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Study on IoT & AI for Smart Warehouse Management for Green Supply Chain Management

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Abstract

In linking the chain partners in supply chain management warehouse is playing a major role in that. Now a days it has become a part and parcel for making efficient utilization for resources at efficient pace. Technology has randomly shaping the fulfillment by providing tech support in every aspect by using various tech enabled gadgets such as Radio Frequency (RF), scanner etc. For efficient monitoring, tracking and controlling the warehouse operations, traditional means are not enough to meet the requirements. So various emerging technologies has been deployed for the same in the ware house management for proper monitoring and controlling such as IOT. Industry 4.0 now has been taken by 4.2 It help the users of the organization to manage their stock inventory and transportations in a very effective way that will be helpful enough for providing enough information useful for the organization, as well as providing various heuristic technique that will be helpful enough to cope the system contents. . To achieve more monitor and controlling the operations of ware house in real time by ware house manager a proposed frame work has been demonstrated to overcome lagging in supply chain management. A review of AI & IoT implementation has been presented in this paper.

Keywords

Artificial Intelligence, Internet of things, supply chain management, smart ware house management, Radio Frequency

1. Introduction:

To reach all regions of India, the Government of India has started to build infrastructure to cope the situation. As we know that India is getting much more attention in recent past due to much more prospective sector of growth. At the local & cross-level border a specialized logistic chain management is required to accelerate industrial production and consumer oriented focus. As explosion in the E-commerce sector has raised due to that a proper and channeled logistics plan is required for the flow of product and information.

To store inventory and buffer in supply chains ware house is a temporary place for doing all the things. It's a dynamic place where goods are moving in and out as per requirements. So to process all operation in ware house there required a management system that is called Warehouse Management System (WMS). To accelerate an organization's development by giving priorities on the reliability of its supply chain WSM play a major effective role.

Selfed Owned logistic warehouse play a more significant role in the production and control of service. So in the last decade the management of warehouse has become much more complex due to increase in the number of components in warehouse due to that the traditional as well as automatic methods are not enough to cope the situation. So to manage all the stuffs new technology & algorithms were integrated in the warehouse management system. It's an information system through which the flow of information happens due to that monitor, control, manage quantities and storage locations and optimize warehousing decisions occur. The most frequently software used for doing all the activities is Enterprise Resource Planning. Its extends a number of features such as accounting, finance, control and production planning. To meet the requirements of dynamics markets flexible software is required. To overcome from that dynamic challenge new concept has been introduced such as Artificial Intelligence (AI) and Internet of things (IoT).

This paper is organized as follows: Section 2 gives a literature review about WMS, AI and the previous research that integrates IoT in supply chains and warehousing. Section 3 illustrates Green Supply Chain. Section 4 illustrates about IoT & AI building blocks and architecture layers. Section 5 discusses the potential of implementing IoT & AI in WMS, and a conceptual framework for this implementation, and the expected challenges. Finally, conclusions are given in section 6.

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

The Michigan State University Industrial Research Association in 1996 has introduced Green supply chain management. In fact, it is a new approach 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 Suppliers: A Green supplier is a supplier who maintain the ecological balance between the customer and environment by maintaining the sustainability of ecology.

Green Purchase: Procurement of materials form suppliers in such way that it will not impact on the environment and human health when it compared with the same types of other packaging materials available in the market.

Green Manufacturing: 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 Packaging: It is also called sustainable packaging. Green packaging sometimes also called biodegradable and recyclable products for packaging.

Green Warehouse: To lessen its environmental impact through practices such as an automated warehouse, lean warehouse, green building, reduced pollution, enhanced efficiency of energy and resources, a slowdown in the loss of biodiversity, and preservation of the services that the ecosystem provides

Green Transport: Green transport, also known as sustainable transport, refers to modes of transportation that do not negatively impact the environment such as fossil fuels. It modes rely on renewable energy sources such as wind and solar energy, hydroelectric, and biomass, among others.

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 Customer: A Green consumer is who tries to maintain a healthy and safe life style without endangering the planet & the future of mankind.

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.

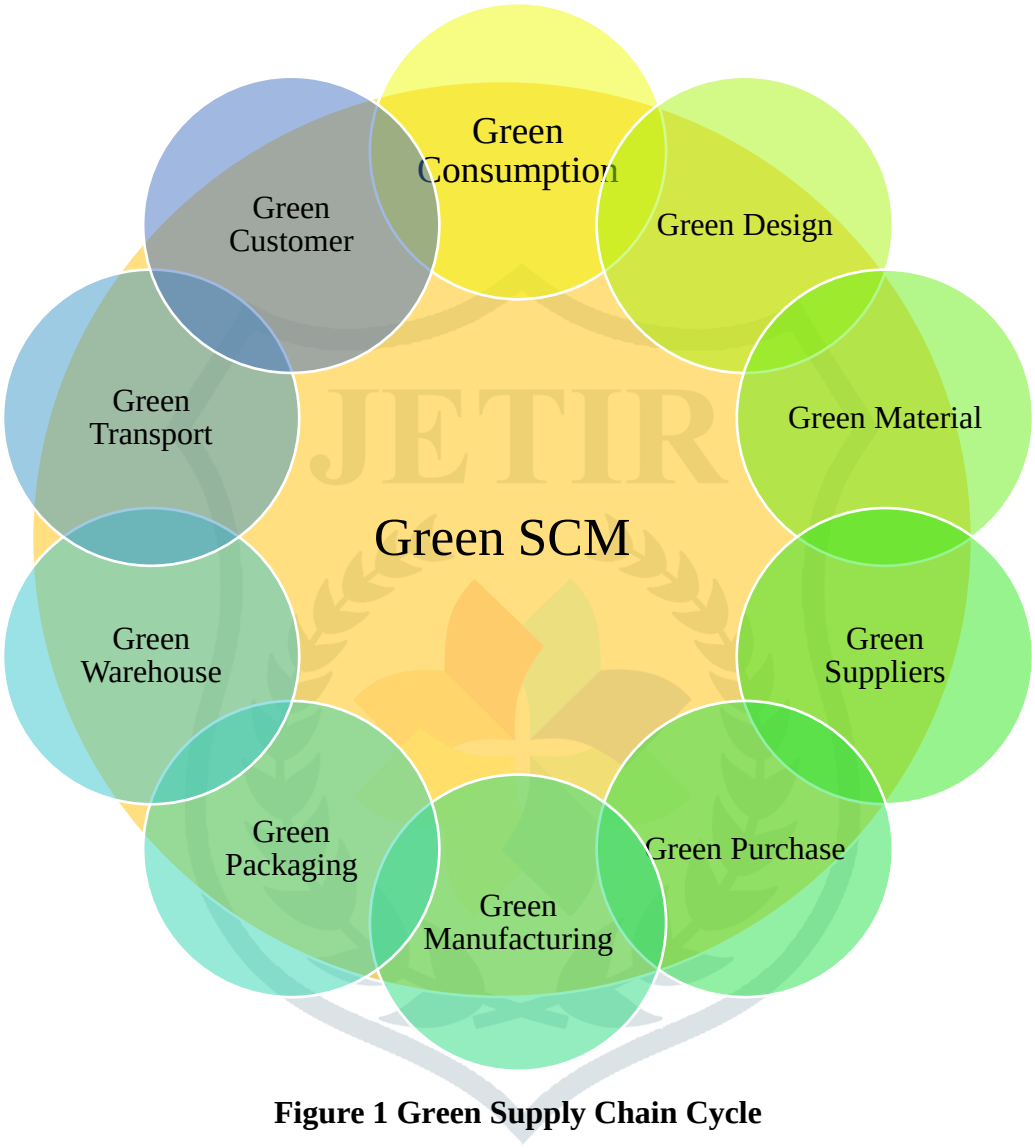


Figure 1 Green Supply Chain Cycle

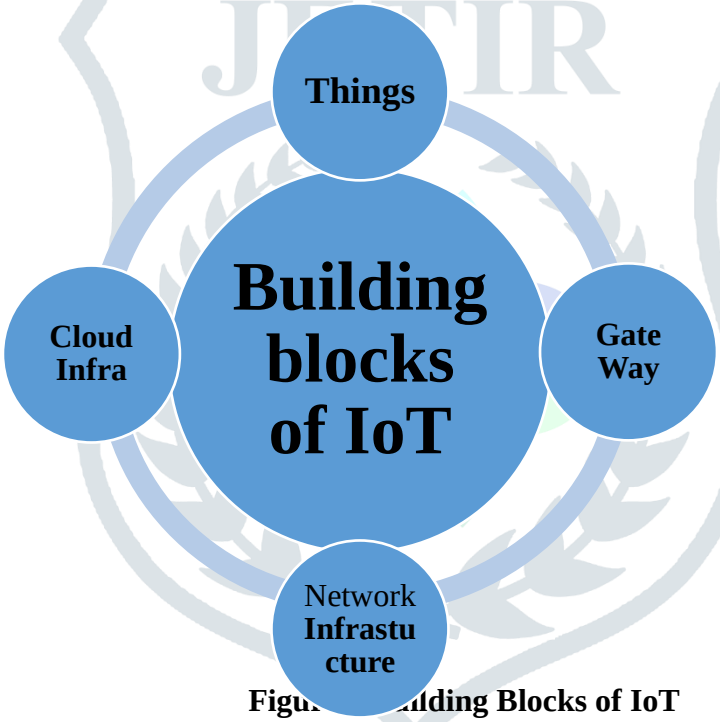
4. IoT & AI in warehouse for Green supply chains management

Now Artificial Intelligence and Internet of Things are playing a big basket of role in the reduction of pollutants and preventing deterioration of environment. To bridge the communication gap between individuals in local, national and international communities; Increases their awareness and interaction with each other internet of things is playing a major crucial role. This helps in social development.

A smart system of transportation system by Internet of Things creates the ability for different components to cater with each other in an interactive way. For a convenient and practical frame work model Internet of Things has already being utilized in supply chains and warehousing.

This system transfer the data without any intervene of human being. As multi-dimensional approach connection of objects with each other, there will be exchange of information and interaction with devices and tools of the system in an effective way. To increase safety, satisfy passengers and solve the problem of traffic and congestion transportation network incorporated with AI & IoT will help to achieve the goal of good transportation. [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. The concept of building blocks of IoT architecture varies depending upon the requirements of system.



Figu… …ilding Blocks of IoT

1. **Things:-**
   - It helps by using technology such as RFID and Actuator.
   - It helps to measure and collect data about physicals in real time.
2. **Gate Ways:-**
   - It offers connectivity between support and cloud.
3. **Network Infrastructure:-**
   - It helps to tracks, control and provide data flow from things to cloud.
   - By using technologies such as routers, repeater, aggregators & actuators.
4. **Cloud Infra:-**
   - It provides analytical and logical computation.
   - It provides data storage system.

4.1 Functional layers of IoT

Depending on the application where IoT is used, its functional layers of IoT is illustrated in the diagram. Various Researcher has proposed different functional layers of IoT as per conditional situational demand.

According to Pacheco and Hariri (2016), the architecture of IoT consists of four layers; the first layer is the devices layer that is responsible for capturing information from physical objects using technologies such as sensors that represent physical world in the digital world and actuators that adjust the environment to a desired state. The second layer is the network layer that is responsible for providing connectivity from/to nodes by using various technologies such as: internet, Wireless Sensor Networks (WSNs), network infrastructures, mobile communication networks and communication protocols. The third layer is the services layer which is considered as a link between application layer and network layer, all the computational power required is provided as a cloud to monitor and control data flow. The fourth layer is the application layer that provides interaction method for users according to their needs; from this layer users can access the IoT services by using technologies such as mobile applications.

According to Farahani et al. (2017) there are four basic layers for IoT infrastructure. Each layer has inherent security issues connected with it. The first layer is sensing layer, its main function is to identify, track and collect data from physical objects by using many technologies such as: WSNs and actuators that are used to monitor and track the status of objects, RFID tags that are used to identify and track objects, then the collected data is transmitted to the networking layer which acts as a link between cloud and physical objects and is responsible for transmitting data to service layer through wired and wireless network. Many protocols are used in this layer such as: Zigbee that is a wireless network technology which has the advantages of low energy consumption, low cost, low complexity and reliability, and Low-power Wireless Personal Area Networks (LoWPAN) that provide great connectivity with self-organization and low energy consumption. The third layer is the service layer that provides efficient and secure services to networking layer and interface layer by managing all types of services to satisfy user requirements. Analytics and service management are used for collecting, analyzing, exchanging, and storage of data and for decision making. The last layer is the interface layer that is responsible for delivering output to the user smoothly, provides interaction methods between users and other applications to get and analyze data.

According to Lin et al. (2017) and Mahmoud et al. (2015) IoT architecture consists of three layers; the first is the perception layer, its main objective is to connect things into IoT network, collect, measure and process data about these objects by using smart devices like RFID, sensors and actuators. The second layer is the network layer that is responsible for receiving information from the perception layer and transmitting it to the IoT hub. Different communication technologies are integrated in this layer such as; Wi-Fi, gateway, hub and switching, etc. the third layer is the application layer that receives data from the network layer to provide the required services, every application has different requirements in this layer like smart cities, smart logistics and smart transportation.

4.2 Advantages of adoption of IoT in warehouse for Green Supply Chain Management

Many researcher have given much more stress on IoT implementation and adoption for Green supply chain management. As we know there are various function of Green supply chain management such as s inventory, routing, distribution, location, purchasing, production and marketing (Mostafa and Eltawil, 2016).With real time information exchange system process we can have the real access of commodities and goods with proper location and information which can be shared with customers. By using such types of information integration process a strong collaboration between carriers, shippers and customers, make service more flexible and agile and reduce hazards and disruptions (Schoen et al., 2016).By utilizing IoT in warehouse, it can be turn into more smart and intelligent. The massive digital data which is stored by IoT can be utilized for smart customer relationship building. By creating a bonding relationship between customer and service provider a strong competiveness can be created among the other service provider and try to compete with each other (Ives et al., 2016).

Information accumulated from IoT system can be analyzed and used in various forecasting models that enables making more accurate demand forecast and responding proactively to market dynamics (Yerpude and Singhal, 2017). If manufacturing industries adopted the IoT system then there are several various advantages related such as Ingredient waste reduction, performance improvement, visibility at each stage of the production process, efficiency and scalability, accurate breakdown prediction (Anita and Abhinav, 2017).By adopting smart gadgets inventory management, forecasting, inventory control becomes very easy and efficient(Qin et al., 2017).

4.3 Schematic flow line diagram of IoT in warehouse for Green supply chain management

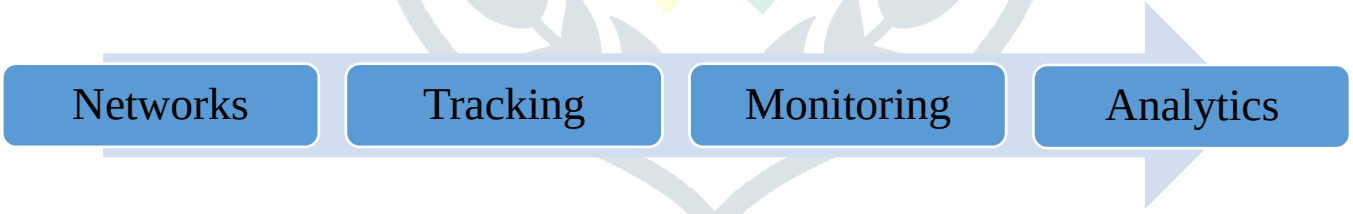


Figure 3 flow line diagram of IoT

5. AI in warehouse for Green Supply Chain Management

Now in this fast abrupt technology advancement the Artificial technology has taken a good hold in warehouse management due its legacy features of operations and management. It's a paradigm shift in the management & operation after adopting artificial intelligence. It provides smooth and efficient working and proper delivery and picking after adopting the smart intelligence. Smart tools enables our system robots and flexible with safety measures.

5.1 Benefits of AI in warehouse for Green Supply Chain Management

- Accurate inventory management.
- Accurate inventory management can ensure the right flow of items in and out of a Warehouse
- Warehouse Efficiency
- Enhanced Safety
- Reduced Operations Costs
- On-Time Delivery
- Bolstering Planning and Scheduling Activities
- Intelligent Decision-Making
- End-to-end Visibility
- Actionable Analytical Insights
- Unlocking Fleet Management Efficiencies
- Streamlining Enterprise Resource Planning (ERP)

5.2 Flow line diagram of AI in warehouse for Green Supply Chain Management

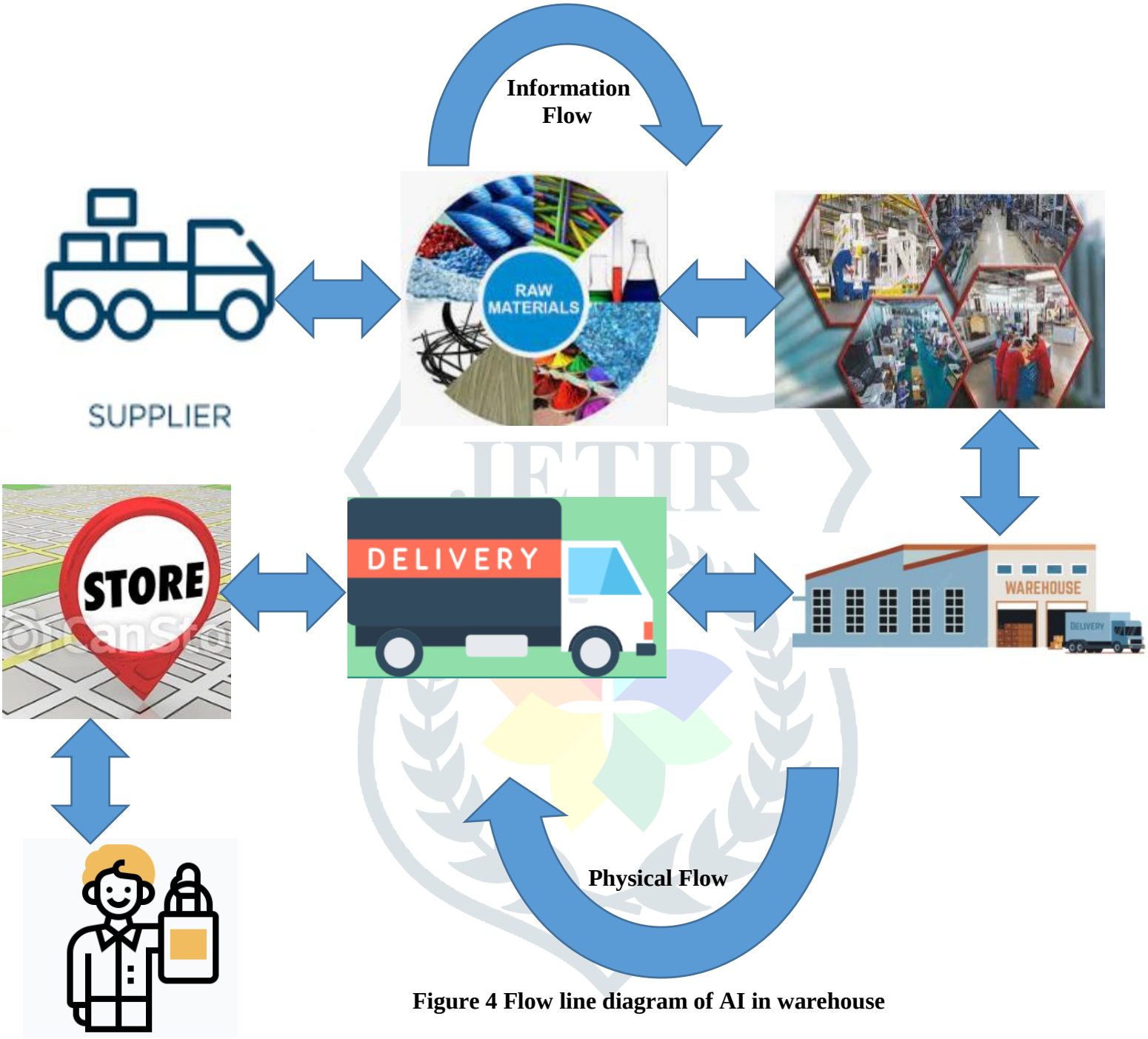


Figure 4 Flow line diagram of AI in warehouse

6. Conclusion

Both IoT and AI are advanced technology which are a promising technology for building a smart warehouse management for tracking and monitoring inside and outside the warehouse. This paper tries to give a basic building blocks of IoT and AI and showing its potential impact for green supply chain management. The proposed flow line diagram can be utilized for increasing the efficiency and productivity of employee which can ultimately improve the overall productivity. It will also help us to cater the demands of customer at the right time with right approach. Ultimately adopting proper line diagram can not only improve the management of

warehouse as well as reduce the cost and manage the reduction of pollutants which will not harm the nature.

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