

Analyzing Industry 4.0 With An Example From Agricultural Manufacturing

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ABSTRAK

Sebuah studi mengenai teknologi industri 4.0 *John Deere and Company* dan dampaknya terhadap operasi perusahaan disajikan dalam makalah ini. Implementasi Industri 4.0 *John Deere and Company* pada pabrik - pabrik dan faktor-faktornya menjadi fokus penelitian. Tinjauan pustaka dengan pendekatan sistematis serta tinjauan komprehensif tentang perkembangan *John Deere and Company* saat ini digunakan dalam studi ini. Studi ini juga mengandalkan informasi yang tersedia secara bebas di situs laman perusahaan. Hubungan masyarakat dan investor juga telah digunakan sebagai sumber informasi yang kredibel. Sebuah analisis menemukan bahwa mengadopsi teknologi industri 4.0 ke manufaktur pertanian menghasilkan produk dengan kualitas lebih tinggi, peningkatan produktivitas, keamanan, dan penerimaan yang lebih luas di antara para pemangku kepentingan. Studi ini mengasumsikan penerapan penuh teknologi ini pada semua perusahaan manufaktur pertanian, dan juga menekankan teknologi terkini. Mempelajari topik ini dapat bermanfaat bagi para insinyur di bidang mekanik dan pertanian, manajer dalam bisnis, dan pemain pasar.

Kata kunci: Manufaktur Pertanian, Industri 4.0

ABSTRACT

A study of industry 4.0 technologies in the John Deere and Company and their impact on company operations is presented in this paper. Deere and Company's implementation of Industry 4.0 to its factories and its factors was the focus of the research. The literature review with the systematic approach as well as a comprehensive review of current John Deere and Company's developments is used in the current study. Also, it relied on freely available information on the company website. Public and investor relations have also been used as credible sources of information. An analysis found that adopting industry 4.0 technologies to agriculture manufacturing results in higher quality products, increased productivity, safety, and wider acceptance among stakeholders. This study assumes full implementation of these technologies in all agriculture manufacturing companies, and it also emphasizes up-to-date technologies. Studying this topic can be useful for engineers in mechanical and agricultural fields, managers in business, and marketers.

Keywords: Agriculture Manufacturing, Industry 4.0

1. Introduction

Due to human population growth requirements for crop production also increased. For example, wheat production increased from 697 MMT (million metric tons) in 2001/2012 to 772.64 mm in 2020/2 [1] Therefore boosting the manufacturing combine harvesters demanded. According to Fact. MR report, combine harvester market's growth expected to be more than 3% between 2020 and 2026. To meet agriculture manufacturing market needs and take sound place in today's competitive global market, Deere and Company (further DE), the leader of the combine harvesters manufacturing actively integrates Industry 4.0 concepts, today's most trending industrial phenomenon during the manufacturing process and in delivered products.

Incorporated in 1958, located in more than 70 countries, JD manufactures farm machinery and industrial, construction, and forestry equipment such as forklifts, bulldozers, and industrial tractors [2]. JD is the pioneer of the implementing Industry 4.0 phenomena on its manufacturing factories and its products delivered to customers [3] [4] other initiatives of the Ministry of Industry, Foreign Trade and Services (MDIC – Ministério da Indústria, Comércio Exterior e Serviços).

1.1 Questions of the study

In this study the following research questions were analyzed:

- What is Industry 4.0 in agriculture manufacturing?
- How does JD integrate Industry 4.0 into its manufacturing factories?
- How does JD integrate Industry 4.0 in its products?
- What are the social, economic, and environmental impacts of implementation of Industry 4.0 in JD assets?

1.2 Objectives of the study

The following are the objectives of this assignment:

- Industry 4.0 and its concepts
- Integration of Industry 4.0 in Deere and Company's manufacturing factories
- Industry 4.0 concepts in DE's products
- The social, economic, and environmental impacts of implementation of Industry 4.0 in JD assets

1.3 Literature review and hypothesis development

1.3.1 Brief history of JD.

Being among the five oldest American companies, JD is the leader in agricultural manufacturing in the world and a leading producer of construction and forestry equipment, as well as lawn and grounds maintenance equipment in the US. Over 5000 independent retail dealers in more than 160 countries distribute the company's products. Ever since John Deere introduced the first self-cleaning steel plough in 1837, the company has been an industry innovator.

In 1868 y. an American blacksmith John Deere incorporated Deere and Company which produced steel ploughs. By 1907 the company had expanded to include cultivators, corn and cotton planters, and other agricultural implements. In 1911 JD had its first public stock offering. Immediately after buying one of the first tractor maker company the Waterloo Gasoline Engine, JD sold 8000 Waterloo Boy tractors in the same year. JD harvester combine production generation started with the production of its first combine harvester the John Deere No.2 in 1927. In 1947 to produce a broad spectrum of the company's construction and forestry equipment, The DEDubuque Works factory opened. And the same year this factory manufactured the Model M tractor and evolved it to the bulldozer. Continuing to focus on innovation in product design, JD manufactured the first self-propelled combine for picking and shelling corn in 1952. By 1955 JD became American largest manufacturing business. Since purchasing a share of tractor company in Mannheim, Germany and acquiring land in Mexico in 1956, JD established itself as a multinational company. Two years later JD released its Industrial equipment branch. to assist in financing a farm equipment dealership, JD Credit Company was founded in the year 1958. In 1960, Deere introduced the New Generation of Power' line of four- and six-cylinder tractors, and once more revolutionized farming. As JD continued to grow and focus on innovation, it introduced the first cotton picker in 1979 that could pick four rows at a time, increasing productivity by 85 per cent for farmers. In response to increasing demand for larger

machinery, JD was a key proponent of the "flexibility-of-manufacturing" system, so that agricultural products could be made for small and mid-sized businesses while also remaining competitive. By adopting this strategy, JD built a \$1.5 billion plant in Iowa in 1981 that incorporated computers and robots to run multiple tiny assembly lines for different products at the same time and earn a profit even at low output levels. This strategy led JD to become the country's largest manufacturer of farm equipment in the late twentieth century. Due to the low demand for the tractors at that period, only a year later, despite the small number of worker requirements, the factory started losing money until 1986. The corporation bought Central National Life Insurance Company in 1982 and expanded its JD Credit Company to include leasing operations, which helped the company recover some losses. Offering credit incentives to the farmers, assisting them financially in purchasing tractors, leads to gaining the farmers' loyalty. That contributed to sales even at a time when farmers profits decreased about 75% due to overproduction. JD purchased Curtiss-Wright Corporation's rotating combustion engine business in 1984 and all rights to Farm Plan, an agricultural-financing program. The corporation created a Worldwide Lawn & Grounds Care Division in 1990, which separated this product category from the agriculture equipment industry. JD was able to manufacture new 8000 series tractors and set new standards in control visibility, maneuverability, and power despite a loss of \$99 million in 1987. Cotton Picker 7760, the first cotton picker that builds spherical cotton modules on the go, was introduced in 1996 another Deere innovation that revolutionizes the business is enabling for continuous harvesting [5].

1.3.2 Industry 4.0 in agricultural manufacturing.

Developing Information & Communication Technologies (ICT), widespread use of the Internet resulted in a new industrial revolution in 2011 by a German initiative of the federal government with scholars and private business, known as Industry 4.0 [6] [7].

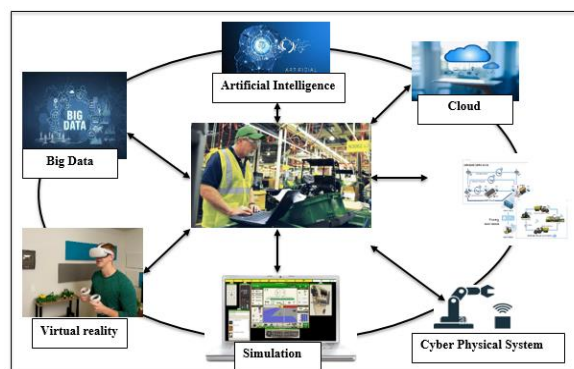


Figure 1. Industry 4.0 in agricultural manufacturing

As a result of the fourth industrial revolution (Industry 4.0), a completely new way of producing goods is being envisioned based on a massive introduction of information technology into industry, extensive automation of business processes and the broad use of artificial intelligence. Industry 4.0 refers to a wide range of contemporary notions that are difficult to categorize in terms of a field or to distinguish precisely in particular circumstances. The essential notions are presented below [8] [7]

- a. Smart manufacturing
- b. Smart Supply chain
- c. Smart products

The agricultural machinery, mainly the heavy machinery and equipment industry segment faces many challenges associated with assembly processes. This industry is characterized by a low degree of flexibility and a high cost of human error, but at the same time, the active use of technologies to achieve and the widespread introduction of agricultural mechanization in new markets. Integration of Industry 4.0 in the heavy machinery manufacturing process will bring significant benefits to manufacturers and reduce their costs. All concepts of the Industry 4.0 is applicable in agricultural manufacturing. Industry 4.0 in agricultural manufacturing is illustrated in Figure 1.

1.3.3 JD integration Industry 4.0 into its manufacturing factories?

To meet the challenges of the modern world with Industry 4.0, JD also continues successfully integrating Industry 4.0 Millenium in its manufacturing sectors. JD engines assembling factory John Deere Engine Works located in Waterloo IA is the model of implementation of

Industry 4.0 [9]. One of the manufacturing lines in this facility is a hybrid of automated and hand assembly, whereas all the remaining assembly lines are manual except few simple activities [9].

Purchasing five mid-band licenses to cover the company's five largest factories in the United States, paying \$545,999 and planning to establish private 5G networks at each location to enable smarter indoor production is another example of Industry 4.0 integration in JD factories.

Moreover, as a part of the initiation of Industry 4.0 in its factories [10], JD is utilizing Intel's artificial intelligence (AI) technology to assist in the resolution of a costly, long-standing issue in the industrial welding process is. In its manufacturing facilities, Deere is testing a computer vision system to automatically recognize frequent errors in the automated welding process. JD employs the Gas Metal Arc Welding (GMAW) process to weld mild- to high-strength steel in 52 facilities across the world, where hundreds of robotic arms utilize millions of pounds of weld wire per year. Porosity or cavities in the weld metal generated by trapped gas bubbles when the weld cools are the main challenges in this welding. GMAW flaw identification has always been a manual process requiring highly trained professionals. Implementation of AI in welding quality control on its factories, JD integrates the company's two primary values: innovation and [10].

1.3.4 Industry 4.0 concepts in JD's products.

From the first day of its existence, JD focused on innovation and has been investing in it. As the one concept of the Industry 4.0 is Smart Product, the company focused on this approach also.

John Deere took a chance fifteen years ago when it began putting mobile modems into their tractors, mostly to broadcast their location. This was an experiment with no real business plan at the time. Today, Deere's incredibly accurate 'Global Navigation Satellite System' (GNSS) is a critical point for future IoT devices, making it a key asset.

DE embedded JDLink™ telematics system to all its combines, which enables monitoring machine operation directly from anywhere with Internet access or mobile phone [11].

AutoTrac, a navigation and steering control system is another innovation used in products from John Deere [12]. It is based on NavCom's StarFire GNSS (Global Navigation Satellite Technology) guiding system, which is compatible with satellite broadcast correction information or local RTK (real-time kinematic), enabling 2.5-cm positioning accuracy, and offering a range of positioning accuracies that can be selected based on application. Additionally, to the AutoTrac system, JD employs the Terrain Compensation Module (TCM) to correct for the vehicle's roll, pitch, and yaw to give accurate ground-level location. [12] [13]

To simplify self-propelled forage harvester's (SPFH) operator's multitasking duties such as filling the transport truck, coordinating machine logistics, monitoring machine performance JD implemented an Active Fill Control system. This system minimizes the time spend truck filling process. This would add up to more than five hours of extra time over a 20-day harvest season. This time can be spent optimizing throughput, coordinating a truck fleet, monitoring forage quality with the HarvestLab™ sensor, or simply enjoying the harvest.

The practical use of aforementioned Industry 4.0 concept based innovated systems among others clearly illustrated in the most recent and tremendous products of DE, X9 series combines and 8RX Tractors.

8RX Tractor

With the orchestration of several integrated technologies, the 8RX Tractor and 60-foot, 24-row planter may achieve a self-driving solution for efficient, precise, and accurate planting in uniform rows [14]. Mechatronics, modern sensors, precision GPS, artificial intelligence, and novel mechanical design are among the technologies used. Every second, John Deere processes five to fifteen million sensor measurements, transferring up to 100 megabytes of data to the Deere data platform [14].

X series combines

In X series [15] combine JDLink™ connectivity, Integrated StarFire™ 6000 Receiver, Generation 4 Display, and Active Vision camera technology is embedded [16]. With these Combine series, JD won an award in

the Robotics category of the 2021 CES Innovation Awards. The Consumer Technology Association owns the awards program, which honours design and engineering in consumer technology goods. John Deere has got the prize for the second year in a row [15].

2. Research Methodology

The methodology of this research is a systematic literature review. The research source for the literature review is Google Scholars, Research Gate, Elsevier, Statista Business Data platform, and DE's websites.

Research and experiments about the application of Industry 4.0 in agricultural machinery, in the example of John Deere, were analyzed to see how far the subject has developed. Study limitations include the use of Industry 4.0 concepts and their application in JD without deeper consideration of Agriculture 4.0 and Smart Farming concepts. Through the research assumed the success of the John Deere and Company's current approach in management and development. These results led to the conclusion that the application of Industry 4.0 promise development to the company by improving the quality of the product and reducing the cost of production.

3. Results

Over its history from the first day of existence JD invested money in innovations. The company continuously implemented Industry 4.0 in its factories and products, adopted an online farm management system – John Deere Operation System which gives access to data whenever and wherever required with smarter machines and improved connections.

Implementing Industry 4.0 to the manufacturing factories of the company JD reduced production costs and improved the quality of the products. Due to the high cost of faults and delays [9] integrates innovative technologies such as AI among others on its production to stay competitive in business and deliver high-quality products.

Implementing Industry 4.0 to its products such as tractors, corn pickers, sugarcane and cotton harvesters, as well as mowers and golf course equipment succeeded over 22.7 billion

U.S. dollars in revenue from the agriculture and turf segment alone [17] [18] [19] [20]. Moreover, Compact Tractor Quik-Knect™ System, PrecisionCut™ and E-Cut™ Triplex Mowers, Commercial Walk-Behind Mowers won the 2020 AE50 Award by the American Society of Agricultural and Biological Engineers (ASABE); The Red Dot and iF awards for product design have been won by 8R tractors, two of the oldest and most renowned industrial design honours; John Deere (NYSE: DE) has been designated a Best of Innovation honour in the Robotics area of the CES® 2022 Innovation Awards from the Consumer Technology Association (CTA), as well as a nominee in the Vehicle Intelligence & Transportation category [17] [18] [19]. The company's success is driven by its core values: integrity, quality, commitment, and innovation.

4. Conclusion

This paper aimed to develop a clear picture of the application of Industry 4.0 in agricultural manufacturing using Deere and Company as an example. Deere and Company have invested in innovation over 184 years of its existence, resulting in being a leader or among the leaders in farm manufacturing. Using Deere and Company as a model, today's innovation – Industry 4.0 implementation benefits are illustrated. Agricultural and mechanical engineers, business managers, and marketing students can benefit from this study.

Limitation and Study Forward

Implementation of Industry 4.0 concepts has been covered in this study. However, the study did not focus on the following points:

- a. Comparison with the competitors.
- b. A deeper study of Agriculture 4.0
- c. Deeper studying Smart Farming.
- d. Some aspects of the topic haven't been discussed due to a large amount of information

Future studies might concentrate on JD strategy on Smart Farming and Agriculture 4.0 in comparison with the competitors. It would also be required to look at the impact of competition on Deere and the company's strategy. The company's management system – John Deere Operation Center is also can be included in further studies.

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