

Manufacturing Company Management and Innovation in the Age of Digital Transition

Nanying Liu¹, Huaping Sun^{1,2*}, Xiumei Du¹, Bless Kofi Edziah¹

¹School of Finance & Economics, Jiangsu University, Zhenjiang, China

²School of Management, Tianjin University of Technology, Tianjin, China

Email: *shp797@163.com

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Abstract

As the world transitions to an era of intelligent manufacturing, China has joined the race to usher in the Fourth Industrial Revolution (Industry 4.0) by transforming and upgrading conventional industries 2.0 and 3.0 to industry 4.0. As a result, many manufacturing workshops are being transformed to make room for machines rather than labour. While businesses may benefit from the conveniences of the intelligent era, they are faced with several challenges, particularly in the management of manufacturing companies. For example, with the intelligence of machines and equipment, companies must contend with the efficiency of their employees. This paper, therefore, primarily discusses current business management issues and makes management recommendations in response. At the same time, it demonstrates that in the age of digital transition and intelligent manufacturing, businesses should use innovative ideas to maximize business management efficiency.

Keywords

Intelligent Manufacturing, Business Management Method, Business Efficiency and Innovation

1. Introduction

The advancement of information technology and the expansion of e-business are the driving forces behind the digital economy. The digital economy has improved industries' production and operation efficiency through e-commerce, automated production, and other means of strategic transformation, optimization, technology innovation, service upgrading, and service level improvement.

The digital economy is an important economy after the agricultural and industrial economy. It is a new economy that emphasizes the importance of data

resources and encourages a more uniform level of fairness and efficiency in the marketplace. The advancement of science and technology has considerably aided the change and upgrading of the economy. Artificial intelligence, cloud computing, big data, and 5G, among other new-generation information technologies, have emerged as critical stepping stones in the growth of the digital economy.

The Industry Age 4.0 has dramatically impacted the manufacturing and information technology industries in recent years. Manufacturers are benefiting from technological advances such as industrial robotics and 3D printing, as well as a shift toward manufacturing as a service. Big data, cloud computing, and the Internet of Things are just a few of the new technologies upending the status quo in the information technology sector. A fundamental element of intelligent manufacturing is to make the manufacturing industry a service. This means that the manufacturing industry is no longer limited to making traditional products but comprises everything from the design and production of the products to the servicing and maintenance of the products. In other words, machines that can perform tasks automatically have replaced machines that perform tasks manually.

In the 1990s, China began to study intelligent manufacturing, but mainly from the perspective of mechanical engineering. According to studies, companies should use robots to replace workers, use intelligent technology to build smart factories, set up a big data platform, and build an open value ecological chain to deal with the new opportunities and problems of Industry 4.0 (Du & Yang, 2015; Sun, 2017; Zhong et al., 2017; Lan & Huang, 2018). In the face of the rise of intelligent manufacturing, innovation also plays an important role, enabling businesses to be relevant in a competitive market (Li & Huang, 2017). Schumpeter (1912) was a pioneer in the field of innovation research. In his study, Schumpeter (1912) proposed that innovation introduces new and better production methods into the production system. Innovation includes companies developing new products, implementing new production methods, and opening new markets. Innovation is a series of interconnected processes, such as acquiring new materials and establishing new organizations (Porter, 1990; Sun et al., 2019). It may be measured in various ways and is critical to economic development and progress (Sun et al., 2021).

2. Business Management Innovation Goals and Prospects

The following are the purpose and prospect of business management innovation.

2.1. The Purpose of Management Innovation

Business management innovation aims to increase production and operation efficiency; conserve energy; reduce consumption; keep up with the market competition, and achieve sustainable development. As a result, Internet technology has revolutionized business management, allowing them to continuously improve their operations, keep up with changing market conditions, and ensure long-

term growth. Intelligent manufacturing is an advanced production mode based on the deep integration of new-generation information technology and advanced manufacturing technology, which runs through all manufacturing activities such as R&D, design, production, and service management. It aims to improve the manufacturing industry's quality, efficiency, and core competitiveness. Intelligent manufacturing requires a new management innovation practice mode to keep pace.

2.2. The Prospect of Managing Innovation

The application of information technology in business management has continuously improved the automation level of business management. The rise of on-line shopping has made e-commerce an unprecedented development; the development of various numerical control technologies in the production field has promoted the industrial ecological civilization construction. These new approaches challenge traditional business management, causing many businesses to transform and improve to stay competitive continually. They also set up a modernization path for Chinese businesses to achieve business management innovation in the current information age. **Table 1** shows the current development of business management, which is a good illustration of changes in business management.

3. Changes Brought by Digital Transition to Intelligent Manufacturing Companies

In recent years, profound changes have occurred in the manufacturing and information technology fields. Networking intelligence has developed rapidly based on informationization, diversification and decentralization. Industrial robots and 3D printing have achieved breakthrough development in the manufacturing field, and manufacturing has also become a service-oriented trend. Emerging industries such as big data, cloud computing, and Internet business continue to penetrate traditional industries in information technology. The advent of the era of intelligent manufacturing has also brought new shocks to manufacturing companies, mainly bringing the following changes to the manufacturing industry, as shown in **Figure 1**.

3.1. Intelligence of Manufacturing

Smart factories and intelligent production are the two major themes of Industry 4.0. Smart factories use Internet technology to realize data exchange and sharing between decentralized factories. Intelligent production focuses on the automation of production and improves production efficiency by promoting and applying human-computer interaction and intelligent management. For example, Zhejiang Province has actively promoted and implemented the "machine substitution" strategy, which has achieved good results. This aligns with intelligent production and provides technical support for industrial transformation and upgrading.

Table 1. Current development of business management.

Management period	Generate an objective basis	Generating background	Core content	Representative view	Representative theory
Information management	Production digitalization, exchange of electronic, management computerization	The universal application of computer information technology in production, life and management practices improves the efficiency and accuracy of management	Data information knowledge	Internet age, knowledge economy, process reengineering	Organizational flattening, process reengineering theory, knowledge management theory
Intelligent management	Big data, cloud computing, internet of things, mobile commerce	Information redundancy highlights the limitations of human processing power, and the development of digital and network platforms makes management intelligence possible	Data human-computer interaction	Smart services, smart factories, driverless cars, 3D printing, smart management	Artificial intelligence theory Intelligent management technology Intelligent manufacturing technology

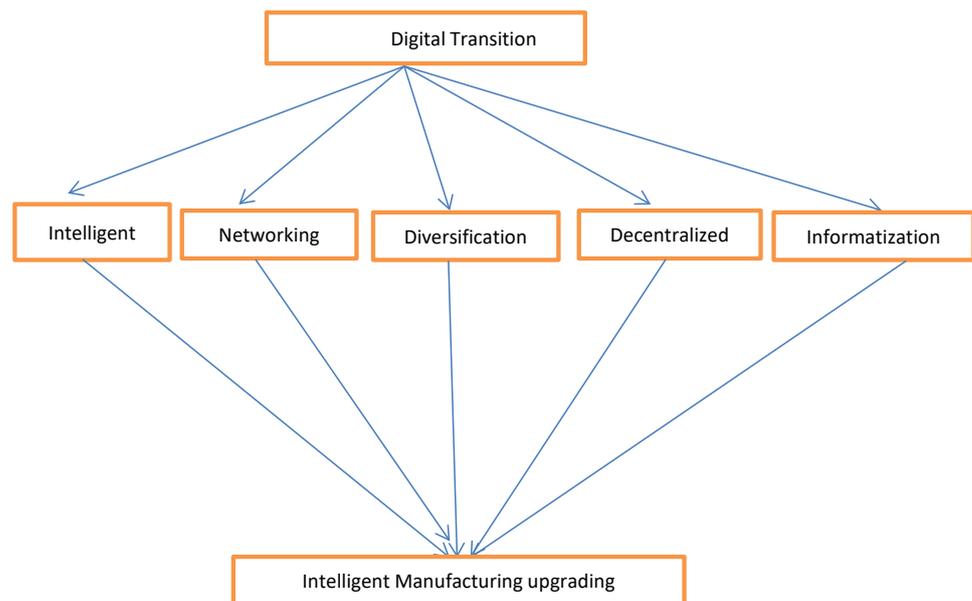


Figure 1. Changes brought by intelligent manufacturing to manufacturing companies.

3.2. Networking of Manufacturing

Traditional manufacturing businesses are isolated from each other. However, Industry 4.0 enables the horizontal integration of several businesses in the same value chain, notwithstanding their relative independence, through Internet technology, resource sharing, and mutual integration. The network of the manufacturing industry mainly includes three aspects:

- 1) The horizontal integration of different businesses in the value chain
- 2) The vertical integration of the manufacturing system network
- 3) The end-to-end integration in the business production process

3.3. Diversification of Manufacturing

With the promotion and application of intelligent technologies, the personalization and diversification of manufacturing industries are becoming more and more popular. First, it is reflected in the diversification of manufacturing technologies and processes; second, it is reflected in the diversification of products, and smart products are becoming more and more popular. Third, with the diversification of customer needs, personalized and niche product demand is growing; personalized, private customized products are more popular.

3.4. Decentralization of Manufacturing

3D printing technology is a cutting-edge technology that allows product decentralization and personalization. Customers will be able to participate in the production process and meet customization requirements due to individualized demand and decentralized production. Small-scale and professional chemical production will become a new way to develop manufacturing businesses in the future.

3.5. Informatization of Manufacturing

Internet technology is embedded in all aspects of production, significantly increasing manufacturing's informatisation level. Manufacturing companies have used information technology to improve the functionality of their products, resulting in value-added and increased competitiveness. As shown in the framework diagram, the dawn of the intelligent manufacturing era has brought about changes that will eventually result in a manufacturing industry upgrade. Regardless of whether they are in management or production, manufacturing companies must constantly change and innovate to adapt to the changing times, resulting in more convenient production conditions and higher profits for businesses.

4. Upgrading of Intelligent Manufacturing Businesses: Case Study of Changchun FAW Group

FAW Group Co., Ltd. (formerly China First Automobile Works), is a Chinese state-owned automobile manufacturer headquartered in Changchun, Jilin Province. Founded in 1953, it is currently the second-largest state-owned car manufacturer in China after six decades of car manufacturing. In 1958, it built its first Dongfeng brand sedan and the first red flag limousine. In January 2018, it was selected as the first batch of the Chinese Industrial Heritage Protection List.

Changchun FAW has had a bumpy road to development. In the face of Industry 4.0, the value of its output fell drastically during the period 2013-2015, and its competitiveness weakened. However, due to its usual innovation and the strong support from the Jilin Province, Changchun FAW Group quickly adjusted to the ongoing development by smoothly adopting intelligent manufacturing and upgrading its industrial production. This is a good reference case for other man-

ufacturing companies in China.

Changchun FAW Group's implementation of intelligent manufacturing is inextricably linked to the ongoing activities in both the international and domestic environment. Internationally, in 2014, Sino-German signed the "*Sino-German Cooperation Program Outline*" document on Industry 4.0, emphasizing the importance of both sides strengthening cooperation in Industry 4.0 and jointly exploring the new opportunities of Industry 4.0.

Domestically, the "*manufacturing of a strong country*" strategy was initiated in 2015, and the State Council issued "*Made in China 2025*" to fully implement the manufacturing transformation and upgrading program. In 2016, Jilin Province actively responded to national policies by developing the "*China Manufacturing 2025 Jilin Implementation Outline*", whose objectives include: accelerating the integration of the national manufacturing strategic layout, focusing on the development of profitable industries, fostering new initiatives, revitalizing local manufacturing, and realize the transformation and upgrading of local industries.

Changchun FAW Group itself has also actively made changes. In the light of the growing intelligent manufacturing, its group management and strategy have also made innovations and adjustments. On March 29, 2018, the FAW-Volkswagen Changchun Audi Q plant was officially put into operation. This is one of the most advanced and environmentally friendly factories globally. With the manufacturing industry's network and informatization, Changchun FAW used the "Internet+" strategy to achieve three-dimensional intelligent warehousing and digital workshops, an intelligent manufacturing industry support service cloud platform and deepened the relationship between different businesses.

Cooperation and interoperability, realize the vertical development of product orders, and achieve vertical integration of the value chain; due to the diversification of the manufacturing industry, it actively explores customers' needs, achieves individualized development, and implements diversified development in business management. According to the Changchun Municipal Bureau of statistics, Changchun Industry output grew remarkably; the GDP of Changchun was released in 2021, with a year-on-year increase of 6.2%. The automobile manufacturing industry is an important economic pillar of Changchun. In 2021, the output value of the city's automobile industry reached 614.3 billion Yuan, accounting for 70.3% of the city's total industrial output value.

In terms of talent management, Changchun FAW fully recognizes the competition in the 21st century. FAW Talent Development Strategy focuses on the cultivation and development of new talents. Systematic talent development creates about 2000 high-level management personnel, high-level technical personnel, and a highly-skilled operational team. As a result, FAW Talent Development builds a team of employees with excellent quality, reasonable structure, and efficiency.

The talent development strategy follows the predecessors' standards, i.e. develops employees into experts such as managers and field operators; it follows

training and talent development. The two major talent projects of “801” and “901”, that is, each management team is equipped with one university student who graduated in the 1980s and 1990s; creating a green channel for employees, that is, mobilizing high-level talents who do not hold any executive leadership positions. Encourage them to delve into the business, develop their expertise, implement the first, second and third grade designers (crafters), managers and operators, and actively create a good working environment for employees in the incentive mechanism and policy treatment. Encourage employees to innovate and actively attract highly educated talents.

Driven by Industry 4.0, Changchun FAW seized the opportunity, achieved a significant turnaround in the manufacturing industry, and achieved industrial up-grading. Its management method is worth learning from. In its transformation process, we can also discover the impact of intelligent manufacturing on it and its technological innovation and management innovation. This shows that in the face of the development of the times, only by courage to innovate and change the business can we stand up.

5. Management Strategies for Manufacturing Companies

Compared to developed countries, China is lagging in developing intelligent manufacturing. Although the manufacturing industry is still developing, it is still at a low level due to a lack of synergy, insufficient development, a delay in creating the intelligent manufacturing basic theory and technology system and a weak capacity for independent innovation. With the introduction of intelligent manufacturing, China’s manufacturing industry must adjust its management practices to address the challenges posed by these new technologies.

5.1. Apply Smart Technology to Build Smart Factories

Standardized, modular and digital product design is an essential embodiment of Industry 4.0. Modularized divisions of labour and flexible production methods are necessary to meet customer and market demands. The so-called modular division of labour and integration is first to decompose the product and then integrate the decomposed modules according to the needs of different functions to create an integrated product. Therefore, business should pay attention to the intelligent strategy, strengthen the integration of human intelligence and factory intelligence, promote human-computer interaction, improve the level of artificial intelligence, and realize software and hardware integration. It is recommended to accelerate the large-scale deployment of new network infrastructure, such as industrial Internet, Internet of Things, 5G, and gigabit optical network, to encourage businesses to carry out internal and external network upgrading and transformation and improve on-site perception and data transmission capability.

5.2. Build a Big Data Platform and a Cloud Computing Center

New technologies such as big data, cloud computing, and 3D printing are im-

portant representatives of the industry 4.0 era. Data in the Internet era will become the most valuable resource for mining. In the lead, the US industrial Internet strategy is a model for building big industrial data. Because big data technology can help businesses grasp and predict customer-centric market conditions and trends, it is an important strategy for building company data centers, improving informationization, and promoting business development through information technology. Whoever has data resources can grasp the market trend. Encourage businesses to actively mine the strategic value of data to take a leading position in the highly competitive market. We should encourage the national manufacturing transformation and upgrading fund, the advanced manufacturing industry investment fund, the national small and medium-sized business development fund and all kinds of social capital to increase investment in intelligent manufacturing.

5.3. Construct an Open Value Ecosystem

In the era of Industry 4.0, businesses and users are at a distance from each other. Businesses guide users to carry out the process of value creation in the whole process. “Networking”, “platformization” and “openness” have become important directions for business production, which will lead to a complete refactoring of the organizational structure and generation process established in the era of mass production. Businesses must create an open ecosystem that integrates internal and external resources, enables access to external resources, and supports a rethinking of the corporate value chain. It is suggested to formulate the intelligent manufacturing public service platform specification and build a service network with complementary advantages and coordinated development. Relying on the international one, such as the “Belt & Road” initiative, BRICs¹ and regional comprehensive economic partnership agreement (RCEP), we will encourage intelligent manufacturing equipment, software, standards and solutions to “go out”.

5.4. Establish an Efficient Workforce Management System

An organization with an overstaffed increases costs and wastes resources; on the contrary, when the organizational structure is lean, the staff is fast and efficient in their work, reducing the cost. The widespread use of information technology will test the coordinating capabilities of traditional business organizational structures, exposing their flaws. The application of these new technologies is conducive to establishing a capable and efficient business organization, innovative structure, reward and punishment assessment methods and incentive mechanism, and the formation of a new corporate culture. It is suggested to regularly prepare the demand forecast report of intelligent manufacturing talents and the demand catalogue of scarce talents and issue industry standards such as the ability requirements of intelligent manufacturing employees.

¹BRICS is an acronym used to describe 5 major emerging economies: Brazil, Russia, India, China, and South Africa.

6. Conclusion and Future Research

An advanced management theory is almost always born from a specific practical application. It usually moves from practical application to thought or technique before becoming a new management theory that can be used worldwide. Intelligent management is replaced by human intelligence and mental work. Businesses must keep up with the latest developments in management theory to make significant advancements and progress. The digital revolution in manufacturing will be the driving force behind the next industrial revolution. Whoever seizes the leading industry of intelligent manufacturing can become the leader and leader of the new industrial revolution. For a newly industrialized country like China, it is necessary to seize the opportunity window of the new industrial revolution and realize the “overtaking of the curve”.

To survive in the field of intelligent manufacturing, businesses must break through the innovation of core technology fields, emphasize the importance of management innovative thinking in businesses, improve the industry’s added value and competitive advantages, build institutional mechanisms and industry development standards that support intelligent manufacturing, and introduce a reasonable industrial supporting policy system and cultivate multi-divisional innovation and development.

The accelerated integration of advanced manufacturing technologies provides a historic opportunity to develop a high-end, intelligent and green manufacturing industry. The development level of intelligent manufacturing is related to the global status of China’s manufacturing industry in the digital future. It plays a vital role in accelerating the development of the modern industrial system, consolidating and expanding the foundation of the real economy, building a new development pattern and building a digital China. At present, China has turned to the stage of high-quality development and is in the key period of transforming the development mode, optimizing the economic structure and transforming the growth power. However, the adaptability between manufacturing supply and market demand is not high, the stability of the industrial chain supply chain is facing challenges, and the constraints of resources and environmental factors are becoming tighter. In the future, we will combine more field research and case analysis to promote relevant theoretical research and empirical testing.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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