to-stock to manufacture-to-order

In the new customer-driven business model, RCG's manufacturing begins only after a confirmed customer order is received, rather than based on demand forecast and inventory. A customer order contains information about a customer's body measurements and suit design preferences. A clothing pattern customized according to the body measurements needs to be created before fabric pieces can be cut and assembled into a suit.

To ensure that customer requirements are accurately captured, RCG developed a proprietary body measurement method based on its deep tailoring expertise and analysis of customer data collected over the course of its business. The patented method named "coordinate measurement" involves creating axes along the vertebra and waist, and measuring 19 places of the body. The method can be mastered in five days by anyone without knowledge of tailoring. Customers can get their measurements by making home appointments with a trained customer service officer, visiting one of RCG's outlets or trained partners, or using one of RCG's proprietary mobile Magic Buses, which takes measurements within 2 seconds using 3D technologies.

RCG also developed an automatic pattern-making system that incorporates its knowledge of tailoring as well as a database of more than two million customers accumulated over more than 10 years. The system shortened the pattern-making time from half a day to 20 seconds. RCG's vice president, Mr. Li Jinzhu, explained:

> *"Automatic pattern making is very complex. Other than big data, there are many rules in the algorithm. A single body measurement value will change 9,666 other values, to ensure that the pattern created fits the customer well."*

A design customization system is also developed to allow customers to configure all aspects of their suit based on personal preferences, including shell fabric, lining fabric, style, color, and buttons. They can also invite families and friends to join the system as co-designers. More than 1,000 trillion combinations are possible and the system can automate design decisions based on other customers' data when they are not specified by a customer.

The mass customization is made possible by breaking down the process of manufacturing suits into over 300 procedures, automatically optimized and assigned to workers based on their availability and skill level. All workers have a six-day work week, and there is never overtime work. A suit takes at most seven days from ordering to delivery, compared to weeks in conventional tailoring. The mass customization system allows RCG to produce more than 3,000 customized suits a day.

The new customer-to-manufactory model eliminated the need for designers and wholesalers, which were important entities in the original value chain. The traditional value chain of manufacturing suits is characterized by the smiling curve, which depicts how value added varies across activities. The two ends of the value chain, design and distribution, added more value and commanded 35 percent and 55 percent of the profit respectively. In comparison, manufacturing, which sits between these activities, makes the least profit. The new value chain has reduced the design cost and inventory cost by more than 90 percent, and the production cost is only 10 percent more than that in mass production. These increased RCG's profit margin by more than 25 percent.

3.2 From tall to flat organizational structure

Connecting customers to its manufactories required RCG to attend to customer feedback in a timely manner. The founding president observed that:

> *"Although the customer service department could direct customer feedback to the relevant work unit, it did not have the means to ensure that the feedback was attended to. There was much buck passing and dispute among different units."*

He saw the lack of power to be the main reason for this issue and authorized the customer service department to manage client accounts. The performance indicators of the department were also modified to focus on customer satisfaction, sales growth, and payment received. These changes endowed the department with the power of influencing the work of other units around customer needs.

Further, based on an intimate understanding of the manufacturing process, the original organization structure comprising more than 30 departments was taken apart and reorganized into six centers, each focusing on a different part of the process: customer service, information technology, supply chain, production, finance, and human resource. Eighty percent of the middle management positions disappeared, and the remaining mangers focused on handling exceptions rather than approving routine decisions. Routine decisions were automated as much as possible, and employees' main responsibility became detecting and reporting problems. This resulted in a much flatter, hub-and-spoke organizational structure that is centered on customers. The management cost decreased by about 20 percent.

3.3 From platform to ecosystem

RCG built its own Internet-based platform to connect customers to manufactories, because it could not find a suitable existing platform. This is a common issue in the application of emerging digital technology (Ying et al., 2018). The president recalled:

> *"RCG considered existing Internet platforms like Taobao, but their business logic is completely different – they are B2C platforms, through which businesses sell their products to customers. RCG focuses more on manufacturing, which is not well supported by the existing platforms. The providers did not want to modify the platform for the sake of just one company. We decided to build our own after all our efforts were to no avail."*

The platform's success attracted the interests of other organizations and the government. RCG hosted factory tours for manufacturers in related and different industries, such as casual wear, shoes, jewelries, cosmetics, home textiles, bicycles, motorcycles, electronics, and building materials. Government officials urged RCG to lead by example and help to transform other traditional manufacturers in the country.

RCG recognized that its experience with the customer-to-manufactory model could be applied to other manufacturers and industries. They started providing consulting services to other manufacturers, especially those in complementary industries such as accessories. A traditional factory can be transformed in about three months.

RCG has begun to develop a digital ecosystem, named KuteSmart, where it offers participating businesses in similar or complementary industries access to its data while they process customer orders through its platform. RCG's marketing director recalled how a direct competitor turned into a complementing partner:

> *"We helped the company transform its production line and also recommended it to focus on suit customization for college graduates. This filled a market niche and complemented RCG's suit-customization business. Our C2M platform could easily support the company's production."*

Businesses that participate on KuteSmart include manufacturers of coats, handbags, accessories, and hair wigs. The system also automatically recommends complementary products that complete a dressing style when an order is placed. The system aims to provide customers with synergistic value, in terms of comprehensive styling solutions rather than disparate products.

4. Lessons learned

This case study shows that the development of IME by a traditional manufacturer involves connections, disconnections, and reconnections among technology, as well as people, organizations, and activities. They manifest in value chain and organizational structure and are enabled by experience-based knowledge. Analysis of KuteSmart indicates four such connections, disconnections, or reconnections, as well as the enabling role of knowledge.

First, IME can connect customers more directly to manufactories and it is critical for manufactories to have deep knowledge about customers. Internet and intellectual manufacturing technologies allow manufactories to obtain customer requirements without going through intermediaries. However, different customers have different priorities and they might not be able or willing to bear the burden of making every single design decision. Knowledge about customer preferences derived from analyses of existing customer data is useful for automating design decisions where necessary. In the development of KuteSmart, RCG applied its knowledge of tailoring and databases containing millions of customer orders and pattern models to develop proprietary coordinate measurement method, automatic pattern-making system, and design customization system. This technology-driven customer-to-manufactory connection predicates on whether customers trust manufactories' design decisions and is thus technological as well as social in nature. The knowledge is also continuously updated and renewed as data are collected from new orders.

Second, disconnections and reconnections in the organizational structure are necessary for a seamless connection between customers and manufactories in IME. RCG did not change just one aspect of performance management – it reorganized the entire structure and focus to support the new intelligent manufacturing model. These institutional disconnections and reconnections in work allocation, coordination, and supervision often result in a flatter organizational structure. This extends the findings of prior studies that digital transformation often leads to changes in organizational routines (e.g., Chen et al., 2013) by showing that the change may be more structural and fundamental. The development of KuteSmart shows that the extensive restructuring is top-down, made possible by the leaders' management knowledge and experience with the manufacturing process, as well as a deep understanding of decision-making rules (so that they can be embodied in software and automated).

Third, institutional disconnections and reconnections in the value chain are also likely in the development of IME. Internet technologies have made it possible to remove value chain entities and shorten the chain, significantly cutting down the amounts of capital and infrastructure required. The new arrangement generates additional value (e.g., timeliness) for the customer and the manufacturer beyond the incremental cost savings derived from having fewer steps or shifting work to other entities. In the case of KuteSmart, designers and wholesalers were no longer necessary in the new value chain. Some designers turned into customers and used the platform to produce suits they have designed for offline sale. The disconnections from designers and wholesalers and reconnection of designers as customers were realized by RCG's Internet-based platform, which was developed based on its suit manufacturing experience and knowledge.

Fourth, social connections among manufacturers offering complementary products are likely in the development of IME. Complementary products are interrelated such that the demand for one product generates demand for another. For example, matching shoes, socks, bags, and ties are complementary and are often purchased to coordinate with a suit. Selling complementary products offers complete styling solutions to customers and increases experiential value as well as customer stickiness. From the IME's perspective, all participants (e.g., customers, manufacturers, designers) benefit from the network effect. The more participants who adopt the platform, the more valuable the platform becomes to them, owing to enhanced access to the network of participants and often a set of complementary innovations. The IME has a permeable boundary that allows both online and offline businesses to join (Huang, Pan, & Liu, 2017). As it grows, it becomes harder to dislodge by rivals or new entrants, with the synergistic value among complementary products acting as a barrier to entry. In the case of KuteSmart, the IME's development was enabled by RCG's ability to apply its manufacturing knowledge to design an

Internet-based platform providing essential technological functions to connect customers to manufactories, and its accumulated customer data offering insights into customer needs and solutions to business problems for other manufacturers.

5. Conclusion

Taken together, the case of KuteSmart's development highlights several important connections that are technological, as well as social and institutional in nature, involving people, organizations, and their activities. They occur in business model, organizational structure, and value chain and can lead to disconnections and reconnections. The case also shows how they are enabled by knowledge of intelligent technology as well as customer needs, manufacturing process, management, and leadership. The case demonstrates that the development of IMEs often necessitates sweeping changes that are multidimensional and requires understanding of the inextricable connections among different entities to realize. The sustained success of IMEs depends on whether these are done in a way that benefits all IME participants as they generate value for customers. Further research on intelligent manufacturing should account for technology as well as social and institutional milieus to avoid oversimplifying the phenomenon and offer useful guidance for its implementation and performance measurement.

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