AGRICULTURE 4.0: SMART REVOLUTION OF THE FUTURE FARMING SECTOR

Abstract:

According to research, some agricultural professionals are worried about the use of some smart technologies. Some studies claim that agricultural cultures may be “Rescripted” in unfavorable ways, and there is precedence to imply that the general public is apprehensive about radical new agricultural technology.We elaborate on these interventions by suggesting that the fourth agricultural revolution should include essential features of responsible innovation, such as anticipation, inclusiveness, reflexivity, and responsiveness. The paper examines the stages of the industrial and agricultural revolutions in recent years, as well as their future possibilities. Although industry is growing, the agricultural sector has certain hurdles in adapting to Agriculture 4.0. The presented study may provide an overview of how technology advancements impact various industries and agriculture sector.

Keywords: Agriculture 4.0; Supply chain; Application research; Industry 4.0; Open source; SMEs.

Introduction:

The first agricultural technology revolution brought forth significant improvements: Between 1961 and 2004, East Asian grain yields increased by 2.8 % each yearly, and more than 300 %, thanks to modern agricultural methods such as irrigation, fertilizer, and pesticide usage, as well as the introduction of varietals of crops that are newer & extremely productive (world bank, 2008). New technologies must be developed, and existing ones must be improved (Clercq*et al.*, 2018). Agriculture's quick use of technology aids production, which is critical at this time. The fourth stage of industrial development has arrived, and its implementation has ushered in a sea shift in the agricultural sector, enabling farmers to increase yields more efficiently (Sharma *et al.,* 2013). Agriculture 4.0, next generation of agriculture revolutions, must be revolution based on scientific research & technologies (Beddington, J., 2010). Agriculture 4.0 must include both the demand and supply sides of the feed crisis equations, leveraging technologies not just for sake of invention, butalso better understand as well as respond to genuine customer requirements, as well as reengineer the value chains. Robotics, temperature and moisture sensors, aerial photography, and Global Positioning System technologies, to name a few, will revolutionize how contemporary farms and agricultural businesses operate (Clercq*et al.,* 2018).

Concept of Agriculture 4.0:

Unlike agriculture, industry uses quantitative approaches to control its supply chains. Inreality, heuristic techniques based on experiences play important roles within agricultural production, from which ecological exposures & deterministic activities lead to an enhanced level of supply chain unpredictability & lack of consistency in agrarian operations (ex, photosynthetic activities & nutrients status, soil, as well as insect infestations) (Ge, H. *et al*., 2015). Existing agricultural supply chain approaches attempt to capitalize on recent modern technological and digital technology like smart agriculture, it combines geolocation techniques alongside the using additional sensor & data to boost productivity (Griepentrog and H. ZukünftigeEntwicklungen, 2016; Marucci, A. *et al*., 2017). Thanks to technology solutions, challenges in Farming, distribution network and strategies may be turned off being profitable. Easy effortless innovations like Wirelesslypersonal area networking technologies i.e. BT, Navigation systems like Global Positioning System (GPS), and radio frequency identification i.e. in combination with communications amongst operators & agricultural equipment at different levels of cooperation enable the establishment of self-optimizing agricultural supply networkstructures (Marucci, A. *et al*., 2017). Without having to pay a lot of money, all stakeholders may simply organize and utilize these technologies, which are contained in a unique farm management platform. In contrast, a contemporary farm generates data that must be analyzed. On the other hand, new technology and software will not be able to handle all of the difficulties that come with digital transformation in the supply chain (Braun, A. *et al.*, 2018; Grady, M.J., and Hare, G.M., 2017; Wolfert, S. *et al.*, 2017). Infrastructure, training, and certifications are all important, as are a safe and legal working environment &a readiness to accept new technology (Braun, A. *et al.*, 2018). In rural locations, Agriculture 4.0 needs a sophisticated telecommunications infrastructure. Furthermore, throughout the Industry 4.0 time, the capacity to utilize data across the agricultural supply chain will be critical for a successful revolution of present agricultural approaches toward farming (Adnan, N. *et al.*, 2018). Using Industry 4.0 principles, the specific difficulties that agriculture confronts throughout the agricultural supply chain will be investigated. Agricultural Industry 4.0 methods may be improved and utilized, but industry is progressing faster than agriculture, with experts already considering Industry 5.0. The 4.0 revolution in agriculture, on the other hand, is still restricted to a few early adopters. As a consequence, it focuses on how technological innovation impacts those two (distinct) sectors of the economy, as well as its upcomingdevelopments & possible solutions. It starts by charting the development of the industrial sector across time, from the dawn of the industrial revolution to the present day. Nonetheless, the goal of this research is to compare industrial and agricultural pollution in order to determine if agriculture has kept up with the times. Virtualizing any agricultural production distribution network in understanding whether present farming operations may be reformed using novel technology in this manner. The industrial and agricultural transitions between 4.0 to 5.0 are also examined, with a focuson Agricultural 4.0's current triumphs.

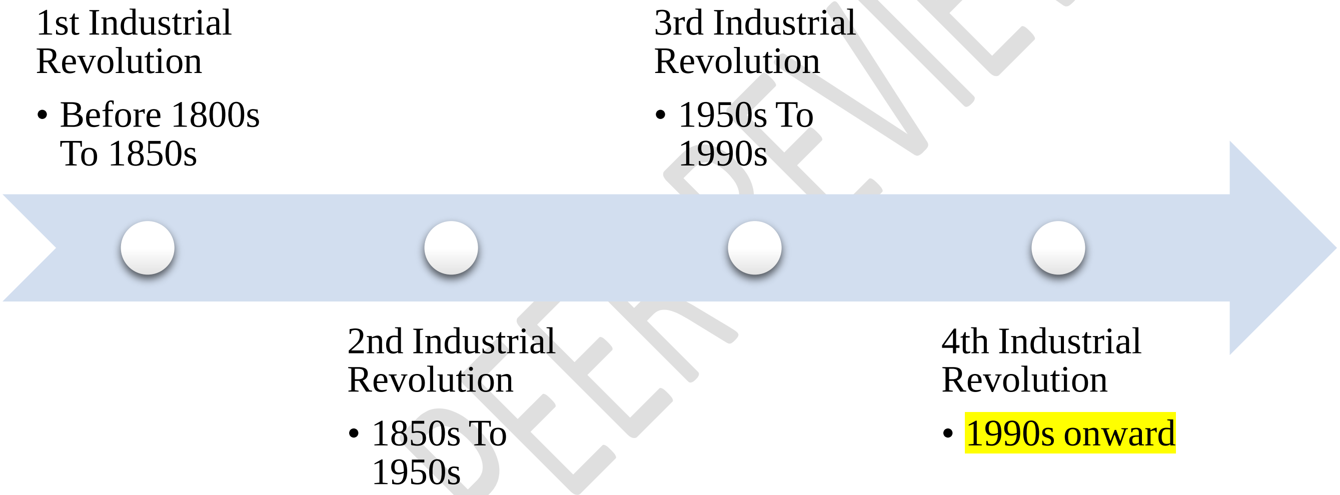
Agricultural Revolutions:

The Green Revolution enhanced agriculture, but the techniques for cultivating crops and rearing of farm animals; processes changed and affected the outcomes. Technology that is presently in development in the agricultural sector will undergo a technological transition as a result of Business 4.0. More intensive agricultural operations are necessary as a consequence of growing population needs. Agriculture plans that include technological improvements have the potential to result in long-term success. Agriculture 4.0 was just recently considered, after the announcement of Industry 4.0 in 2014. Manufacturing process difficulties (Saucedo-Martnez, J.A. *et al.*, 2018; Yin, Y. *et al.*, 2018), enterprise, supplier, and customer integration, logistics procedures, skilled lean production staff, and new management techniques are all covered under Industry 4.0.(Kolberg, D.*et al.*, 2017; Calitz, A.P. *et al.*, 2017). By boosting crop quality and soil fertility, the usage ofIoT in agriculturemay enhance the quantity and types of goods produced in the industry.IoTsystems are made up of sensor devices, gadget connections, processing of data, cloud, and user interaction. Computer and machine vision have allowed remote monitoring of farms and data processing thanks to the advancement of artificial intelligence (AI). Agriculture may profit from innovation and technology since it allows for a more precise & effective strategy, resulting which leads to better profitable & long-term agriculture. Doctor Jan Regtmeier, a product management director at HARTING IT Software Development Gmbh& Co. KG, states, "The agriculture industry has just recently started to embrace digitalization." Smart farming entails replacing obsolete technology with self-aware and self-learning machines, aided via Industries 4.0, that improve entire efficiency, repairs, and maintenance, & interface with the environment. Industrial sector 4.0 might be used by an open smart platform to measure and monitor the state of agricultural operations in real-time, as well as send control directives.

Industrial Revolutions:

Digital technology has a number of benefits for businesses (Braun, A. *et al.*, 2018). The first industrial revolution was sparked when mechanical manufacturing units driven by liquid water or steam were invented about 1780. The creation of the first electrically driven mechanical assembly line ushered in the second industrial revolution 30 years later. The dawn of the era of mass manufacturing had arrived. The 3rd industrialrevolution began whenthe 1st PLC was constructed during the late 1960s. Electronics & information technology (IT) made it feasible to automate production from that point forward (Strozzi, F. *et al.*, 2017). The automated version is eight times more efficient than the manual version of what was previously produced on basic spinning wheels. The power of steam had already been proved. Human productivity grew as a result of the usage of steam power in industry. People and products could travel farther distances in less time thanks to steam engines. Sir H. F.(1863-1947) pioneered mass manufacturing along with automobile, wherever vehicle was constructed in small batches on a conveyor belt, enabling faster & lower-cost production.Since the introduction of these technologies, the manufacturing process has been completely automated, requiring no human intervention. The fourth Industrial Revolution, sometimes known as Industry 4.0, is now in transition. It necessitates the use of data and the formation of a connection. The Third Industrial Revolution has reached the end of its life cycle. The subjects addressed in this course include supply chain, computerization, and internet connectivity (Jehoon Sung, 2018). This is next phase in manufacturing automation.

Figure 1: From Industry 1.0 to 4.0.



Industry 4.0:

Traditional methods are being transformed by Industry 4.0, which combines the use of cutting-edge smart technologies. It is built on the use of Machine-to-Machine (M2M)andinternet of things (IoT)to boost automation, real-time monitoring, and self-monitoring. Mobile devices, internet of things (IoT) platforms, enhanced life form - machinaries interfaces, sensor technologies, virtual truth/wearables, foggy, edges, & so forth accessibility to PC services are just a few examples of what Industry 4.0 entails. Resources for physiological structures, Internet - of - things, & data centers are four categories in which all of the components may be classified. Industries 4.0 represents disruptive forcesthat are based upon disrupting techniques like the IoT, huge data, &AI, as well as digital habits like collaboration, mobility, and open innovation.

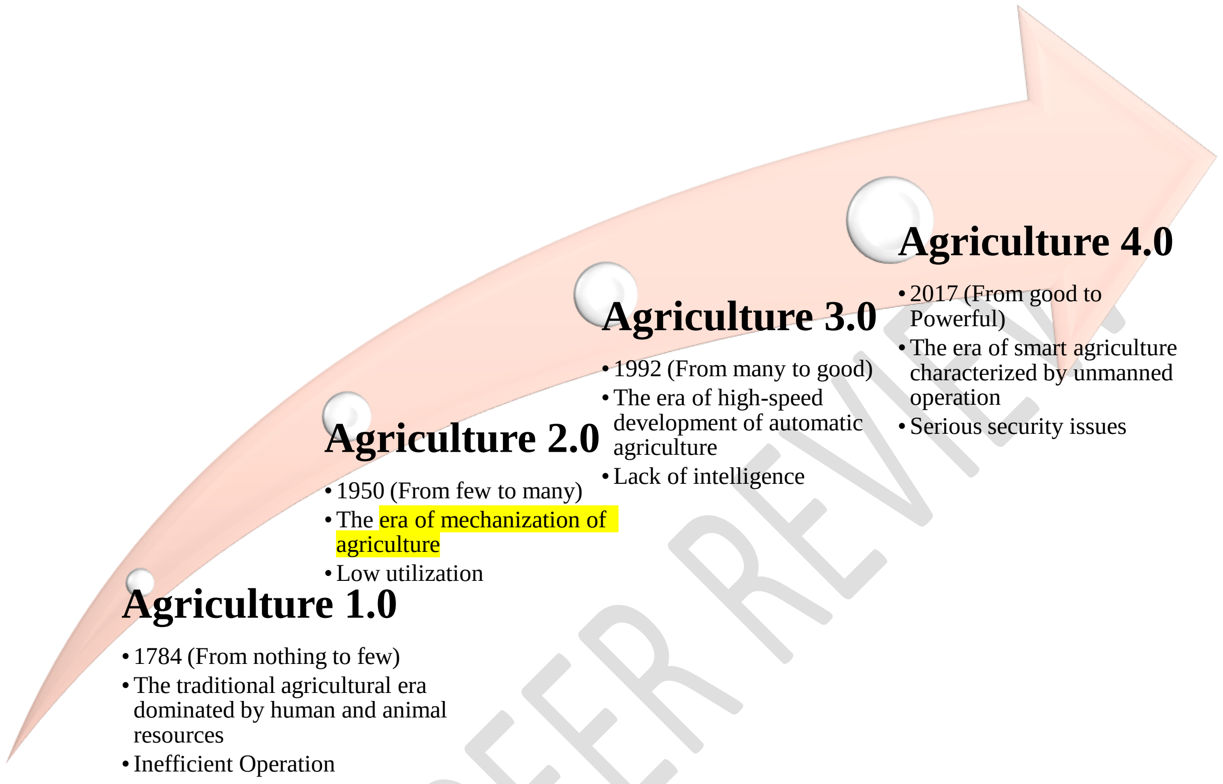
Agriculture 4.0:

Precision farming& Interconnected network of Agriculture have combined to create Agri. 4.0 (virtual farming), which brings together a number of technologies targeted at boosting crop yield and sustainability, working conditions, and production and processing quality. Furthermore, Agriculture 4.0 advancements benefit not just farms but also long-term development (Adnan, N. *et al.,* 2018). Throughout reality, a cross-analyses of ecological, meteorological, as well as social aspects can be used to determine crop watering & nutrient requirements, but to also protect psychopathology & classify weeds until they spread; as a result, it's indeed feasible to engage in such a selective manner, rescuing both contents & time while also handling out further intervention programs that seem to have a positive effect on the quality of the finished product. As a consequence, both qualitative and quantitative gain exist. Farmers save 30% on agricultural inputs while increasing productivity by 20%, and they get higher-quality, chemical-free produce (Chen, J. *et al.,* 2016). Agriculture 4.0 delivers the greatest value by integrating this data throughout the supply chain. It is feasible to track and verify items according to the farm to that same manufacturing plant, to build supply networks that are short, to acquire high-quality products, and to increase efficiency not only in manufacturing processes but also in commodity and information interchange between valuable networks participants. In rural regions, Agriculture 5.0 envisions the implementation of autonomous technology.The term "Agriculture 5.0" describes the next phase of agricultural development, which uses data-driven methods and cutting-edge technologies to improve farming techniques' efficiency, sustainability, and production. Agriculture 5.0 is a vision for the future of agriculture that incorporates cutting-edge technologies like artificial intelligence, robotics, biotechnology, Internet of Things (IoT), and big data analytics into agricultural systems, even though it is not yet widely accepted or formally defined. All things considered, Agriculture 5.0 is a paradigm change in the production of food, using state-of-the-art technologies to meet the problems of feeding a rising world population while encouraging environmental stewardship and sustainability in farming operations. Autonomous driving technology advancements for automobiles, such as multi-camera object identification and radar and lidar technologies, have already decreased the cost of producing autonomous agricultural equipment, paving the way for even more technical progress (Chen, J. *et al.,* 2016; Halachmi, I. *et al.,* 2003).

Virtual reality is useful because it allows users to completely immerse themselves in virtualized devices throughout programming, setups, use phases, & designs. Following the trend toward increasing autonomy, surprising results may be gained bymerging artificial visions, touch, sensitivity, cooperation & only the most basic decision-making abilities (Zhang, Y.F. *et al*., 2012). Vision systems, for example, can now do not just real-time object tracking but also categorization and conceptualization, allowing them to study objects & figures on your own, differentiating them based on qualities and categorizing them.

Weather data acquired in real-time by weather stations or other sensors offers data on a variety of elements such as Humidity, Rainfall, Temperature, &more. If the weather is bad, alerts are sent out. One firm in the United States employs machine learning algorithms to provide farmers, crop advisers, and merchants with smart meteorological information. Sensors can detect texture, salinity, nutritional status, organic content, and other soil characteristics. Tracer Genetics hascreated an analytics engine capable of mapping and protecting living soil. The purpose of variable-rate applications (VRA) is to use data obtained from sensors to determine the relative productivity of various places. Then, using automatic equipment& gear, you may administer herbicides, fertilizers, and other products at various rates while avoiding overlap. The accuracy of machinery navigation and location is ensured by maps and GPS. Pesticides and insecticides made with nanomaterials increase accuracy even further (Jehoon Sung, 2018). On the ground and in the air, drones are increasingly being employed for agricultural planting, monitoring, and field analysis. Irrigation patterns for various crops may be detected using thermal or multispectral sensors. A desktop or smartphone device may be used to regulate irrigation remotely. Drone Seed, Agribotix, Skycision, and HiveUAV are among the companies that provide drones for agricultural purposes (Phil Hogan and Bernd Schere, 2017). Optical sensors, drones, and satellite photos might all be utilized to monitor the health of different crops. Agricultural robots are also being developed by a number of companies. These are often used to automate irrigation, weed control, planting, fruit picking, soil management, plowing, crop harvesting, &other agricultural tasks. For example, Ecorobotix&blue river have built a robot that helps to identify unwanted plants like grasses, ragweeds in real time using cameras & then transmits info to another piece of equipment through telematics to determine the best course of action for dealing with them.

Figure 2: From Agriculture 1.0 to 4.0



Agriculture 1.0

- 1784 (From nothing to few)
- The traditional agricultural era dominated by human and animal resources
- Inefficient Operation

Agriculture 2.0

- 1950 (From few to many)
- The era of mechanization of agriculture
- Low utilization

Agriculture 3.0

- 1992 (From many to good)
- The era of high-speed development of automatic agriculture
- Lack of intelligence

Agriculture 4.0

- 2017 (From good to Powerful)
- The era of smart agriculture characterized by unmanned operation
- Serious security issues

BenefitsOf Industry 4.0 In Agricultural Sectors

1. Monitoring of Livestock:

Installing CCTV surrounding farms & grasslands for remote patient monitoring allows you to keep an eye on your animals from anywhere, IOT-based systems may gather information on the whereabouts and health of livestock. RFID, GPS, &biometrics may all be used to automatically identify and convey vital data about animals.This information is compatible with Arduino and Resberrypi boards. Connecterra IDA and other similar apps are used to keep track of the animals. This also helps to identify unwell animals and separate them from the rest of the herd to avoid disease transmission (Jehoon Sung, 2018).

2. Data management software and platforms:

Predictive analytics tools are used to examine weather, animal, and agricultural data thanks to end-to-end Internet - of - things systems & cloud-based storage and data systems. Cropio software packages aggregate data from a variety of precision agricultural hardware devices on a common network for visualization and interpretation,whichis crucial for generating educated farm choices. Farmers may get aggregated data from data systems, which keep everything in one place. Production budgets and operational plans may be readily created using task management software, and yields can be compared to industry standards (Jehoon Sung, 2018). Using cloud-based technology, farmers may learn how to adjust their production depending on market needs, increasing productivity &profitability.

3. Precision farming:

Precision agriculture is becoming more popular&efficientas smartly designed digitalized farming applications like vehicle tracking, database collecting, livestock monitoring, &irrigation monitoring gain traction.Sensors can now give data that can be examined to make smart and fast choices. Sensors may be used to detect soil characteristics, moisture, and nutrient levels in real-time, and the Internet of Things can keep track of everything. Farmers may increase their operational efficiency with these Internet-of-Things (IoT)-based technologies. (https://www.cropin.com/precision-farming/)**.**

4. Smart Greenhouse:

Farmers may be able to automate their labor with the aid of an IoT-based greenhouse system. It shields plants from the impacts of bad weather including wind, hail, UV rays, insects, and pests. In a greenhouse,soil moisture, temperature, light intensity, &humidity may all be readily monitored. It entails gathering data, processing it, & publishing it for distant access on an internet server. Because they produce insecticide- and pesticide-free crops and create an atmosphere suitable to plant development, smart greenhouses are more efficient than traditional farming (Muthupavithran, S.*et al.*, 2016).

5. Drones for Agriculture:

Drones aren't exactly a novel invention. Their time may have arrived, Thank you to greater investment & more relaxed regulatory environment: The value of drone-powered solutions across all major industries might be worth more than $127 billion, according to research. Drones have the ability to solve major problems in agriculture, one of the most promising businesses (The Race Is onOliverWyman, 2015).

8. Genetic modification:

To meet future food needs, genetic engineering will be necessary. CRISPRtechnologiesare groundbreaking nova approaches to genomic editing that allow for more selection & minimizethe danger of error. The technology might be used to inject important vitamins, nutrients, and minerals into crops, as well as generate breeds with better yields and greater resistance to harsh environments. CRISPR is making genetically modified animal food more widely available.

Conclusion and Future Implications:

In the agricultural industry, model creation has taken a long time and a lot of work. Despite the potential advantages of smart agriculture, the use of new models on individual farms is restricted; the mechanism for doing so in terms of Yield, Profitability, & Sustainability is unclear (Grady, M.J., and Hare, G.M., 2017). Both Agriculture 4.0 and Agriculture 5.0 need a stable and legal working environment, which may be achieved via new technology, training, and certification. Policymakers might put out calls for proposals to encourage more start-ups and small &medium-sized enterprises to invest in these technologies. To stay competitive & ahead of other economic realities by keeping up with the coming technological revolutions(Bakkari, M. and Khatory, A., 2017). A training program must also be developed in order to lead to successful farm solutions that react to the demands and interactions of farmers' operational contexts. The capacity to utilize data throughout agricultural supply chains might help current farming operations become more efficient and imaginative.

SME executives must understand how to approach innovation and what benefits may be gained by concentrating on Industry 4.0 or Agriculture 4.0 initiatives. (Zhong, R.Y. *et al.*, 2017). The way you behave as a customer and/or a supplier has a significant influence on how small companies run. There are various limitations to methodology and conclusions in the context of Agriculture 4.0. Future academics will be able to give generalizable fallouts on how organizations migrate or grow their marketing strategies have shifted through manufacturers via information and communications technologies (ICT) and back again thanks to Revolution 4.0 (Müller, J.M. *et al*., 2018). Agriculture's food production process is influenced by industry practices. Soil pollution,compaction, deterioration, anderosion are all issues that have arisen as a consequence of the recent modernization of the agricultural production process (Keesstra, S. *et al.*,2018; Keesstra, S.D. *et al.*,2016). Soil quality suffers as a consequence, as do the ecologicalsystemically functions that the earth soil has provided us through time (Galati, A. *et al.,* 2016; Cerda, A. *et al.,* 2018). Evidence of this severe soil disease, as well as some potential remedies, may be discovered in a number of places across the globe (Keesstra, S. *et al*., 2018; Cerda, A. *et al*., 2018; Rodrigo-Comino, J. *et al*., 2018). Soil deterioration has come from a failure to appreciate how present agricultural systems manage agriculture, which must be corrected. As a result, the 4.0 revolution should be concerned not just with technology advancements, but also with environmental concerns (Stafford-Smith, M. *et al*., 2017; Rodrigo-Comino, J. *et al*., 2018). In this light, the UNs' goals includedtheeconomic sector as a responsible & valued participant in the creation of a sustainable future (Novara, A. *et al*., 2017). In order to progress toward more sophisticated technological development, natural resources in the primary sectors, such as soil, might been managed in line with sustainable principles (Bucci, G. *et al*., 2018; Demirbaas, N., 2018).

Conclusion:

While Primary Sectors remains unsatisfactory, and Agriculture's 4.0 Revolution is currently restricted to a few pioneers of enterprises, Future of Industry is heading towards 5.0 Industry. Policymakers could propose laws or solicit ideas to assist SMEs(Small and Midsize Enterprise)in expanding their technical and sophisticated skills, enabling them to compete more effectively in the market. In order to support creative and long-term development, this report recommends policymakers and decision-makers to invest in technology innovation and suggest alternative solutions for all economic sectors. Agriculture has a lot of potential to become more efficient and productive with Industry 4.0. Although several well-known companies have begun to use digital solutions, there is still a long way to go in terms of actual implementation. Manpower shortages, resource allocation, and supply chain management are all problems that must be solved. New advantages like as real-time monitoring, smarter operations, &enhanced business processes will, nevertheless, stimulate deployment as time goes on.

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