USE OF ARTIFICIAL INTELLIGENCE (AI) IN MANAGING INVENTORY OF MEDICINE IN PHARMACEUTICAL INDUSTRY

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ABSTRACT: *Inventory is one of the vital components of current assets. Excess holdings of inventory may increase cost as well as wastage. As such, effective and efficient management of inventory is an integral part of supply chain. Especially, in the field of management of pharmaceutical products and medicine it bears more importance. Improper use of pharmaceutical products or shortage of medicine would not only cause financial loss but also may affect the patients adversely. Rather than using the traditional techniques of managing inventory use of Artificial Intelligence (AI) can make the process more effective and efficient. AI is the application of computer program that demonstrates action like a human being, learns from experience, gets new input and processes big data by reasoning. It can acquire large amount of data and create rules for turning the data into actionable information. This study has been conducted based mainly on secondary sources of data. It is a qualitative study that gives a conceptual idea regarding how the functions of AI can support managing inventory of medicine in pharmaceutical industry.*

Keywords: *Supply Chain, Inventory, Inventory Management, Artificial Intelligence (AI), Big Data, Pharmaceutical industry, Medicine*

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Introduction

A business, be it manufacturing or service oriented, cannot think of a day without dealing with its inventory. Inventory is a vital component of current asset. It involves both the stock of raw materials as well as finished goods. A producer keeps inventory of raw materials so that it can produce at desired level during the time when there is an unexpected hike in customer demand. Effective and efficient management of inventory is important not only from the perspective of operation but also from the perspective of finance. Especially, in the field of management of pharmaceutical products and medicine it bears more importance.

Level of inventory influences the cost structure of a business. Total cost of holding inventory involves cost of ordering and cost of carrying. Though, order at bulk size may reduce ordering cost due to discount or other benefits offered by the supplier. But at times, when the demand for the raw material is high, such benefit is not provided by the supplier. On the contrary, carrying cost of raw material or finished goods inventory is positively related to the level of inventory maintained. Increased cost of ordering and carrying ultimately affects the pricing of finished goods. All these are also true for pharmaceutical products or medicines. This is why; inventory of this emergency product should be managed in an effective and efficient way so that cost associated with inventory does not affect the price.

Several techniques of managing inventory are there in practice. Some of the mostly used techniques are- ABC system, Economic Order Quantity (EOQ) model, Just in Time (JIT) system and Material Requirement Planning (MRP) system. At present, different computer-based software are used by the companies to manage the inventory. Whatever

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technique is in application at a manufacturing firm, one of the major common goals is cost minimization. Total cost of inventory depends on ordering costs and carrying costs of inventory. As such, each of the techniques applied for managing inventory covers two major decisions- what should be the size of order and when to order. And at this digital age, an Artificial Intelligence (AI) can give the best solution. The Ubiquitous Intelligence (UI), Assisted, Augmented, and Autonomous Intelligence (AAAI), and Invisible Interface or No-User Interface (II) functions of an AI can assist a pharmaceutical firm to manage its inventory effectively and efficiently. Use of AI in managing inventory of medicine would not only be beneficial for the producers but also for the customers at individual, institutional and government level. In this paper it has been explained how AI functions can provide solutions to the different problems related to the management of inventory. Attempt has also been made to identify the benefits and challenges of using AI in managing inventory of medicine in pharmaceutical industry.

Literature Review

Both from the economic and organizational perspective, management of pharmaceutical supplies are crucial for pharmaceutical companies. Incidents like improper handling of pharmaceutical products, shortage of essential medicines in the market and spending on unnecessary or low-quality medicines would result in a high cost in terms of wastage, preventable illness and death. This is why several researches has been undertaken to find ways to manage the supply chain of pharmaceutical firms effectively and efficiently. Kim (2005) develops an integrated supply chain management system to specifically address issues related to pharmaceuticals in the health care sector. For a pharmaceutical company, Meijboom and Obel (2007) addresses supply chain coordination with a multi-location and multi-stage operations structure. According to Aptel and Pourjalali (2001), management of pharmaceutical supplies should get greater attention as it is one of the most vital issues that management deals with in health care industries. Almarsdóttir and Traulsen (2005) identified a number of reasons why special consideration should be given in the inventory control of pharmaceutical products.

Inventory involves the pile of some physical commodities; while, determining the optimal way of procuring the commodities to satisfy the future demand is referred as inventory management (Star and Miller, 1986). Inventory management involves anticipating demand, purchasing at bulk size, taking actions to minimize wastages and avoiding ordering at an unwanted size (Francis, 1998). It is an integral part of the logistic system of an organization. Logistics involves the controlling, planning and effective implementation of flow of goods and services from the point of origin to the final customer in a way to satisfy their request (Logisticsworld.com., 2009). This requires a business to deal with the environment both internal and external to the firm not only for order fulfillment but also for outbound and inbound return of goods (Turban, McLean and Wetherbe, 2001). Thus, a considerable size of data is generated by the activities related to the logistics, while enormous flows of goods are being controlled and monitored (Jeske, Grüner and Weiß, 2014). And, intelligent use of the resulted data is a central challenge (Spangenberg, et al., 2017). Inventory Management is one of the determinants of efficiency in the overall logistic system and it can also influence the financial condition of the business reflected by the balance sheet. Thus, attempt should be made to keep inventory in optimum level to eliminate over inventory as well as under inventory, which otherwise may disrupt the financial

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condition of the business (Lingam, 2018). As business grows and varieties of items in the inventory are required to be maintained, the task of an inventory manager becomes difficult and complex. Artificial Intelligence (AI) and machine learning can manage these daily tasks and can result a process which is highly automated (Lingam, 2018). It is the new digital technologies that are rebuilding the landscape of the economy, organizational feature and the way they interact in the ever-changing complex business environment (Snow et al., 2017). In this regard, transforming the business into a digital one has major implication not only for the business and management but also for the society and labor market (Brynjolfsson & McAfee, 2014).

EOQ is the first model that provides a simple mathematical solution to determine the optimum delivery size developed by Ford W. Harris (1913). It is a single-product deterministic model with periodically replenished inventory and constant size of delivery. Due to the dynamic and ever-changing business environment the assumptions of EOQ model, especially the stationary demand with no capacity constraint, has made application of this model difficult in the latter half of the 20th century. Later, Wagner and Whitin (1958) proposed a model called Wagner-Whitin model assuming a finite planning horizon. In the model, Wagner-Whitin subdivided the planning horizon into several discrete periods. For each period a given demand varying over time is considered. No capacity limits are considered in the model which gives a simple solution (Aggarwal et al., 1993). The models developed next to the WW model considered different capacity limitations and dynamic approaches. Even, with purchase planning the size of delivery was also extended (Drexl et al., 1997). Extensions to the model also consider certain variability in demand or lead time by introducing safety stock as an additional parameter (Grzybowska, 2010), (Nizinski and Zurek, 2011), (Krawczyk, 2011).

To accommodate the cases like-delay allowed in payment including interest charged, discount in purchasing, inflation, time value of money and managing inventory with two warehouses special models were developed later (Goyal and Giri, 2001). Models for phenomena arising from economic reality has also been developed by statistical data and methods predominantly based on mathematical models like operations research, linear programming, dynamic programming, and optimization, etc. (Novotná, 2012 or Novotná, 2014).

Considering several variables affecting the analytical model several studies has been made that suggests identification of uncertainty through identifying a fuzzy environment. In their article Mandal and Roy (2006), Roy (2007), Taleizadeh (2009), Hsieh (2002) and Maiti (2006), assumed demand, lead-time, carrying cost of stock, customer service etc. as fussy values. In economic processes, a new concept has also been proposed by Ioana et al. (2010) for fuzzy logic. Tanthatemee et al. (2012) proposes a fuzzy logic to control inventory continuously considering uncertainty in demand and supply. Aburto and Weber (2007) presents a hybrid intelligent system for forecasting the demand by applying Autoregressive Integrated Moving Average models and Neural Networks.

Hamzaçebi (2008) uses Artificial Neural Network (ANN) to compare the result to that of the traditional statistical techniques and proves that the proposed ANN model is more efficient to forecast the demand, an essential input to inventory management, than the time series model. Hachicha (2011) also applied ANN to the problems involving lot size, multi-step, multi-product, multi-location production planning considering constraints in capacity and stochastic parameters like lot arrivals order, time of set-up and delivery, as well as processing time, etc. and finds

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the model effective, flexible and useful for application in reality.

Research has also been done by combining the methods of fuzzy modeling and neural networks, called Neural-fuzzy systems, to combine the benefits of both for high adaptability, speedy convergence and greater accuracy (Shie-Jue and Chen-Sen, 2003). Research by Taleizadeh (2013), Khanlarpour (2013) and Gupta (2015) applies genetic algorithms to find the optimal solution considering more complex situations and elaborateness.

To predict the price of stock in a pharmaceutical firm with more accuracy and transparency, Abdolllahzade et al. (2012) applied a simulation based Emotional Learning Fuzzy Inference System (ELFIS) and a Locally Linear Neuro-Fuzzy (LLNF) model. Fruggiero et al. (2012) applied Radial Basis Function (RBF) neural network to forecast the demand of local pharmacies. The model was found to be successful for reducing the average level of inventory and required cost of carrying in the warehouse.

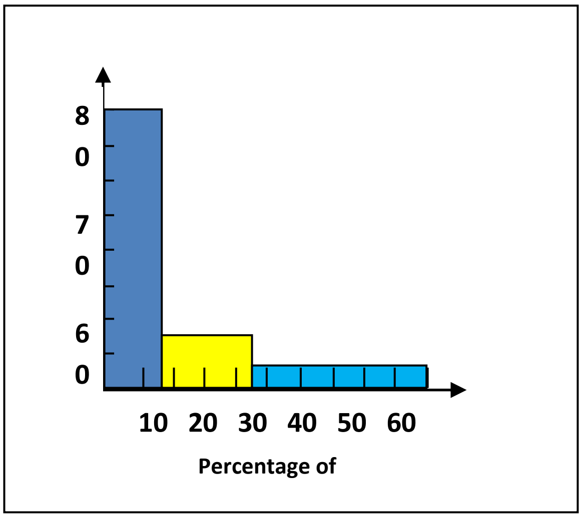
Methodology

It is a qualitative study that has been done based mainly on secondary source of data. Content analysis based on different related books, articles, research papers and online resources have been done to conduct the study. Much effort has been given to develop the literature on the application of AI in management of inventory. The main objective of the study is to focus on the functions of AI and the way these functions play a role in managing inventory of medicines in the pharmaceutical industry. Especially, focus has been made on the Ubiquitous Intelligence (UI), Assisted, Augmented, and Autonomous Intelligence (AAAI), and Invisible Interface or No-User Interface (II) functions of AI. A brief description on different traditional inventory management techniques has also been given along with a detail on AI. Besides, it also provides a basic idea regarding the challenges a pharmaceutical firm would face while using an AI supported inventory management system.

Inventory Management Techniques

The most familiar techniques of inventory management includes the ABC inventory planning system, Economic Order Quantity (EOQ) Model, Just in Time (JIT) system, Materials Requirement Planning (MRP I & II) and Enterprise Resource Planning (MRP).

According to Heizer (2020), under the **ABC system** inventory is divided into three group like- A, B and C based on the amount of investment done and their relative importance. Items on which amount of investment is about 80 percent of total value of inventory are classified as group A. Though, such items represent only about 20 percent of total inventory they gets intense monitoring. Inventory items of medium value (15 percent to 25 percent of total value) are classified as group B. These items represent about 30 percent of total inventory items and are monitored periodically. In group C, large number of items that represent 55 percent of total inventory with low value (only 5 percent of total value of inventory) is kept.



Graphical Representation of ABC System

Economic Order Quantity (EOQ)

EOQ is one of the mostly used classical techniques of inventory management. The model determines the optimal size of order to minimize the total cost of inventory. Two components of the total inventory cost, namely, ordering cost and carrying cost is controlled by applying the technique. When the demand for the items in use and the lead time (time between the placement of order and its receipt) is well known, this technique of inventory management can be applied by firms to minimize the total cost of ordering and carrying the inventory. According to the model, total cost of inventory is the sum of ordering cost and carrying cost. The formula used to calculate order cost and carrying cost are as follows:

Ordering cost = B. (A / Q)

Carrying cost = C. (Q / 2)

Where,
A = units consumed in each period
B = per unit cost of order
C = per unit carrying cost in each period
Q = EOQ = size of order in units

EOQ is considered as the point where the cost of order and the carrying cost are equal. Simplifying the aforementioned formula of determining ordering cost and carrying cost we get the following formula to get the value of EOQ:

$$EOQ = \sqrt{\frac{2 . A . B}{C}}$$

EOQ helps to determine how much to order, to decide when to order a reorder point is preset. The reorder point is the product of lead time and daily usage of raw materials. If the lead time and usage of raw materials are not well known, that time firms need to keep safety stock to avoid stock outs.

In **Just in Time (JIT) system**, investment in inventory is minimized by having the materials on floor exactly at the time when they are required for production. No inventory of raw materials is kept in the system except the work in process inventory (Gitman, 2018). This system does not work without extensive coordination among the employees, suppliers and the delivery agents of the firm. Any delay or failure to the arrival of quality raw materials on time shuts the line of production down. If the system works smoothly, it brings efficiency in the overall production process of a firm.

In this digital era, different computer-based inventory management techniques like Barcoding, Radio Frequency Identification (RFID), Materials Requirement Planning (MRP) system, Manufacturing Resource Planning (MRP II) and Enterprise Resource Planning (ERP) systems are also in use.

Materials Requirement Planning (MRP)

MRP is the application of EOQ model by the use of computer to determine the size of order (Gitman, 2018). Three steps are involved in the technique: receiving the materials in the inventory, identifying the additional ones required and preparing the schedule for production, delivery or purchase. MRP uses a bill of materials that lists all the items of materials or assemblies required to produce a product. The bills are arranged in accordance with the use of materials in the production process. This gives the manager an idea regarding the level of raw materials that are consumed, in the line and quantity of raw materials to be ordered for the next production. A master schedule outlines the quantity of products to be produced and the length of time it would take to complete the production.

Manufacturing Resource Planning (MRP II)

MRP II is the extension of MRP which integrates data from all the area of a

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business to assess the effect of changes in one operational area on others. It generates schedule of production as well as financial reports for managerial decision making.

Enterprise Resource Planning (ERP)

ERP system provides more integrated, updated and error free information continuously by a database management system. It facilitates sharing of information not only among the internal functional departments but also with the external stakeholders of a business. ERP systems can note changes automatically, such as inability of a supplier to meet a delivery in scheduled date, so that necessary steps can be taken.

Artificial Intelligence (AI)

Artificial Intelligence (AI) is also called machine demonstrated intelligence. When a machine learns, thinks, acts or demonstrates intelligence like human being then it is called Artificial Intelligence (AI). Jarrahi, (2018) defines AI as a machine that has ability to emulate cognitive tasks performed by human. It is the application of computer program that demonstrates action like a human being, learns from experience, gets new input and processes big data by reasoning. AI can acquire large amount of data and create rules for turning the data into actionable information. The rules that provide instruction of what to perform are referred as algorithm. Choosing an algorithm that is right requires reasoning and AI is designed to ensure fine-tuned algorithm continuously for smooth functioning of an operation.

In 1950, British mathematician Alan Turing was the first to propose that machine can also process data to generate information by reasoning, learn from experience and solve problems to make decision like human being. In the paper Computing Machinery and Intelligence, he explained not only how the machine would work but also how to test the intelligence of the machine. He also proposed the idea regarding “Child Programme” and explained “Instead of trying to produce a program to simulate the adult mind, why not rather try to produce one which simulated the child’s?” The concept like Turing Test, machine learning, genetic algorithms, and reinforcement learning has also been introduced by him. Advancement in the model suggested by Turing has been done after 1974 when computers with faster data processing and storage capability were flourished. In 1980s research on AI become a hot cake with an expansion of algorithmic tools and funds. “Deep learning” techniques popularized by John Hopfield and David Rumelhart allowed computers to learn from experience. On the other hand, expert systems introduced by Edward Feigenbaum made machines able to mimic decision making processes like a human expert.

The Digital Equipment Corporation is the first to start operation for commercial expert system, R1 (McDermott, 1982). In 1981, Japan takes a plan for 10 years to build intelligent computers titled “Fifth Generation” project. Next to Japan, Microelectronics and Computer Technology Corporation (MCC) was formed by United States to assure competitiveness. AI was central in both cases. Later on, Britain started funding on IKBS (Intelligent Knowledge-Based Systems). All these initiatives by different countries gave pace in growth of AI industry. In 1988, the industry boomed from millions to the billions of dollars with hundreds of companies who started building expert systems, robots, vision systems, software and other devices and equipments required to produce them. As a result, research on AI achieved many landmarks till 2000 despite the attention of public and contribution of funds from the government.

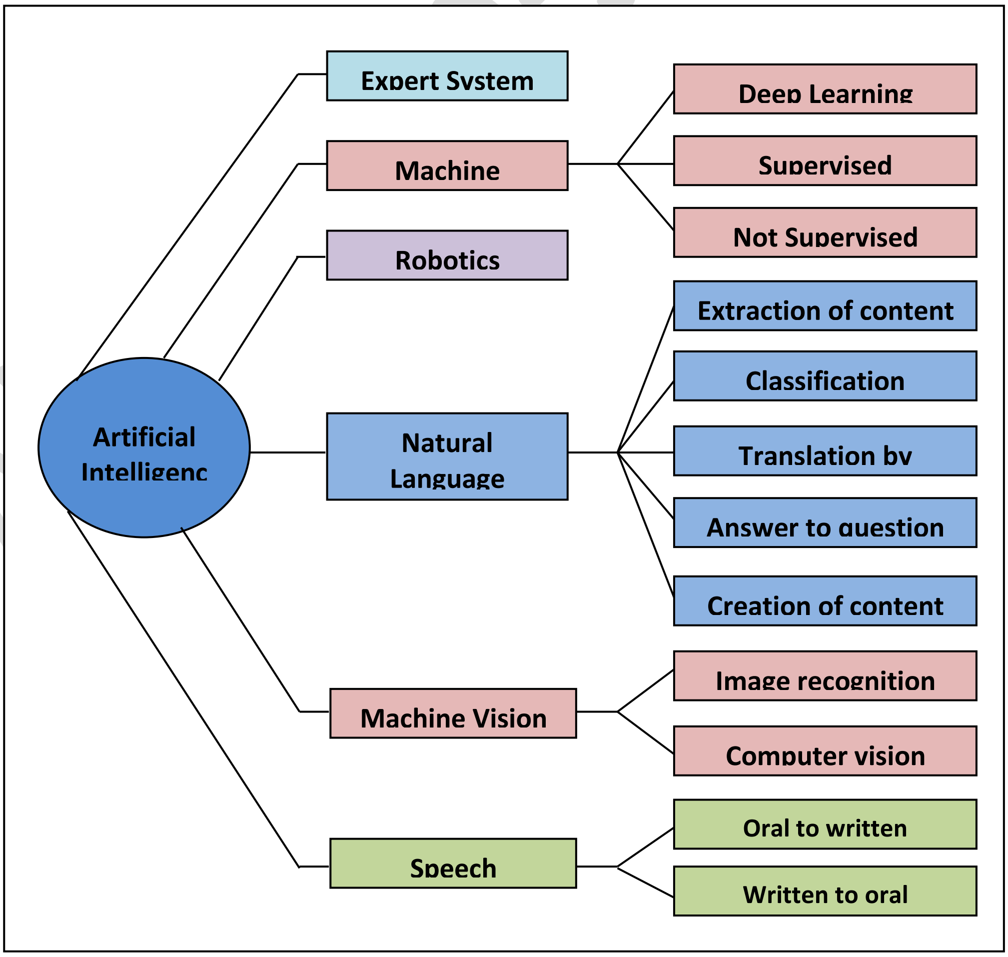
Moreover, study has also been done to teach the machine mimic the way in which human learns, human recognizes

AU-GSB e-Journal

(Mnih, 2015), prefers and controls resource (Christiano, 2017). Though, the fast-paced advancement on machine learning has made it to be the one of the major transformative technologies of the present century (Jordan, 2015), several mechanisms behind the science i.e. deep neural networks are yet to be clear. According to Voosen, the stream of research to investigate the unknowns behind the science regarding decisions made by machines is referred as AI Neuroscience.

Today, almost all the areas of economy and industry are affected by the digitalization and its associated digital transformation of processes (Kersten, 2017). As such, the dynamic business world needs intelligence for combining idea, knowledge, information, methods, and procedures from diversified sources. AI provides better solution by adapting itself with such environment. It connects a company to the market place and makes it more responsive to the changes and developments that take place in the market. A human intelligent can handle large amount of data by using computer software to process it into information. But, it is very difficult for him not only to search for the appropriate data required, but also to make decision after a critical analysis without the help of a digital system. AI can overcome this problem very efficiently. It uses neural network to find the appropriate data, no matter whatever the size of data is, and turn it quickly into actionable information.

AI is applied successfully in different area of disciplines like- art, healthcare, industrial production and transport, finance, etc. Dejoux & Léon (2018) used the following figure to show the wide-ranging functions that AI can perform:



AI Functions (Dejoux, Léon, 2018, p. 188)

As an expert system AI can simulate the problem solving behavior of a human being. Machine learning function of an AI refers to "the ability of a computer to automatically refine its methods and improve its results as it gets more data" (Brynjolfsson & McAfee, 2014). Besides deep learning, Supervised Learning and Unsupervised Learning is the most common machine learning algorithm (John Lu, 2010). When training is provided to a computer program by using known data to get a known output then it is referred as supervised learning. It performs two important tasks like- Classification and regression (Kirste and Schürholz, 2019). On the contrary, unsupervised learning is known as "learning without a teacher". Similar task includes - Association Rules, Multidimensional Scaling, Self-Organizing Maps and Nonlinear Dimension Reduction (Marsland, 2015, p. 281); (Russell and Norvig, 2016, p. 694); (Hastie, Friedman and Tibshirani, 2017, 485 ff.). Natural Language Processing makes an AI to understand and analyze the human language and at the same time acts as the base for Speech Recognition. And finally, Machine Vision is "algorithmic inspection and analysis of image" (Jarrahi, 2018).

According to Mohanty and Vyas (2018), AI solutions can be classified into three areas like AI as Ubiquitous Intelligence (UI), AI as Assisted, Augmented, and Autonomous Intelligence (AAAI), and AI as Invisible Interface or No-User Interface (II).

As an UI, an AI replies to the queries of the user and acts according to the command. As an AAAI, an AI guides the best plan of action. Assisted Intelligence assists the user in efficient decision making in day to day activities. Augmented Intelligence provides augmented and dynamic service to the users that build new capacities in human effort. Autonomous Intelligence can make machines acting on their own ignoring any human effort or involvement. It makes the system automatic. Invisible Interface or No-User Interface (II) is the extreme use of AI. At the other levels of AI, UI or AAAI, a human has to understand the language of the machine. But, at II level, the machine understands the language of the human. It operates the whole system without the involvement of human.

Use of AI in inventory management of medicine in pharmaceutical industry

Pharmaceutical firms are the producers of medicine in the market. Management of inventory in a pharmaceutical firm includes a chain of activities. Some of the activities are: checking the current level of inventory of each category of pharmaceutical products and medicines, being informed about the required level of each category of pharmaceutical products along with their timing, forecasting demand, searching for the quality raw materials, bargaining down the price with the suppliers, ordering raw materials when the existing level reaches at the reorder point, receiving the supplies after a through checking of each category of the items, placing the supplies in the inventory at their due place based on their importance, placing the produced outputs or medicines in the inventory, delivery of medicine in the market, checking the inventory regularly to get informed regarding replenishment of medicine etc. Dealing with the activities requires extensive involvement of human effort and achieving a fine-tuned coordination among all these activities is very much difficult, challenging and time consuming. For an example, a pharmaceutical firm may have to procure pharmaceutical products for production of medicine from different local and foreign sources. To do so, they need to search for quality pharmaceutical products at cheapest cost. Searching for the required materials and bargaining with them to minimize the cost of supplies may be time consuming. Especially when decision is related to different categories of pharmaceutical products that are to be ordered to different suppliers located at different location of the globe at different time. For a procurement manager dealing all this issue together is very much difficult.

All of the aforementioned activities related to the management of inventory in a pharmaceutical firm can be well managed by using AI. Being connected with big data it can deal the issues related to the management of inventory very efficiently and effectively.

A pharmaceutical firm may have to maintain even more than thousand types of pharmaceutical products and medicines. Checking for the level of inventory for each of the items separately is really time consuming and difficult. By using its Ubiquitous Intelligence function, an AI can generate the list of pharmaceuticals and medicines that the firm holds at the inventory along with their quantities instantly with higher accuracy and perfection. It can also generate the schedule at which each category of pharmaceuticals that are to be ordered for the next batch of production and the schedule of medicines that are ready for delivery along with their location of delivery and quantity. Using this function an AI can also generate the report of sales that has been made in the past.

Assisted Intelligence function of AI can guide an efficient way of performing an activity. It can search for the list of suppliers that could supply the required supplies at minimum price, at the right time, at the right quantity. It can also prepare the most effective schedule of activities related to the procurement of pharmaceutical supplies, receiving, their placement in the warehouse, production of medicine and their delivery.

There are some diseases that depend on factors like- temperature, rainfall, humidity etc. Considering such seasonal variations or some other demographic changes, pharmaceutical firms has to decide on quantity of medicines to be produced. It is difficult for a human decision maker to consider the past and present data together to have and exact prediction of future condition of the diseases. Moreover, having a clear picture of the disease in accordance with the number of people affected at different locations is more difficult for a decision maker. An AI can consider such real time factors affecting the decision making related to production and delivery of medicine by using its Augmented Intelligence. It can also consider the historical data to have a clear prediction of the future demand of the medicine. At the same time, it is also important to have the information related to the market shares of competitive pharmaceutical companies operating in the same location. Such information affects the level of production as well as quantity of related materials to be ordered. Using its augmented intelligence, an AI can provide such information connected with big data. It can accurately forecast the exact level at which a certain medicine is to be produced at a particular point of time.

Placing the order for supplies to the right supplier at the right time at right quantity is another vital issue that an inventory manager has to deal with. It becomes difficult, especially, when the manager has to deal with different types of raw materials to be ordered from different locations. As it is mentioned earlier, searching for supplies is time consuming when the pharmaceutical firm does not have any fixed supplier with long term relationship. An AI can provide the solution of the problem by using its Autonomous Intelligence function. Use of the function of an AI can make the task automatic. That is, an AI can search for the least cost source of raw material and place order as per the firm’s requirement considering the quality and delivery time of the supplies. Even, as the level of inventory reaches at reorder point, an AI can automatically place order to the supplier for required level of supplies using its Autonomous Intelligence function. Besides, placing order to the suppliers, using this function a firm can also receive order from the customers automatically. In the future, all this relevant data is used to forecast the future demand for medicine in accordance with the season and time for different segment of the market. Sales data of medicine is also useful to analyze the extent by which a particular disease has spread across the country.

Receiving the deliveries from the suppliers can also be difficult when a large order is to be received. Checking the qualities of the each of the items, counting and taking weights of the supplies and placing them in accordance of their importance and use at the right place is not only challenging but also difficult. All these tasks can be performed without the involvement of human being using its Invisible Interface or No-User Interface function of an AI. This function can also manage the inventory of medicines effectively and efficiently. Just after the production of medicine, using its II function, an AI can package and place them for delivery in accordance of their location of distribution without the involvement of human being. Human can also perform the tasks but use of AI reduces the possibility of doing errors and use of time. Here, AI should not be a replacement for human effort; rather, it should be used to get the advantage of speed, consistency, repeatability, scalability and lower cost.

Challenges of using AI

AI is extremely data hungry and requires vast amount of mined and inferred data that is owned by the company. Without access to all sorts of accurate data accurate action cannot be expected from AI. It is costly not only to install the AI supportive inventory management system but also to maintain. It requires employing highly skilled data scientists and technological experts who are highly paid. For the companies operating in a country that lacks infrastructural facilities like uninterrupted flow of electricity and high-speed internet, adoption of AI supportive system is less fruitful. Moreover, AI is a computer program and it is also not out of risk of difficulty and error. Full automation using AI is still under investigation. As such, firms using AI solutions need to keep themselves in regular contact with the external parties from which they buy the product or service in case of any difficulty. This may create a dependency on the AI service provider by the user firm.

Conclusion

Inventory management is a part of the whole supply chain process. This study focuses only on the use of AI in inventory management of medicine in pharmaceutical industry based on secondary data. AI can be used in each of the stages of the entire supply chain of a pharmaceutical firm. As such, future research on this area of study can include use of AI in the overall supply chain of management process by using primary data. Moreover, it is a qualitative study that provides a conceptual framework on the application of AI in management of inventory of medicine. There is an opportunity for further study on this area by using empirical data. Case analysis focusing on a particular pharmaceutical company that uses AI in management of its inventory can also be done in the future. Furthermore, use of AI in managing inventory may not be feasible for all types of pharmaceutical firms. Whether it is beneficial for the firm or not depends on the size of the firm, its type of operation, size of the market and communication infrastructure of the country. Studies based on empirical evidence should be done to identify the benefits and costs of using AI in managing inventory.

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