Smart Economy Helps the Construction of Future Factories for Grain Circulation

Dong-mei Li¹,a,*

¹Institute of Food Economics, Nanjing University of Finance and Economics, Nanjing, China

*Corresponding author

Abstract. Food is the paramount necessity of the people. This saying highlights the importance of food circulation, a pillar industry related to people's livelihood. Impacted and driven by ever-changing IT technologies in the new era, conventional grain circulation is also undergoing leapfrog innovation, and the factory of the future for grain circulation has begun to emerge, which is used by grain manufacturers for grain cultivation, grain purchase, grain warehousing, grain processing, grain circulation, grain trade by advanced IT technologies.

1. Introduction

Artificial intelligence (AI) is the future development direction, while smart economy is the new engine of future economy. Since listing of AI in the Guiding Opinions of the State Council on Actively Promoting the "Internet+" Initiative as one of the 11 key actions in July 2015, a series of policies have been promulgated every year to guide the development of AI and promote the integration of conventional industrial economy and AI. The Government Work Report in March 2019 pinpointed that the transition and upgrading of manufacturing industry were enabled by building an industrial Internet platform and expanding "smart+". Active expansion and integration of AI technology by various industries has led to the generation, development and planning of smart economy in various industries, which acts as engine and incubator for economic development in the new era.

2. Development Environments of Smart Economy

The foundation of smart economy is based on the industrial entities, and the AI technology is fully applied to the industrial entities, whose development depends on the core development environment and industrial foundation. The new Internet and new IT technologies(cloud computing, IoT), are changing the business operation model of AI and industrial entities—from workshops to operation, which run through the business system of manufacturing enterprises. To fully benefit from this wave of transformation, IT technology is the core driving force.

2.1. Development Demand Environment of Smart Economy

Development demand of the new era is the core foundation of smart economy. Planned economy focuses on production and redistribution as per plan, and market economy emphasizes resource allocation based on market demand. The development of smart economy, in contrast, pays more attention to the consumer propensity, preference, agility and convenience.
2.1.1. Focusing on Customer Needs

Future economic development will be people-oriented. It is the magic weapon to cater to customer needs and consumer experience all the time. In the new era, the trend of fully competitive economic environment leads the market to the mode with customer demand as the core competitiveness. For factories of the future, agile product delivery, high performance-to-price ratio and customer satisfaction constitute the key to success. The feedback of consumers in the new era is more transparent, important and changeable in the Internet economy. Replacement of existing services is decided directly by the consumption experience and satisfaction of customers. Any industry and industrial entity need to face up to the multi-angle customer base. In the era of sharing economy and multimedia development, Consumers will give feedback on the consumer experience through multimedia and share it with their circle of friends at the same time. Consumer reviews promote the product reputation quickly, as well as the accumulation and collapse of credibility. AI-based solutions, collaborative tools are all conducive to offering customers with a better experience, thereby enhancing their satisfaction.

2.1.2. Mobile Terminals, Social Networking Activities and Sharing Economy

Respecting mobile terminals, managers from all walks of life in the 21st century shall not be confined to the office or PC. They should make decisions outside of any social event, factory production or corporate operation site, who also need 24 hours of remote understanding and monitoring, mobile working and social networking anytime and anywhere. The entire process from farm planting, harvesting, circulation, processing, warehousing and sales to after-sales is supervised and operated by mobile devices like cell phones. Now the function of mobile phone is becoming more and more powerful. At present, the number of end-users of mobile devices in the world has far exceeded the total population of 7.2 billion in the world.

Respecting social networking activities applications, Enterprises need to carry out system integration, analyze the collected big data, and re-optimize the production and overall supply chain according to the analysis structure. According to Mckinsey Global Institute estimation, enterprises can enable employees to interact more easily, timely and conveniently through multi-faceted application of social networking technologies, which can improve the work efficiency of managers and technicians by 20-25%.

With regard to sharing economy, new industries like Meituan, Ele.me and Mobike have been established under the Internet+ model. Which have sprung up in recent years. Their development has prompted the development of sharing economy rapidly, thereby ushering in subsequent development of AI. With the constant expansion and accelerated reform of conventional industries by AI, more sharing economy and industries are bound to emerge.

2.1.3. Interconnectivity of Big Data

In order to realize the flexibility and value maximization of the value chain, all links of the supply chain must realize the integration of isolated data, so that the different data in the whole supply chain can be interconnected. In view of the lack of full-dimensional analysis of the business and results of only isolated data, the value of the data can’t be fully reflected and applied as a whole. If real-time monitoring and data collection and analysis are carried out for the whole value chain, instead of being limited to a specific process of the whole supply chain, the result will be a step higher than simple data collection. To achieve the exchange and sharing of data in the whole supply chain, interconnection is the ultimate goal. [1]
2.1.4. Agility Brought by Cloud Solutions

Nowadays, the rapid development of IT technology has brought the fast lane of enterprise development. The operating pressure of enterprises comes from all-round market competition (emerging markets, customer demand, sales channels, etc.), forcing enterprises to constantly push through the old and bring forth the new to cope with the rapid changes in the market. Speeding up the change of output, enriching product lines and differentiated products are the foundation for enterprises to gain a foothold. Cloud solutions can bring more convenient, more agile, faster, more efficient layout and optimization for enterprises, and promote the development of enterprises to the fast track.

Cloud solutions can help companies quickly lay out branches, expand new production lines and set up new distribution hubs without investing in hardware and servers. The implementation cycle of the cloud solution is very short, allowing expanding new companies to quickly start normal operations. Cloud solution has been the first choice for mainstream enterprises.

2.2. Operating Technological Environment of Smart Economy

The development of smart factory in the future needs the development of operation technology under the environment of smart economy. The value stream of factory operation depends on materials, production, assembly, packaging, logistics and planning. Whether each link of the value chain achieves lean production is the core control factor of the value flow, and it is a very important operation index for enterprises to improve efficiency. Facing extremely meager profits and variable supply chain costs, manufacturers are increasingly looking for operational flows that facilitate the improvement of efficiency and productivity. In many cases, manufacturers have already cut down on typical over-budget items, and downsized the number of employees. Nevertheless, given their limited control over market prices and rivals, operational strategies become the best way to control workshop costs and improve profitability.

2.2.1. Modern AI

The environmental policy of the development of AI in China is unprecedented, the revolution of emerging IT technology has accelerated the reform of industry, the development and continuous application of AI, block chain, big data, 5G and other technologies, Internet economy and smart economy have ushered in spring and broad development prospects.

In July 2017, a three-step strategic goal was set in the Development Planning for the New Generation of Artificial Intelligence for the development of new generation AI, which elevated AI to the national strategic level to carry out holistic planning and development. During that period, AI developed rapidly, which led to the emergence of a number of new physical things. During the ninth collective study session of the Political Bureau of the CPC Central Committee on "Promoting the healthy development of new generation of artificial intelligence in China" in October 2018, Xi Jinping stressed that AI is a vital impetus for the new round of scientific and technological revolution. Accelerating the development of new generation AI is a strategic matter of whether China can grasp the new round of the technological revolution and industrial transformation. We must have a profound understanding of the significance of accelerating the development of new generation AI to consolidate the foundation for its development in China, and promote its deep integration with economic development.
Mathematical basis of AI encompasses probability statistics, linear algebra, calculus and etc., while its technological foundation includes principles of computer, programming languages, machine operating systems and etc. of distributed systems. The continuous booming of AI is inseparable from the advancement of these mathematical and technological infrastructures, as well as the development of science and technology. The development of AI began with the Dartmouth Conference held in 1956, which marked the first year of AI era (inference period). After experiencing two winters in 1970 and 1991, it entered a development period in 2006, and finally ushered in an explosion period since 2016 after nearly 60 years of accumulation and development. For manufacturers already reaching the bottleneck of controlling costs and improving product accuracy, the use of robots has become increasingly important. Past few years have witnessed a sharp rebound in orders for industrial robots, which was approximately three times the amount before the economic crisis. According to an allied Market Research estimation, the global robotic system market (including software peripherals and other related costs) will reach $41 billion by the end of 2020. According to a *Time* magazine report, online retail giant Amazon spent $775 million to acquire the robotics project of Kiva Systems. This fully reflects its confidence in robotic warehouse operations, which has deployed 10,000 robots in its warehouse network. The move is said to save up to $900 million in order execution costs, which approximates a cost saving of up to 40% per customer order.

2.2.2. Modern Information Technology

Based on the 5G technology, a data-driven, interconnected and intelligent core information system is created for circulation, and a unified social platform is consolidated to provide enterprises with supply chain solutions. By organically combining advanced modern information technologies like automatic control, intelligent robot and digital logistics technologies, the effective integration of production factors is achieved, including human, machine, material, method and environment. In this way, the "brain" and "center" of smart factory are formed, which can process various information related to the product aggregation, such as market demand, product design and circulation instructions, thereby meeting the market demand for personalized products and providing smart system services. Cloud deployment offers information support to the transformation of those manufacturers with business agility and distributed manufacturing, enabling them to complete business deployment in weeks instead of months or years.

2.2.3. IoT-aided Logistics Supply Chain Management

Without doubt, IoT will have an impact on many aspects of the global supply chain. Supply chain management and logistics appear to possess the greatest potential. For monitoring the movement of goods in warehouses and delivery trucks, sensors, barcodes and GPS tracking have been used. A latest survey reveals that 35% of manufacturers are currently using smart devices to strengthen the manufacturing process and improve the operation process, whereas another 17% of manufacturers plan to initiate IoT application projects in the next three years. At present, 38% of manufacturers embed sensors into their products for collecting operating data from end users/clients for product improvement, and another 31% of manufacturers plan to adopt this measure in the future. Moreover, 34% of manufacturers believe that the adoption of IoT strategies is "extremely important" to them.

3. Current Status of AI Integration with Grain Circulation Industry

Grain circulation is a traditional industry, and AI is a new industry in recent years. The integration
of traditional industries and emerging industries brings broad prospects and future, but we need to fully understand the current situation and know ourselves and enemies in order to better integration and development.

3.1. Shortcomings in China's Grain Circulation Industry (Macro Level)

There lacks collaborative optimization among supply, industry and value chains during grain circulation. The circulation process, which comprises grain planting, grain purchase, grain warehousing, grain processing, grain circulation, grain trade, etc. features insufficient industrial integration, presenting a serious contradiction between stocks and increments. Due to the overcapacity and selective shortage in the market, there is excess homogeneous competition.

Grain planting industry is relatively backward. In China, urbanization is still progressing rapidly, and the older generation of peasant households with contracted production remains the major labor force for grain production. Due to the slow advancement of land circulation, rural industrial clusters are yet to be formed, and the agricultural modernization is still some way off. These limit the development of AI in agriculture.

Grain processing industry is relatively dispersed, the AI layout is somewhat weak, and systematic smart manufacturing solutions are lacking. The concept of lean production is inadequate during the grain processing and circulation, the smart application of AI is insufficient, and the overall processing efficiency is rather low.

Taking a comprehensive view of the grain processing industry, there are excess medium- and low-end products and insufficient high-end products, so further development and popularization of smart high-end products are necessary. Medium and low ends imply utter competition, inability to lead the market and an overall low return on investment.

3.2. Shortcomings in China's Grain Circulation Industry (Technological Level)

China's grain circulation industry started relatively late, the whole process of grain circulation is insufficient, and the isolated island phenomenon between various links is obvious. there are many shortcomings in the circulation process from field head to food tail, which are mainly as follows from the technical level.

3.2.1. Operational Decision Level Based on Value Flow

The correlation between the decision-making of grain circulation supply chain and the value chain is not high, the distribution of industrial clusters is uneven, the distribution of industrial chain is too concentrated, and the market demand is not balanced. The level of standardized circulation process is low, and it lacks the market decision-making mechanism of equilibrium, differentiation and agility. As a result, there are too many waste links in the value flow of grain circulation at the level of management and decision-making. The output ratio of planting, the logistics of collection and storage, the efficiency of production and processing, the fine packaging, the marketing channels and so on all reflect the management effect, which also brings the uncertainty and blindness of decision-making.

3.2.2. Grain Circulation Level Based on Material Flow

Improvement in the overall efficiency of grain circulation is necessary. The control of grain circulation links depends excessively on the experience and knowledge of workers, the level of refined and standardized optimization control is not high.
The logistics energy efficiency analysis and optimization ability of differentiated grain product R & D, design, processing, technology and circulation are insufficient, and application of virtual simulation technology is lacking.

3.2.3. AI Application Level Based on IT Information Flow

There are isolated islands in the data chain in the process of grain planting, grain purchase, grain warehousing, grain processing, grain circulation and grain trade, and the data cannot be interconnected. Big data, IoT and cloud computing are insufficiently applied in the grain circulation and management optimization. Expansion of information resources with IoT is still needed to achieve in-depth understanding of complex circulation characteristics.

3.2.4. System Support Level

Regarding China's grain circulation industry, the overall efficiency of supply chain is undesirable, which is not only reflected in the low cross-level output efficiencies of planting, harvesting and storage links, but also in the low cross-domain operational efficiency of circulation and logistics links. The existing system can hardly achieve automatic processing of unstructured data to drive smart decision making, which also remains unable to support software platforms covering complex knowledge and entire industry chain for assisting manual decision making. A novel operating architecture is needed to achieve control–optimization–decision making.

4. Development of Smart Economy in the Grain Circulation Industry

Taking digital transformation as the core direction and strategy of development, the factory of the future for grain circulation will implement the optimal strategy of integrated operation, and achieve full integration of modern information technology with AI and the digital assistance of sustainable development, in order to realize digitalization of circulation processes, including Grain cultivation, grain purchase, grain warehousing, grain processing, grain circulation, grain trade, etc.

4.1. Achieving Deep Integration Among Grain Circulation Industries via the Internet, and Establishing an Agile Grain Circulation Factory Driven by Customer Demand

Only through integration among various industries in grain circulation, can the factory of the future for grain circulation be truly built, and can a grain circulation cycle centering on the future factory that is driven by customer demand be formed. Customer consumption, which guides front-end production, is somewhat influenced by factors like location, living habits and customer group. The combination of consumption factors varies with the environment. Building a future factory requires development of product strategies and reconfigurable products that delay product differentiation and agility, in order to cope with ever-changing product requirements.
4.2. Establishing an Optimization Mechanism for Full-process Operation of Grain Circulation

For full-process operation of grain circulation, establishing a comprehensive optimization mechanism is required, which features digitalization centering on big data; intelligent robots, intelligent agents and knowledge automation; networking via the IoT, the Internet, and physical information networks; automation by means of auto-induction, active response and automatic control; agility for responding quickly to the market, dynamic resource allocation and flexible production; high efficiency of coordinated control, real-time dynamic monitoring and service standardization; and greening of social responsibilities like environmental protection, energy conservation and safety risk traceability. With this measure, effective utilization of resources can be enhanced over the entire process, thereby achieving a flexible full-process operation.

4.3. Achieving Green Real-time Monitoring and Traceability Control for Grain Circulation

Real-time monitoring and traceability control can be realized for the entire process of grain circulation by using the 5G, IoT technologies in collaboration with smart AI technology. Through the front-end monitoring of planting soil, seeding, fertilization, irrigation, harvesting and sales of grains, the scientific, green and efficient planting can be accomplished. Through the middle-end monitoring of warehousing, processing, packaging, sales and transportation in grain processing plants, the efficiency of production and processing can be enhanced. Meanwhile, collection and analysis of big data on grain distribution, circulation and after-sales are achievable, so are the analysis of consumption data by region and customer group, and the feedback and overall adjustment of grain planting structure. Through interconnection and sharing of big data over the entire front-, middle- and back-ends of grain circulation, the green, efficient real-time monitoring and traceability control for grain circulation can be achieved.

5. Construction of Future Grain Factory Based on Smart Economy

The grain future factory based on smart economy can realize the agile circulation supply chain of integrated operation from field head to food tail, and the digitalization of sustainable development. It can realize digital planting, storage, processing, technology, simulation, technology, operation and maintenance, and service, so as to achieve self-perception of grain information depth, intelligent optimization and self-decision-making, accurate control self-execution and service feedback self-adjustment under smart economy.

5.1. The Central Control System of the Future Grain Factory

The future factory focuses on creating a data center platform that implements data interconnection in the grain industry based on technology under the intelligent economy, and conducts intelligent analysis for big data. Based on cloud computing, AI and big data, real-time data collection and graphical display are carried out through docking TMS, OMS, ERP, MES, PDM, WMS, BMS, UC/DC, etc., to provide managers with a convenient integrated information platform for real-time monitoring of the circulation process, and to achieve digital and scientific production decisions.

5.2. The Business System of the Grain Future Factory

(1) Smart planting business system

To achieve regular automatic monitoring of soil, automatic monitoring of moisture, daily monitoring
of diseases and insect pests, etc., based on detection data, automatic replenishment and repair of soil, automatic irrigation, fertilization, pest control.

(2) Cloud warehousing business system

Realize the centralized storage and regional planning of grain purchase through cloud warehousing. And distribute the reasonable allocation of resources, types and quantities between the central warehouse and the regional warehouse. Real-time monitoring of inventory data to avoid stagnation and waste, improve the rapid early warning of inventory water level fluctuations, and improve inventory utilization and turnover.

(3) Processing business system

Through processing modeling to manage the processing basic information platform, complete the digital asset management to support the operation, and realize the centralized maintenance of production factor information such as equipment, product, process, organization and so on. Improve the overall abnormal management and production management level.

(4) Planned business system

Through planning and management, comprehensively manage the resource capacity and dynamic load of planting, acquisition and processing, draw up plans at all levels of planting, acquisition, warehousing, processing, circulation and trade, and provide real-time feedback on the implementation of plans at all levels to form a closed loop.

(5) Field operation system

Through on-site operations to strengthen the pre-, during and after the implementation of the process constraints, reduce quality risk factors, real-time feedback on-site operation dynamics, the formation of on-site-centered operation coordination.

(6) Circulation operation business system

Carry on the traceability management to the product life cycle state through the circulation management, introduce the service management concept with the site as the core, improve the implementation efficiency and ensure the smooth circulation of each link from planting, warehousing, processing, trade and other links. Support forward, reverse traceability, full-link traceability, to create an efficient factory.

6. Conclusion

In the real world, the definition of Factory of the Future for grain circulation is constantly changing with the continuous advancement and development of core social IT technologies like the Internet, big data and intelligent manufacturing. Meanwhile, with the continuous technological advancement, people's naming of the factory has also undergone changes. Some call it "Smart Manufacturing" or "Digital Enterprise". Despite terminological differences, but the development trend is certain: technology will dominate everything in the future, technological innovation will bring about industrial change and rapid development, the future will be a high degree of integration and development of technology and industry, and smart economy will continue to be applied to the grain industry. And promote the construction and development of grain factories in the future.
The exacerbated instability of the global economy by the Sino-US trade friction, the stagnant development in the post-economic crisis era and the feeble economic recovery in the new era will gradually evolve into a period of rapid development for enterprises. The increasingly fierce competition will further squeeze the profits of enterprises and the return on investment of shareholders, but with the help of new technologies under the modern and future intelligent economy, we can optimize the orderly development of the industrial chain and value chain of enterprises, enhance profit space, and increase competitive advantages, so that enterprises can better achieve their business goals. In the entire grain circulation field, such influence will be ever-stronger and even more prominent as a growing number of enterprises and their suppliers transform into factories of the future that cover product design to supply chain logistics. With the advantages of faster speed, greater value, more innovations and better catering to personalized needs of customers, the factory of the future will become the future development trend of every industry.

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