### 2.4 Impacts of Industry 4.0 over reverse logistics

Increased environmental regulations and economical consciousness of customers is forcing industries to start implementing new operational models with the help of reverse logistics [19]. It looks like the more mature implementation of industry 4.0 technologies like IoT, Big Data, 3D printings are from which valid data are available for the research purposes, as it is already in a phase of adoption by many industries (Apple for example) [20]. The following table (table 1) will present some basic advantages on, implementation of Industry 4.0 within reverse logistics in different industries [21], [22], [23], [24], [25], [26], [27].

**Table 2.** Advantages of Industry 4.0 for improved reverse logistics

| **Advantages of Industry 4.0 over reverse logistics based on specialist reviews.** |
|---|
| ***Asset Tracking Efficiencies-*** The use of GPS and RFID tracks products from the customer back to manufacturer and can utilise IoT sensors even to gain information about the product and analyse for further process. The information provided enables companies to continuously improve quality control mechanisms, product forecasting and timely deliveries. |
| ***Enhanced Responsiveness-*** Better information and sophisticated analytics can help accelerate responses to competitors' moves, technology shifts, and changing demand and supply signals. |
| ***Forecasting -*** The use of industry 4.0 technologies allows forecasting and planning for effective reverse logistics models and process. It therefore helps in monitoring goods and tracking them for placing replacements, or recycling of returned products. This improves efficiency in meeting lead times while adequate stock is timeously delivered to the right place without increased inventory for reversed products. |
| ***Connected Fleets-*** Industry 4.0 proves to be more efficient as it helps in connecting supply chain fleet to a common database for tracking. This includes all the companies' carriers, shipping containers, suppliers' delivery trucks which are out for sourcing and delivery. Therefore technology industry 4.0 helps the companies to get customers, suppliers and other related information faster and accurately on products in reverse logistics. |
| ***Performance management system –*** Integrating the Industry 4.0 technologies like IoT, big data helps to analyse the data collected from the products involves in reverse logistics that makes the performance metrices and performance management system for efficient reverse logistics |
| ***Revenue Opportunities-*** Enabling the industry 4.0 technologies in reverse logistics enables an in-depth understanding of customer requirements such as their buying behaviour which is critical for the organisational planning. Closer relationships are formed that results in improved revenue opportunities for the industries. |
| ***Recycling –*** The complexity of design to recycle/reuse used products are minimized with innovative technologies in industry 4.0.Variety of recycling or design technologies for recycling products are available by integrating different technologies like 3D printing, AI , within the industry 4.0. |
| ***Improved Inventory Practices –*** Industry 40 technologies like IoT helps organization to monitor inventory within the reverse logistics in a more effective and efficient way. This includes checking inventory levels at different times and getting alerts on products reaching the recycling plants and increase on products being in reverse supply chain. Apart from monitoring inventory, there exists some additional information which a business can gain from the up to date information on customer demands from the reverse logistics process. The usage of different materials and products can helps to identify trends and these trends can help to manage more effectively. |

## 3. Conclusion

Industry 4.0, unlike previous technologies developed in the past, uses internet to connect machines, tools, workers, customers and products in real-time. Technology involves the customer giving them opportunity for late customization. Industry 4.0 encompasses improvements throughout the supply chain such as reduced time of transactions, improved quality of products, security of information, transparency of the movement of goods allowing customers an opportunity to trace orders with ease. This results in trust by customers, collaborative relationships between suppliers and customers and maximized profits for businesses. Technology allow smart planning at the manufacturer, it allows selection of best routes for transportation that results in cost savings because with best routes comes cost saving on fuel and minimum impact on the environment from gas emissions. Technology also improves care of the environment because of minimum use of raw materials, better management of transport which results in less frequency of travel and less carbon gas emissions. With such improved technologies, reverse logistics will be better managed and increase in customer satisfaction realized.

Reverse logistics happens for many reasons that include: defective goods that do not meet the set quality standard, manufacturer recalls of products that have quality defects that cannot be corrected in the field, for example Toyota had recalled corolla model due to manufacture defect. Use of technology allows each reason for return to be sorted in the most satisfying manner for the benefit of both the customer and the retailer. Technology also assists in assessing the status of returns such as finding out if for example, same items

are returned over and over again and the volume of such returns so that corrective measure are applied if the same item is returned many times; the percentage of sales lost to returns and taking relevant measures to minimize the revenue lose, assessing the condition of the product returned so that if it is faulty, corrective measures could be taken to rectify the error and measuring financial value derived from reverse logistics. Customers will have their returns dealt with efficiently and timeously, hence customer satisfaction and loyalty. Manufacturers and retailers will be able to manage inventories and reduce overhead costs that come with keeping inventory. Inventory overheads such as insurance of goods, security for the goods and so on. Manufacturers will be able to save cost by making proper plans for returns and keep required quantities of inventories. Organizations will have an opportunity to derive maximum value from returns because technology will allow correct categorization of returned items. Organizations will be able to keep their customer because customer queries will be dealt with in the most amiable manner. Dealing with returns will be dealt with faster as there will be more effective communication within the supply chain. With use of Industry 4.0 reverse logistics will bring increased revenue for business and maximized satisfaction and cost saving to the customer because the 4th revolution technology unlike previous inventions, encompasses more software such as I-cloud and many others to connect cyber and physical

## References


1. Govindan, Kannan, and Marina Bouzon. "From a literature review to a multi-perspective framework for reverse logistics barriers and drivers." *Journal of Cleaner Production* **187** 318-337, (2018)
2. Blunck, Erskin, and Hedwig Werthmann. "Industry 4.0–An Opportunity To Realize Sustainable Manufacturing And Its Potential For A Circular Economy." *DIEM: Dubrovnik International Economic Meeting*. **3**(1) (2017)
3. Stock, J.R., Reverse Logistics. Council of Logistics Management, Oak Brook, IL (1992)
4. Mangla, S. K., Govindan, K., & Luthra, S,. Critical success factors for reverse logistics in Indian industries: a structural model. *Journal of cleaner production*, **129**, 608-621, (2016)
5. Ho, G. T. S., K. L. Choy, C. H. Y. Lam, and David WC Wong. "Factors influencing implementation of reverse logistics: a survey among Hong Kong businesses." *Measuring Business Excellence*, **16**, no. 3, 29-46, (2012)
6. Srivastava, Samir K. "Issues and challenges in reverse logistics." *Reverse supply chains–Issues and analysis*, 61-82, (2013)
7. Hillary, Ruth. "Environmental management systems and the smaller enterprise." *Journal of cleaner production* **12**, no. 6, 561-569 (2004)
8. González-Torre, P., Álvarez, M., Sarkis, J., & Adenso-Díaz, B., Barriers to the implementation of environmentally oriented reverse logistics: evidence from the automotive industry sector. *British Journal of Management*, **21** (4), 889-904, (2010)
9. Govindan, K., Soleimani, H., & Kannan, D, Reverse logistics and closed-loop supply chain: A comprehensive review to explore the future. *European Journal of Operational Research*, **240** (3), 603-626, (2015)
10. Baena, Felipe, et al. "Learning factory: The path to industry 4.0." *Procedia Manufacturing*, **9**, 73-80, (2017)
11. S. Kothari1, S. V. Jain and A. Venkteshwar ,International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056 **05**, 08 Aug (2018).
12. de Man, Johannes Cornelis, and Jan Ola Strandhagen. "An Industry 4.0 research agenda for sustainable business models." *Procedia Cirp* **63**, 721-726, (2017)
13. Wang, Y.H., Hsieh, C.C,. Explore technology innovation and intelligence for IoT (Internet of Things) based eyewear technology. Technology Forecast Society. Chang. **127**, 281–290, (2018)
14. CSCMP & Tate, W. (2014. The essential concept of purchasing and supply management. Accessed from https://www.informit.com Accessed on 21st March 2019
15. Thompson, S. (2019) How Blockchain can address Reverse Logistics challenges. Available from www.rlmagazine.com Accessed on 23rd March 2019
16. Jodejko-pietruczuk, A. N. N. A., & Marcin, P. Components' rejuvenation in production with reused elements. *International Journal of Performability Engineering*, ***10*** (6), 567, (2014).
17. Sun, C.. Application of RFID technology for logistics on internet of things. *AASRI Procedia*, **1**, 106-111 .(2012)
18. Gulcin Buyukozkan, and Fethullah G, "Digital Supply Chain: Literature review and a proposed framework for future research", Computers in Industry**,** **97** , 157–177,(2018)
19. Bouzon, M., Govindan, K., & Rodriguez, C. M. T. Evaluating barriers for reverse logistics implementation under a multiple stakeholders' perspective analysis using grey decision making approach. *Resources, conservation and recycling*, **128**, 315-335, (2018)
20. Vanpoucke, E., Vereecke, A., & Muylle, S., Leveraging the impact of supply chain integration through information technology. International Journal of Operations & Production Management, **37** (4), 510-530.(2017)
21. Liu, W., & Gao, Z., Study on IOT based architecture of logistics service supply chain. International Journal of Grid and Distributed Computing, **7** (1), 169-178 (2014)
22. Perera, C., Member, C. H. L., Jayawardena, S., & Chen, M., Context-aware Computing in the Internet of Things: A Survey on Internet of Things From Industrial Market Perspective. IEEE Access, **2**(1ng), 1660-1679, (2015).
23. Borgia, E., The Internet of Things vision: Key features, applications and open issues. Computer Communications, **54**, 1-31,(2014).
24. Abdulrahman, M. D., Gunasekaran, A., & Subramanian, N.. Critical barriers in implementing reverse logistics in the Chinese manufacturing sectors. *International Journal of Production Economics*, **147**, 460-471,(2014)
25. Shaharudin, M. R., Zailani, S., & Tan, K. C. , Barriers to product returns and recovery management in a developing country: investigation using multiple methods. *Journal of Cleaner Production*, **96**, 220-232, (2015)
26. Bouzon, M., Govindan, K., & Rodriguez, C. M. T. (2015). Reducing the extraction of minerals: Reverse logistics in the machinery manufacturing industry sector in Brazil using ISM approach. *Resources Policy*, **46,** 27-36, (2015)
27. Menon, Sarath, Satya Shah, and Alec Coutroubis. "An Overview of Smart Manufacturing for Competitive and Digital Global Supply Chains." *2018 IEEE International Conference on Technology Management, Operations and Decisions (ICTMOD)*. IEEE, (2019).