

ROLE OF IOT ENABLED CIRCULAR ECONOMY IN SUSTAINABLE SUPPLY CHAIN MANAGEMENT

Ms. Ashwini Malani, Department of Computer Science, Tilak Maharashtra Vidyapeeth, Pune, India
:Email: malaniashwini@gmail.com

Dr. Asmita Namjoshi, Department of Computer Science, Tilak Maharashtra Vidyapeeth, Pune, India
Email: asmita03@gmail.com

ABSTRACT:

The integration of Internet of Things (IoT) technologies has emerged as a crucial key of circular economy principles. It mainly focuses on providing creative solutions to optimize waste management, maximize resource utilization, and promote sustainability in supply chains. The IoT-enabled circular economy combines capabilities of the Internet of Things (IoT) technology with the principles of the circular economy to create a more sustainable and efficient system of resource management.

The role of IoT-enabled circular economy in sustainable supply chain management is pivotal for achieving environmental sustainability, resource efficiency, and economic viability. By integrating IoT technologies into the circular economy framework, organizations can transform their supply chains and drive positive impacts.

Keywords: IOT, Circular economy [CE], supply chain management, sustainability, closed loop system.

INTRODUCTION:

Sustainable Supply Chain Management has gained significant global attention over the past two decades. The IoT-enabled Circular Economy provides economic, environmental, and social benefits by integrating the power of Internet of Things (IoT) technology with the principles of a circular economy.

Effective supply chain management includes the implementation of smart devices, IoT sensors, and data analytics tools to monitor and optimize resource usage. These technologies enable companies to track and control raw materials, products, and waste which leads to well-organised and more efficient processes and helps to gain significant boost for sustainable environment.

In the traditional linear economic model resources are extracted, products are manufactured, used, and eventually discarded as waste. It follows a "take-make-dispose" approach. In contrast, a circular economy mainly focuses on reduction in waste and maximizes resource efficiency by promoting recycling, reusing, and repurposing of materials. It focuses on creating a closed-loop system where products and materials are kept in use for as long as possible.

LITERATURE REVIEW:

Linear Economy:

In this traditional model, raw materials are collected and transformed into products that consumers use until discarding them as waste, without considering their ecological footprint and the potential consequences for environment.

The linear economy operates under a traditional business model where products are purchased, used, and ultimately thrown away. This model mainly follows a "take-make-waste" pattern without consideration for recycling or reuse.

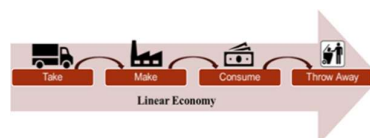


Fig 1: Linear Economy

CIRCULAR ECONOMY:

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A circular economy is an approach that aims to reduce waste and maximize the use of resources. It involves designing products to be reused, repaired, or recycled, rather than thrown away. The goal is to create a more sustainable and efficient system where materials are kept in circulation for as long as possible.

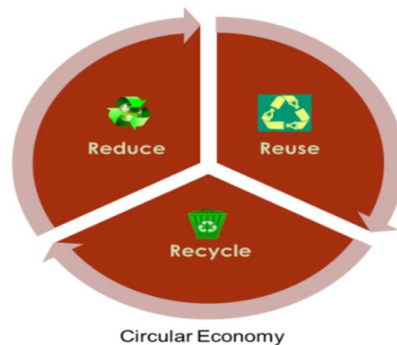


Fig. 2: Circular Economy

a. Closed loop System:

A closed loop system is like a never-ending loop where materials are constantly being reused and kept in circulation, making the system more sustainable. In this type of system, resources are used and reused in a continuous cycle, without being wasted or discarded. It involves recycling and reusing materials to minimize the need for new resources.

b. Supply Chain Management (SCM):

SCM mainly focuses on the coordination and management of all activities involved in the flow of goods, services, information, and finances from the sourcing of raw materials to the delivery of the final product to the end customer. It includes the planning, execution, control, and monitoring of various processes within a supply chain network, with the goal of optimizing efficiency, reducing costs, and meeting customer demands. By implementing efficient supply chain management practices, businesses can achieve better operational performance, reduced costs, improved customer satisfaction, and enhanced overall competitiveness.

NEED OF CIRCULAR ECONOMY:

The urge for a circular economy arises from the limitations and challenges of the traditional linear economic model. Some key reasons are mentioned here:

Lack of resources:

In a linear economy, resources are extracted, used, and ultimately disposed of as waste. As our planet has limited resources [fossil fuels, minerals, water, forests, etc], the linear economical approach is not sustainable in the long duration. If we continue to consume resources at an unsustainable rate, we deplete them, leading to shortage and probable struggles over access to these resources. A circular economy addresses this challenge by promoting the efficient use of resources. This model mainly works on 3R's: Recycling, Reusing, and Remanufacturing. It focuses on reducing resource extraction by maximizing the lifespan of products and materials with these three principles. By extending the life cycle of products and materials, a circular economy minimizes waste and preserve valuable resources for future generations. It reduces the pressure on ecosystems and create a more sustainable and resilient economy.

ENVIRONMENTAL IMPACT:

The old way of doing things may cause pollution, greenhouse gas emissions, and ecosystem degradation. A circular economy aims to reduce these bad environmental impacts by promoting sustainable practices.

Waste Reduction:

The linear model generates significant waste, creates a lot of waste, which fills up landfills and causes pollution. A circular economy aims to minimize waste by designing products for durability, can be fixed easily, and can be recycled.

Economic Opportunities:

Switching to a circular economy can create new business opportunities, like recycling, remanufacturing, and repairing. This can create more jobs, bring new ideas, and help the economic growth.

Energy Efficiency:

In a circular economy, we recycle and reuse materials instead of always using new ones. This requires less energy compared to extracting and processing virgin resources. Circular Economy contributes in energy conservation and reduced carbon emissions.

Overall, transitioning to a circular economy is crucial for sustainable development, resource conservation, and mitigating the negative impacts of our current linear economic model.

The IoT-enabled Circular Economy builds upon this foundation by leveraging the power of IoT to enable real-time tracking, monitoring, and optimization of resources throughout their lifecycle. By embedding sensors and connectivity into products, waste management systems, and supply chains, IoT technology enables the collection and analysis of vast amounts of data. This data can then be used to optimize resource allocation, reduce waste, and enhance the efficiency of circular economy practices.

EXPLORING OPPORTUNITIES IN IOT ENABLED CIRCULAR ECONOMY:

The Internet of Things (IoT) has the potential to transform the circular economy. By connecting devices and objects, IoT enables real-time data collection, analysis, and optimization, which leads to more efficient resource management and waste reduction. IoT plays a crucial role in enabling and enhancing circular economy practices and supply chain management.

Let's understand important opportunities in IOT enabled Circular Economy.

Resource optimization: IoT can enable real-time monitoring and optimization of resource usage. IoT performs data collection on resource consumption to help in identifying inefficiencies, and also helps to improve overall efficiency.

Energy Optimization: IoT-enabled devices can track energy consumption, provide real-time data for energy optimization, identify inefficiencies, and reducing waste and promoting sustainable energy practices.

Supply Chain Optimization: IoT sensors can track and monitor products throughout their lifecycle, enabling better inventory management, reducing waste from overstocking or spoilage, and ensuring timely repairs or recycling.

Product lifecycle management: IoT sensors can track products throughout their lifecycle, providing valuable data on usage patterns, maintenance needs, and end-of-life options. This data can facilitate better recycling, refurbishment, and remanufacturing processes, extending the lifespan of products and reducing waste.

Circular Design and Remanufacturing: IoT can support circular design principles by providing data on product usage, maintenance needs, and end-of-life options. This data can inform design decisions and facilitate efficient remanufacturing or recycling processes.

Consumer engagement: IoT devices can provide information to consumers about the sustainability attributes of products. This empowers customers to make more informed choices and encourages them to support circular economy practices by opting eco-friendly manufacturing processes, products with longer lifespans, recyclable materials.

These are just a few examples, the opportunities in IoT-enabled circular economy are vast and continuously evolving. Conducting thorough research, surveys and staying updated with industry developments will help to discover even more opportunities in this exciting field.

CHALLENGES IN THE IOT-ENABLED CIRCULAR ECONOMY AND SUPPLY CHAIN MANAGEMENT:

Data Security and Privacy: With increased connectivity and data collection, ensuring the security and privacy of IoT-generated data becomes crucial. Protecting sensitive information from unauthorized access or breaches is a significant challenge. Robust security measures and encryption protocols need to be in place.

Connectivity and Infrastructure: IoT devices rely on a robust and reliable network connection to transmit data. In areas with limited connectivity or inadequate infrastructure, implementing and maintaining IoT-enabled systems can be challenging.

Energy consumption: IoT devices require power to operate, and their energy consumption can have environmental implications. Developing energy-efficient IoT devices and exploring sustainable power sources is important to minimize the environmental impact.

Data Management and Analytics: The vast amount of data generated by IoT devices requires effective management and analysis. Ensuring data accuracy, integrity, and making sense of the data to derive actionable insights can be complex and resource-intensive.

Stakeholder Collaboration: Implementing IoT-enabled Circular Economy practices often requires collaboration among multiple stakeholders, including suppliers, manufacturers, logistics providers, and customers. Aligning interests, sharing data, and fostering collaboration can be a challenge, especially in complex and diverse supply chains.

Standardization: Establishing common protocols and standards for IoT devices and data exchange is essential. Without standardization, compatibility issues can arise, hindering the smooth integration of different devices and systems.

Integration and Compatibility: Integrating IoT devices into existing supply chain management systems and processes can be challenging. Ensuring compatibility and seamless integration with different technologies, software, and legacy systems may require significant effort and investment.

Cost and ROI: Implementing IoT-enabled solutions in supply chain management can involve substantial upfront costs, including device procurement, installation, and system integration. Organizations need to carefully assess the return on investment and long-term cost savings to justify the expenses.

Addressing these challenges requires a complete approach that includes investment in infrastructure, cybersecurity measures, data management systems, and stakeholder engagement. Organizations need to plan carefully, evaluate risks, and develop effective strategies to overcome these obstacles and gain the benefits of IoT-enabled Circular Economy in supply chain management.

A VISION FOR A SUSTAINABLE FUTURE:

IoT enabled Circular Economy has become a valuable and feasible model across industries, offering practical solutions for sustainability. Integrating IoT enabled products helps manufacturers address challenges like regulations and resource scarcity, leading us towards a more sustainable world.

CONCLUSION:

IoT-enabled Circular Economy presents a promising pathway towards a more sustainable and resource-efficient future. By adopting IoT technology, organizations can enhance resource efficiency, reduce waste, and improve transparency throughout the supply chain. This approach helps meet stringent regulations but also works for more sustainable and resilient future. This can create a path for a greener, more efficient, and socially responsible supply chain ecosystem.

IoT-enabled sensors and devices can facilitate better inventory management, reducing overstocking and minimizing waste. This leads to improved resource utilization, cost savings, and reduced environmental footprint.

Overall, the combination of IoT technology and Circular Economy principles revolutionizes supply chain management by enabling data-driven, resource-efficient, and environmentally conscious practices. It empowers organizations to embrace sustainability, meet regulatory requirements, and contribute to a greener and more sustainable future.

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