



Green supply chain based on artificial intelligence of things (AIoT)

Javid Ghahremani Nahr¹, Hamed Nozari^{2*}, Mohammad Ebrahim Sadeghi³

¹ Faculty member of Academic Center for Education, Culture and Research (ACECR), Tabriz, Iran

² Department of Industrial Engineering, Islamic Azad University, Central Tehran Branch, Tehran, Iran

³ Department of Industrial Management, Faculty of Management, University of Tehran, Tehran, Iran

ARTICLE INFO	ABSTRACT
<p><i>Received: 6 March 2021</i></p> <p><i>Reviewed: 17 March 2021</i></p> <p><i>Revised: 6 April 2021</i></p> <p><i>Accepted: 30 April 2021</i></p>	<p>Purpose: The most important driving force for the IoT is artificial intelligence. The dramatic growth of the Internet of Things in various fields necessitates the use of artificial intelligence capabilities in the optimal use of data. By combining these technologies, it reduces cost, automation and productivity more dynamically. This hybrid technology is called artificial intelligence of things (AIoT).</p> <p>Methodology: Intelligent solutions in the supply chain, i.e. the use of the Internet of Things with the capability of artificial intelligence, has been able to make various industries great.</p> <p>Findings: Due to the colorful role of IoT technology in the sustainability of industrial systems, this paper provides a framework for the implementation of an AIoT-based green supply chain. This framework shows a clear path to understanding the impact of this hybrid supply chain technology.</p> <p>Originality/Value: In his paper, a framework for the implementation of an AIoT-based green supply chain is provided.</p>
<p>Keywords: <i>Internet of Things (IoT), Green Supply Chain, Artificial Intelligence of Things (AIoT), AIoT Based Green Supply Chain.</i></p>	

* corresponding author: ham.nozari.eng@iauctb.ac.ir
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1. Introduction

The IoT connects hardware, sensors, and devices with different technologies to each other and to the Internet by receiving, controlling, and analyzing information. The use of low-cost sensors, thanks to scientific advances and low-cost connectivity, has expanded the use of the Internet of Things. Help mass systems that use different equipment and produce a lot of data. Managing and extracting valuable information from these systems is very difficult. In this situation, the best solution is to use artificial intelligence [1]. In the IoT, things like: connectivity, security, data storage, system integration, hardware, application and network development, and processes that change in this space; There will be a need for remote management and control, updating, safety and cost-effectiveness. The combination of IoT-enabled devices and sensors with machine learning creates a shared world, where innovation and optimal results are the fruits [2]. IoT and AI have changed many industries and businesses. Customer-related businesses collect data through IoT and turn it into usable and valuable data to boost industries and businesses. If the data is used for specialized tasks such as predicting events, component failure; you need to be aware of the type of data and its processing. It is difficult to use traditional tools to analyze data that is constantly changing and abundant. Artificial intelligence is a powerful and effective tool in such cases. These various advances in information technology capabilities have changed the face of the industry more rapidly than in the past decade [3]. Adoption of IoT technology along with artificial intelligence and its efficient implementation can improve the cooperation between supply chain members through the rapid transfer and distribution of accurate information and the use of information systems and increase the efficiency of the supply chain. Suppliers can use the Internet of Things, artificial intelligence, and advanced methods of analysis to determine the risk of refrigerator failure, the health of a consignment of frozen goods, by monitoring location, weather conditions, environmental conditions, traffic patterns, and so on. Is it threatening or not? In such a situation, they can automatically deliver the goods to one of the nearest distribution centers or send a technical repair team to solve the problem, to prevent equipment breakdown, based on the insight gained from this important member of the family of sustainable supply chain technologies. Therefore, these hybrid technologies can play a valuable role in stabilizing and improving environmental conditions. For this reason, this study provides a framework for green supply chain based on artificial intelligence of things [4].

The second section reviews the literature. In the third part, the green supply chain is presented. The fourth section addresses the role of artificial intelligence in sustainable development. In the fifth section, a conceptual framework is presented and finally in the last section, a conclusion is presented.

2. Literature Review

This technology uses information tools, intelligent equipment such as RFIDs, wireless sensor networks, etc., firmware, web-based software platforms and relies on cloud computing to meet the challenges of automated detection devices, which results in the production of large volumes of data. By creating a virtual infrastructure in the Internet of Things, cloud computing integrates monitoring and storage processes, analytics tools, visualization platforms, and customer delivery [6].

With the daily increase in data production on the Internet and the advent of IoT devices worldwide, artificial intelligence is emerging to provide its countless capabilities with IoT connectivity [5]. It is important to note that IoT applications require a data-driven culture of analysis. Analytics will increasingly be used at the edges and focal points of networks rather than in data centers or cloud

systems. In fact, it provides data on moving to the right place, and current analysis gives us a perspective on the right place and time [7].

An artificial intelligence system is a computer system that makes a decision or performs a task that a human being is capable of performing. At present, artificial intelligence is a form of advanced analysis that relies on machine learning, optimization, and in-depth learning. Connections enhance the smart elements in products and devices by externalizing their capabilities. This makes monitoring, control and optimization conditions possible. Connected objects themselves do not promote learning but pave the way. Many IoT applications rely on sending data to a cloud system or data center, as well as analyzing and modeling data and applying these perspectives. They ultimately give us results and possibly return modified logic to the same devices. Interconnected devices in order to enhance learning and collective intelligence, and to take advantage of objects' artificial intelligence capabilities, they must understand the value of the information provided to them and used in informal and automated networks [8]. Artificial intelligence of things (AIoT) provides a unique opportunity to enhance learning and personalization at the same time. These AI systems can work well with other AI systems. With the rapid advancement of the Internet as well as intelligent technologies such as RFIDs and sensors, the Internet of Things and its combination with the artificial intelligence that make up AIoT technology, has passed the initial stages and gone beyond and is considered a kind of IT technology revolution that the Internet Transforms from a static environment to a dynamic and integrated environment [9].

Due to the complexity of the supply chain and in order to better manage those companies, new technologies are considered as a potential factor in improving the performance of their supply chain. The use of these technologies can help companies as a competitive advantage and improve their performance in the supply chain. Therefore, the most accurate use of integrated information devices such as Internet technology of objects in this part of the management of the organization is important. Coverage of this information accurately and in an instant facilitates matters and makes the process progress more transparent. To improve this process, cloud computing is used as a solution. In addition, other cloud computing capabilities can be used, such as facilitating object communication, integrating monitoring devices, and IoT storage, data analysis, and cyberspace to provide the customer with supply chain management. This requires a model that defines how Internet technology relates to objects, cloud computing, and supply chain management [10]. There is a great deal of information about supply chain processes, and this allows for more insight than ever before. Add to this the machine learning capabilities used in many IoT platforms, creating a veritable ocean of practical information that businesses can use to improve processes and more environmentally sound performance. For this purpose, in this paper, by examining the valuable factors affecting environmental sustainability, a framework has been developed that can be used to create a sustainable space.

3. Green Supply Chain

Green supply chain management was introduced by the Michigan State University Industrial Research Association in 1996. In fact, it is a new management model for environmental protection. Green supply chain management from the perspective of product life cycle includes all stages of raw materials, product design and manufacturing, product sales and transportation, product use and product recycling. By using supply chain management and green technology, the company can reduce the negative environmental impacts and achieve optimal use of resources and energy. Supply chain greening is the process of considering environmental criteria or considerations throughout the supply chain. Green

supply chain management integrates supply chain management with environmental requirements at all stages of product design, supply chain selection and greening, the process of considering environmental criteria or considerations throughout the supply chain [11]. Although in the supply chain literature the concepts of sustainable supply chain management and green supply chain management are often used interchangeably, the two concepts are slightly different. Sustainable supply chain management includes economic dimensions and social and environmental sustainability [12]. Therefore, the concept of sustainable supply chain management is broader than green supply chain management and green supply chain management is part of sustainable supply chain management. In the past, the product life cycle included processes from the design phase to consumption. While with the environmental management approach, it includes the processes of raw material preparation, design, construction, use and recycling, reuse and the formation of a closed loop of material flow to reduce resource consumption and reduce the harmful effects of the environment [13].

Green supply chain Components includes the following.

Green design: The Company must consider a complete description of the environment, human health and product safety in the process of obtaining raw materials, production, distribution and its purpose is to prevent pollution at the source.

Green materials: refers to materials that consume less resources and energy and make less noise, are non-toxic and do not destroy the environment. Green productivity is much greater than all management productivity.

- **Green production:** Green production is also known as clean production. At different stages of development or in different countries, the names of green production are different. But the main meaning is the same.
- **Green marketing:** The purpose of green marketing is to create coordination between the goals of economic development and environmental development and social development and promote the perception of sustainable overall development.
- **Green consumption:** means trying to choose an environmentally friendly product and service to use and deal with a waste product that may be harmful to the environment.

The components of the green supply chain are shown in Figure (1).

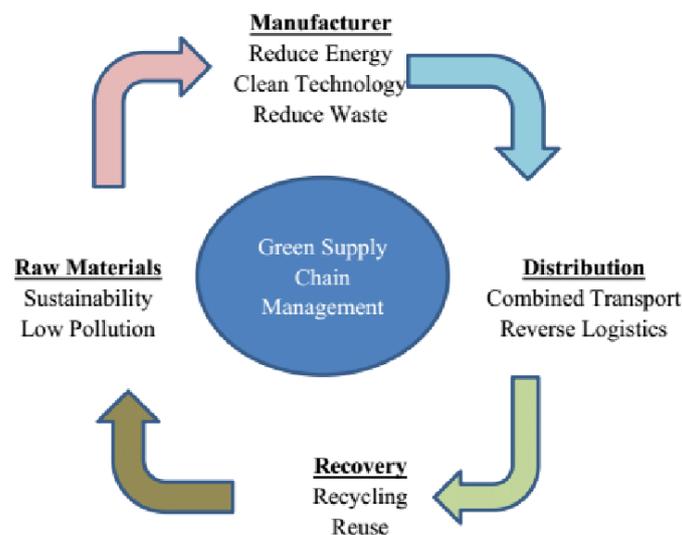


Fig. 1. Green supply chain components

4. AIoT in Sustainable Development

Environmental sustainability emphasizes reducing the use of natural resources and non-renewable energy, preventing the loss of energy resources, reducing waste production and emphasizing the reuse and recycling of waste, using recyclable materials and reducing pollution in industry and agriculture. Implementing AIoT to improve the environment is one of the areas that will have a great impact on preserving the environment and reducing pollutants.

The use of the Internet of Things in the field of social sustainability leads to greater communication between individuals in local, national and international communities; Increases their awareness and interaction with each other. This means social development. An intelligent transportation system, through the Internet of Things technology in the transportation process, creates the ability for different parts to interact with each other in an interactive way. The Internet of Things has already provided a convenient and practical framework for intelligent transportation studies. This technology exchanges information about the transportation of vehicles through the network without human intervention. As a result, based on the connection of objects with each other, the devices and tools of the system will become particularly intelligent and will exchange information and purposefully interact with each other. In such a way that the goals of the transportation network will be achieved, which will increase safety, satisfy passengers and solve the problem of traffic and congestion [14].

IoT technology provides an opportunity to increase energy and productivity through green energy and renewable energy. IoT collects real-time data on energy and water resources, facilitates the conservation of more informed resources, and collects data in a simple way in order to achieve traffic patterns and parking availability, reduce gas consumption and uses greenhouse gases. So, in general, we can say that in sustainable urban development, improving the quality of urban life, including environmental, cultural, political, institutional, social and economic sectors without exerting any pressure on future generations or pressure resulting from reduced natural and local capital.

5. Proposed Work

The Internet of Things, in addition to being a revolutionary technology for all industries; It has also demonstrated its potential in processes such as supply chain. Combining this technology with artificial intelligence technology helps management, forecasting and monitoring applications to improve the operational efficiency of their company's distribution and increase transparency in their decisions. So more than ever, the benefits of using AIoT in the supply chain are obvious. Because a wide range of AIoT applications are used in supply chain management. This facilitates the tracking and monitoring of goods and creates more transparency in the communication and planning process. All complex areas of the supply chain process can be improved with AIoT. Pursuing and monitoring some of the main goals of AIoT deployment in supply chain management. This technology allows warehouse and fleet managers to track their shipments and inventory. However, AIoT has more potential for the supply chain. Here are more reasons to use AIoT in SCM:

- **Real-time shipment location tracking**

AIoT provides managers with a coherent flow of real-time data about product location and shipping environment. In this way, you will be warned if the goods are transported in the wrong direction and you can monitor the delivery of finished goods and raw materials.

- **Monitor the storage status of the product during shipment**

Thanks to environmental sensors, managers can track transport conditions and actively respond to changes. For example, one of the most common AIoT solutions in the supply chain is displaying information about in-car temperature, pressure, humidity, and other factors that can compromise product integrity. These conditions can also be adjusted automatically.

- **Predicting product movement and arrival**

Managers use AIoT devices and data analysis systems to improve decision quality and increase the accuracy of delivery forecasts. Thanks to real-time tracking, companies are able to monitor goods during shipment and forecast delivery, as well as predict and reduce risks associated with delays.

- **Put the goods in the relevant warehouse**

The integration of AIoT-based supply chain management systems is one of the most important technological trends in warehouse. Its benefits range from increasing the efficiency of warehousing processes to better inventory management and employee safety. For example, thanks to real-time location trackers, on-site employees can easily find goods and get to the exact aisle of a particular product faster. In this case, AIoT enables integrated workflow and performance that would otherwise be impossible to achieve. In addition, AIoT fully automates the warehouse with artificial intelligence.

- **Improving potential planning**

The Internet of Things and data analytics help supply chain managers plan for potential accidents or other delays, taking into account traffic and weather. AIoT controls all the data needed to prepare potentially flexible applications and reach the cause of existing delays. This technology immediately provides the necessary warnings to supply chain managers.

Supply chain management is a multifaceted field. During delivery, a large number of operations are performed simultaneously, and managers need to simplify objects through artificial intelligence of Things. In an intelligent supply chain, AIoT is one of the technologies that helps managers comply with current environmental laws and emission restrictions. Using various AIoT sensors for supply chain management and asset tracking, they can now get an accurate picture of how resources such as electricity and water are being used, and implement green strategies and environmental initiatives. Figure (2) presents the framework developed for a green supply chain based on artificial intelligence of things.

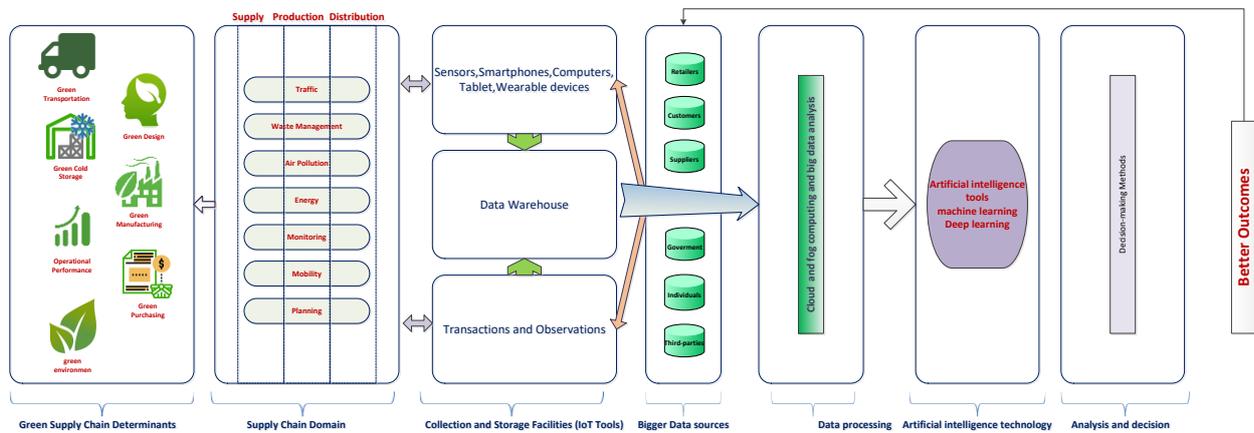


Fig. 2. A framework for a green supply chain based on artificial intelligence of things

6. Conclusion

The subject of the Internet of Things (IoT) is one of the most hotly debated issues in recent years. In previous years, many experts considered the Internet of Things to be the next big step in technology that would conquer the future. The logistics and supply chain industry is one of the areas where the IoT has been able to show its benefits and capabilities. When AI and IoT are combined, the artificial intelligence of the Internet of Things, or AIoT for short, is obtained. Connections enhance the smart elements in products and devices by externalizing their capabilities. This makes monitoring, control and optimization conditions possible. In logistics, AIoT improves not only material flow systems, but also global positioning and automatic load detection. It also increases energy efficiency and thus reduces energy consumption. In this regard, AIoT technology, due to its flexibility and many benefits, is a very suitable method for automation purposes of object identification. Using new AIoT technologies and integrating them with other technologies such as sensors, it is possible to achieve continuous communication of objects around us with the World Wide Web, the results of which are instant, accurate and easy monitoring. Since this technology has a high impact on system stability. Therefore, in this paper, a framework for an environmentally sustainable green supply chain with emphasis on AIoT technology is presented. The use of this framework can be a good guide for the implementation of this technology and the growth of sustainable development.

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