

ARTIFICIAL INTELLIGENCE APPLICATION IN SMART WAREHOUSING ENVIRONMENT FOR AUTOMATED LOGISTICS

Dr. A. Pasumpon Pandian,
Professor, Department of CSE,
KGISL Institute of Technology,
Coimbatore, India.
Email: pasumponpandian32@gmail.com

Abstract: The advancements in the technologies, the revolution in the business procedures and the entailment to modify the operation in the warehousing as the result of the accumulating orders along with the complications involved in it, and the shortage in the management skills has paved way for the emergence of the smart ware housing. More over as the warehousing takes a vital role in the supply chain and prevails as the key feature in the logistics, smart ware housing is very much necessitated to enhance the organization management and success. The application of the artificial intelligence in the warehousing operations enhances the potentials of the warehousing functioning in the logistics, management and the co-ordination. The application of the artificial intelligence in the warehousing to make it a smart environment for the automated logistics is proposed in the paper. The paper concentrates on the automated storage and the retrieval using the internet of things, artificial intelligence and the cloud computing to have an any time access of the stock available in the warehouse.

Keywords: Artificial intelligence, Smart Warehousing, Automated Logistics, Internet of Things, Robot Process Automation and Cloud Computing.

1. INTRODUCTION

Ware housing is a storage repository that enables the goods and the cargo to be stored and handled properly when requested for. They take a vital role in the enhancing the success of an organization. The major operation of the ware house involves the storage of goods, protection of goods, risk bearing, financing, processing, grading/branding and transportations.

1.1. THE NECESSITY FOR WAREHOUSING

- The warehouse becomes essential for storing the goods that are produced in offseason and the goods that are demanded in offseason.
- They play a significant role in the organizations that has a bulk production and supply.
- They ensure the quick and the faster supply of the goods that are in demand and also in the continuous production and the movement of the goods.
- They main reason for the warehouse is (i) price stabilization and (ii) bulk breaking.
- They enhance the economic benefit of the business as well as the customer.

Despite the advantages of the ware housing, the growing demands and the difficulties in it has made the conventional ware house operations incompatible for the smooth and the easy handling of the goods and the cargo stored in it. So this necessitates a change in the operation of the warehousing. Several researches' proceeded for the smooth handling of the ware house operations involved the application of the internet of things, cloud computing, The wireless sensor networks , RFID, tag readers, drones , robots and the artificial intelligence etc., to automate the process in the warehouse ensuring the efficient storage and the retrieval of the products and efficient functioning of the warehouse. The fig.1 below provides the functions incorporated in the ware housing.

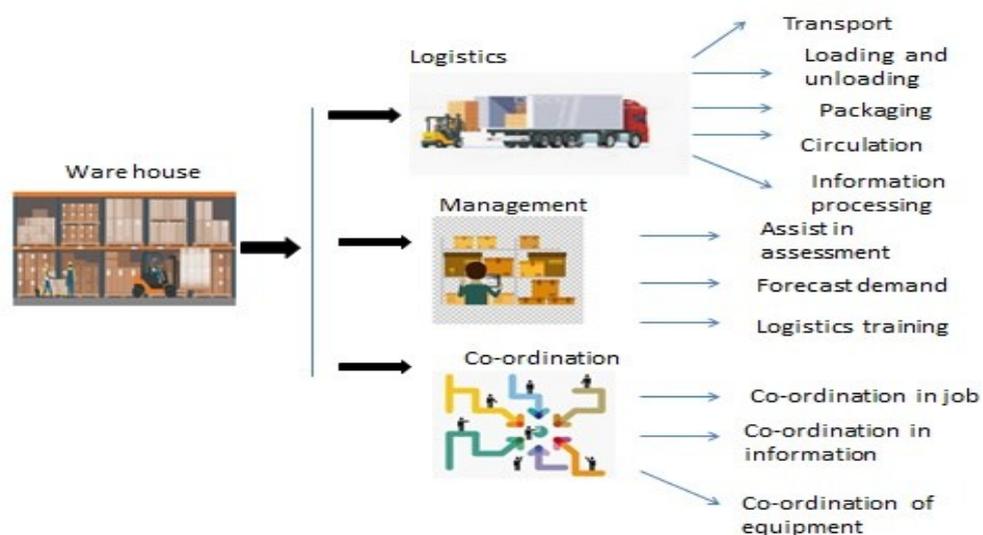


Fig.1 Functions in a Warehousing

Nowadays the AI has become a prominent word among the industrialist, product developers, logistic service renders, vendors and the marketers. They cause in innovation in the field of the logistics [2] and the supply chain [8, 10, and 11] the fig.2 below provides the potential drivers of the artificial intelligence.

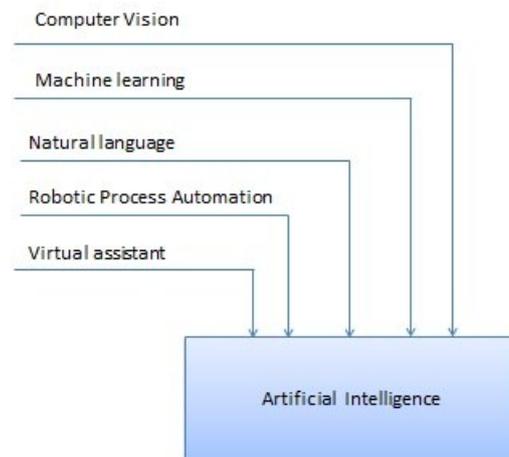


Fig .2 Potential Drivers of AI

To enhance the operations of the warehouse the paper also puts forward the application of the artificial intelligence in the smart warehouse to ensure an automated and an efficient warehouse logistics.

The remaining of the paper is arranged with the related works in 2 the proposed work in 3 the results and discussion in 4 and the conclusion in 5.

2. RELATED WORKS

Lee, et al [1] the paper about the ware housing managing incorporating the internet of things to ensure a smart ware housing for the smart logistics in the industry 4.0 to help in improving the efficiency of the ware house functioning and enhancing the job satisfaction for the workers.

Klumpp et al [2] the author elaborates a “comprehensive case study on the on the truck driving in the logistics to identify the idea behind the practical implications. The author ensures the possibility of the effective trusted collaboration between the human operators and the artificial intelligence.

Mahroof et al [3] The paper is a “qualitative study revealing the challenges in the artificial intelligence for the ware housing due to the deficiency in both the skill and the mind-set of the operational management. The paper also provides the opportunities in the IT infrastructure and the prevailing artificial intelligence for the management.

Han et al [4] the author presents the “study on the relationship between the production structure and its process. The further provides the analysis and the implementation of the process optimization, production structure to enhance the flexibility and the applicability of the organizational structure based on the strategic mission of the organization”.

Klumpp et al [5] the article is about the “robotics and the AI application in the transports, logistics and the supply chain management, and plan a sort of mapping for the future research topics to enable the smooth and an efficient changeover with the trends in the digitization”

Matthias et al [6] The paper aiming to develop an efficient human computer interaction along with the incorporation of the motivated workers, automated robotics and the transportation systems and proceeds with the analyses of the interdependent parts along with the conclusion with the practical implications and the directions of the future research and the business applications.

Loske,et al [7] the article exploits the “practice oriented examples for the distribution of the logistics provided for preparing the truck drivers and the dispatchers for the logistics innovation , to have an efficient, effective and a qualified work force”

Wang et al [8], the paper formulates the agent based supply chain management along with the agent structure, agent interaction, decision making and the functioning to provide an intelligent co-ordination algorithm process that influences the entire supply chain values.

Zijm et al [9], the paper proposes a sustainable logistics and the supply to elude the environmental pollution and the depletion of the rare commodities found in the nature and the contribution to the Global warming along with the capacity to endure the safety and the security threats.

Bălan et al [10] the paper explores the “potential influence of the artificial intelligence on the managerial skills of the supply chain executives”

Hellingrath et al [11] the author address the queries faced in the supply chain tasks and the involvement of the AI within the supply chain through the structured literature review and focusses on the application areas of the recognition approaches in the supply chain computation.

Li et al [12], the paper is review about the “application of the artificial intelligence in the developing an intelligent manufacturing” based on the review it puts forward novel method of intelligent manufacturing system model.

Ready et al [13], the paper organises an Internet of thing frame work for the ware house operation with the integration of the radio frequency identification, ambient intelligence, and multi-agent system

Kayikci et al [14] the study is encompassed of the “benefits in the digitization of the process involved in the logistics to determine the sustainability achieved in it. It continues with the case study in the FMCG companies and their transport service renders involving a qualitative method”

Rymarczyket al [15] the paper incorporates the artificial intelligence based on the fuzzy interference system and the genetic algorithm in the logistics to make it smart and efficient.

Abdul-Rahman et al [16] the author s an "Internet of things application using tethered msp430 to thinkspeak cloud" for the constant monitoring of the data and the information's gathered in the real time.

Dorigo et al [17] the author proposes an optimization based on the foraging behaviour of the ants to identify the optimal shortest path for the travel.

Silver et al [18] the paper puts forward the essentiality of the deep neural networks and the decision tree in the mastering the game.

3. PROPOSED WORK

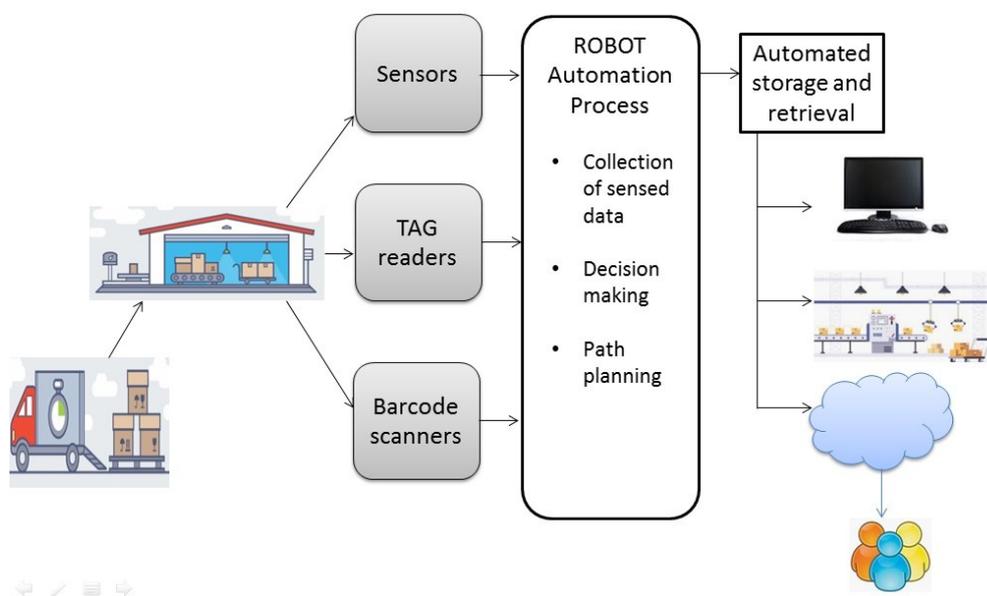


Fig .3 Proposed Smart Warehouse Logistics

The modification in the process of the automation is brought in the warehouse-logistics using the Internet of things, artificial intelligence, sensor networks, and the cloud computing, could improve the customer satisfaction by enabling them to avoid wrong order placement and enhance the efficiency in goods handling. The magnetic sensor in the system ensures the total number of goods unloaded in the store house, the RFID tags used enables the tag readers to identify the type of goods received and the barcode ensure the variety in the goods. The robot process automation, inbuilt with the sensor and the tag reader and the barcode sensors, receives the output from the sensors, tag readers and the barcode scanners to recognizes the product types and behave as the autonomous tigger's and the forklifts to load them in the appropriate rack, the sensors fitted to the rack intimates the count over Wi-Fi to the nearest PC to be monitored by the workers and the production unit as well as the THINKSPEAK cloud[16] to provide with the stock availability for the customers. Once the order is placed for a particular variety of goods, the customer is assigned with the order and the tracking number. The details of the customer are provided to the warehouse and where the manual interference is required for the feeding of the product required. The information's of the order is transmitted to the ROBOTS, that decides with the proper item to be fetched based on the based on the barcode mentioned and the decision algorithm fed to the decision algorithm based on the data mining and the deep learning [18] provides the detailed information of the items in

the ware house the rack it is placed and the barcodes in it. Once recognized with the type of the goods, the path planning is done using the ant colony optimization [17], to recognize the shortest path to the rack. Further the computer vision and the machine learning in the robotics help their movement to be safe eluding the collision with the other robots using the distance measurement system based on the visual dual camera to sense the movement of the other robots in the front and the back. The robot on reaching the destination picks the ordered goods and updates the count to the of the orders picked up to the over the Wi-Fi to the worker monitoring and the sensors in the rack updates the count of the left over in the rack to the nearby PC, production unit and the cloud. Thus the proposed system provides the knowledge of the goods in stock and out of stock for the customers and the goods in demand to the production unit.

The decision algorithm based on the deep learning and the decision tree is and the path planning and the collection of the sensed data are programmed using the python. The control device gathers the data from different monitoring and the executive devices to for training, based on the information gathered the deep learning algorithms are engaged to gain knowledge based on the data and ensure a professional way of decision making in the bots.

4. RESULTS AND DISCUSSION

The proposed system with the ability to handle the warehouse-logistics in the smart way enhances the efficiency of the warehouse-logistics operation. By utilizing the internet of things, artificial intelligence and the cloud computing. The proposed methods put forward an effective work to reduce the procedures and the time consumption in the procuring and dispatching of the goods form the warehouse, if done manually. Still the billings of the goods purchased and delivered are done manually. The fig.4 below shows the automatic storage and the retrieval of the goods from the ware house.



Fig.4 Automated Warehouse-Logistic

The table.1 below provides the delay in the procurement and the dispatching form the warehouse when done manually and with the automated system

Warehouse-Logistics	Delay in Procurement	Delay in Dispatch minutes	Errors committed in billing, procuring and dispatching %	Inventory Management %
Manually	2- 3 hours	1-2 hours	60%	85%
Automated	30 -35 minutes	10- 20 minutes	10% due to Network Problem	100%

Table.1 comparison of the Manual operations with the Automated

5. CONCLUSION

Smart ware housing with the automated logistics to handle the goods inside the warehouse is proffered in the paper. The proposed method of automated warehouse logistics uses the sensor networks to gather the information about the number of the items entering and leaving the warehouse and the artificial intelligence in properly handling them inside the store house such as placing them in the proper rack, picking back the items from the rack as per the order placed etc. The information gathered through the sensor is transmitted using the internet to the ThinkSpeak cloud to enable the customers from anywhere to know about the goods availability in the warehouse. The proposed system of smart warehousing logistics shows higher performance and enhanced efficiency for the warehouse that holds a vast range / types of goods that are available in huge number. In future the paper would continue with the survey on the procedures to automate the billing in the goods purchase and the sale in the warehouse using the artificial intelligence.

References

- [1] Lee, C. K. M., Yaqiong Lv, K. K. H. Ng, William Ho, and K. L. Choy. "Design and application of Internet of things-based warehouse management system for smart logistics." *International Journal of Production Research* 56, no. 8 (2018): 2753-2768.
- [2] Klumpp, Matthias. "Automation and artificial intelligence in business logistics systems: human reactions and collaboration requirements." *International Journal of Logistics Research and Applications* 21, no. 3 (2018): 224-242.
- [3] Mahroof, Kamran. "A human-centric perspective exploring the readiness towards smart warehousing: The case of a large retail distribution warehouse." *International Journal of Information Management* 45 (2019): 176-190.
- [4] Han, Yanxiong. "6. Research on Optimization of Production Process and Warehouse Management System." *Revista de la Facultad de Ingeniería* 32, no. 15 (2017).
- [5] Klumpp, Matthias, and Caroline Ruiner. "Regulation for artificial intelligence and robotics in transportation, logistics, and supply chain management: background and developments." *Netw Ind Q* 20, no. 2 (2018): 3-7.
- [6] Klumpp, Matthias, Marc Hesenius, Ole Meyer, Caroline Ruiner, and Volker Gruhn. "Production logistics and human-computer interaction—state-of-the-art, challenges and requirements for the future." *The International Journal of Advanced Manufacturing Technology* (2019): 1-19.
- [7] Loske, Dominic. "How to prepare workers for logistics innovations today and tomorrow."

- [8] Wang, Ye, and Denial Wang. "Multi-agent based intelligent supply chain management." In Proceedings of the Ninth International Conference on Management Science and Engineering Management, pp. 305-312. Springer, Berlin, Heidelberg, 2015.
- [9] Zijm, Henk, and Matthias Klumpp. "Logistics and supply chain management: developments and trends." In Logistics and Supply Chain Innovation, pp. 1-20. Springer, Cham, 2016.
- [10] Bălan, Carmen. "POTENTIAL INFLUENCE OF ARTIFICIAL INTELLIGENCE ON THE MANAGERIAL SKILLS OF SUPPLY CHAIN EXECUTIVES." *Calitatea* 20, no. S3 (2019): 17-24.
- [11] Hellingrath, Bernd, and Sandra Lechtenberg. "Applications of Artificial Intelligence in Supply Chain Management and Logistics: Focusing Onto Recognition for Supply Chain Execution." In *The Art of Structuring*, pp. 283-296. Springer, Cham, 2019.
- [12] Li, Bo-hu, Bao-cun Hou, Wen-tao Yu, Xiao-bing Lu, and Chun-wei Yang. "Applications of artificial intelligence in intelligent manufacturing: a review." *Frontiers of Information Technology & Electronic Engineering* 18, no. 1 (2017): 86-96.
- [13] Reaidy, Paul J., Angappa Gunasekaran, and Alain Spalanzani. "Bottom-up approach based on Internet of Things for order fulfillment in a collaborative warehousing environment." *International Journal of Production Economics* 159 (2015): 29-40.
- [14] Kayikci, Yasanur. "Sustainability impact of digitization in logistics." *Procedia manufacturing* 21 (2018): 782-789.
- [15] Rymarczyk, Tomasz, and Grzegorz Kłosowski. "The use of artificial intelligence in automated in-house logistics centres." *Informatyka, Automatyka, Pomiary w Gospodarce i Ochronie Środowiska* 8, no. 1 (2018): 48-51.
- [16] Abdul-Rahman, Ahmed I., and Corey A. Graves. "Internet of things application using tethered msp430 to thingspeak cloud." In *2016 IEEE Symposium on Service-Oriented System Engineering (SOSE)*, pp. 352-357. IEEE, 2016.
- [17] Dorigo, Marco, and Mauro Birattari. *Ant colony optimization*. Springer US, 2010.
- [18] Silver, David, Aja Huang, Chris J. Maddison, Arthur Guez, Laurent Sifre, George Van Den Driessche, Julian Schrittwieser et al. "Mastering the game of Go with deep neural networks and tree search." *nature* 529, no. 7587 (2016): 484.