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Improved Supply Chain Management in E-Pharmacy Supply Chain Using Machine Learning Intelligence

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Abstract: The applications of artificial intelligence and machine learning will eventually be useful in every industry. By putting any of these strategies into practice at work, you can make your work more productive in any area. Both of these can be utilized in the context of the retail pharmaceutical industry. However, their uses are very different from one another in a number of important respects. Not only is it feasible to anticipate the health of the patient with the assistance of the machine learning prediction model, but it is also possible to forecast the therapy that will be delivered to them. When AI technologies are used for automation, the amount of work that has to be done with the same number of resources can be accomplished with fewer persons working and with fewer resources. In this paper, we develop an improved supply chain management in e-pharmacy supply chain using the assistance of the machine learning intelligence. The machine learning intelligence using supervised learning offers an improved support on the supply chain for the drugs to be transported, tracked and delivery to the customers. The simulation in conducted to test the efficacy of the supply chain management of e-pharmacy drugs using machine learning algorithm. The simulation is conducted to test the efficacy of the model against various other models. The results of simulation shows that the proposed method achieves higher rate of accuracy than the other methods.

Keywords: *Artificial Intelligence, Retail Pharmacy, Machine Learning, Patients, Supply Chain.*

1. Introduction

A retail pharmacy is a different sort of pharmacy from a typical pharmacy since it functions more similarly to a retail than a traditional pharmacy does. This retail establishment gives a diverse group of customers access to drugs that are tailored to their specific needs [1]. Community pharmacies, often referred to as retail pharmacies, are run by pharmacists who offer a service to the areas in which they reside by stocking supplies that are normally required for medical treatment. Retail pharmacies are also referred to as community pharmacies. Community pharmacists are responsible for more than just filling prescriptions; in addition to this, they are expected to provide patients with advice regarding the appropriate use of the medications they dispense [2].

Artificial intelligence (AI) and machine learning will be implemented across all industries in the not-too-distant future. It is recommended that the use of artificial intelligence in the pharmaceutical sector be carried out in a manner comparable to that which has been carried out in the banking industry and in other industries [3]. It is a common practice to use the terms machine learning and artificial intelligence interchangeably, despite the fact that they don't refer to the same thing in the same way. Nevertheless, there is a contrast between these that is not quite as evident as one might think. The task that has to be done is carried out by machines equipped with artificial intelligence and algorithms for machine learning [4].

Utilizing the antiquated medical and pharmaceutical practices that were prevalent in the past is not a prudent course of action any longer. According to the thoughts of those who are knowledgeable in this field, a prompt response is necessary in order to avert the impending disaster that will occur in the healthcare system [5]. When essential drugs are no longer available at local pharmacies, the health of the general people is put at serious danger. It is of the utmost importance to formulate an outlook regarding the impending drug scarcity [6]. Theft of pharmaceuticals by those working in the medical sector, such as nurses and pharmacists, is an additional aspect that contributes to the problem. This is a factor that contributes to the problem [7]. The construction of a mechanism that will prevent people like them from gaining access to the

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drug is necessary since there is a requirement for it. The vast majority of the time, a doctor will prescribe a drug not because he believes it to be the best option available but rather because he has previous experience working with that specific medication. It is of the utmost importance to develop a method that is able to decide which medicines are most effective in the treatment of a particular condition [8].

The current period of narcotic epidemics, which is a direct result of the rising global improper use of controlled medications, calls for a regulation that is rigorous and strict in managing and monitoring the total distribution of narcotic medicines [9]. This regulation is required because the current period of narcotic epidemics is a direct result of the rising global improper use of controlled medications. In light of the current state of widespread drug abuse, it is imperative that we implement this rule [10]. The compliance of private pharmacy retail retails with the regulations controlling the sale of narcotic prescription drugs was found to be insufficient through a combination of methods (descriptive cross-sectional and simulated consumer). These methods led to the discovery that the compliance of private pharmacy retail retails was insufficient [11]. This was the realization that was arrived at. When it comes to the research of the impact that facts have on pharmacy practice, it is likely that the simulated methodology will be considered as a more reliable and dependable methodological instrument. This is something that is possible because it has the potential to be more resilient. According to the findings of this investigation, during the time period covered by this study, private pharmacy retails that supplied powerful drugs did not adhere to the criteria for controlled medication prescriptions even though they stocked these products. They are willing to offer massive quantities of medications to a single customer even if that customer does not have a prescription for narcotics provided that they have sufficient stock of the medication. Because of this, obtaining opioids and abusing them is now lot simpler than it was before [12].

Before dispensing narcotic medications, pharmacists have a moral responsibility to monitor and confirm that customers have prescriptions for the drugs in question, as well as to conduct customer abuse risk assessments. In addition, monitoring and confirming that customers have prescriptions for the drugs in question is an important part of this responsibility. On the other hand, as was said before, a sizeable portion of the workforce in the pharmaceutical industry is complicit in a wide variety of unethical practices and violates professional ethics in ways that are unacceptable [13]. A recent investigation into the supply chain for illegal narcotics in the United States revealed that pharmacy fraud, in which licensed pharmacists undercount dispensed pharmaceuticals or incoming inventories, is a significant entry point for obtaining more of these substances. This finding was made public as a result of the findings of the investigation. As a result of this inquiry, this finding was made available to the public [14].

Before you, there have been a significant number of researchers who have argued for the importance of artificial intelligence and machine learning. AI and ML have been shown by researchers to have the ability to help minimize the demand for human labor, which is a positive development. The outcomes of the studies indicate that the fundamental goal of both machine learning and artificial intelligence is to reduce the amount of labor that must be performed by a human being. This purpose applies to both fields. They advocated for the use of AI and ML in a wide variety of businesses and identified retail as a great option for such applications due to the industry poor profit margin and high human labor expenses [15]. They also pushed for the use of AI and ML in the military. Several research have come to the conclusion that the volume of patients that retail clinics treat bestows enormous benefits upon the community. Patients have access to a variety of retail clinics from which they can make their selection in order to receive assistance in meeting their criteria for the medications they require. As a direct consequence of this, a lesser quantity of strain is positioned upon the nation public hospitals. The most challenging obstacle, however, will be successfully connecting these retail clinics to the larger healthcare system. At the same time that they are administering the medication to the patient, they will be able to collect the patient medical history [16].

In this paper, we develop an improved supply chain management in e-pharmacy supply chain using the assistance of the machine learning intelligence. The machine learning intelligence using supervised learning offers an improved support on the supply chain for the drugs to be transported, tracked and delivery to the customers.

2. Related Works

In prior sections, we examined the numerous applications of machine learning (ML) technologies that have been made in the management of supply chains. These technologies include artificial intelligence (AI), robotics, and computer vision. A conceptual framework was developed to provide a high-level overview of the results that may be expected from deploying ML throughout the entirety of SCM, but which would be impossible to attain using more conventional approaches. In particular, the purpose of this framework was to provide an overview of the effects that may be expected from installing ML over the rest of SCM. This was accomplished by developing

this framework. In addition, some helpful information regarding the conditions that are required as well as those that are sufficient for making efficient use of ML in SCM was supplied [17].

As can be seen in Figure 5, the fundamental effect of utilizing ML methods such as LSTM in the supplier evaluation process is the extraction of critical information that may have a significant influence on the segmentation of suppliers and the selection of those suppliers. When it comes to the evaluation of suppliers, this is one of the primary advantages of using ML methods. The amount of time spent evaluating vendors in regard to criteria can also be decreased by using machine learning algorithms, which make use of a more limited number of characteristics for classification. This keeps the number of features that are used in the classification process manageable [18].

The application of ML yields more accurate risk forecasts, analyses, and mitigation strategies when it is used to SCRM. The incorporation of ML into SCRM has the potential to produce a solid supply chain, which, in turn, can shield the company operations and improve its bottom line. This is only one of the numerous potential advantages that would arise as a consequence of doing so. The use of machine learning to estimate demand and sales can result in more accurate forecasting of both, which can then lead to lower inventory costs due to a more accurate evaluation of the quantity of goods that need to be kept on hand. Using machine learning to estimate demand and sales can also result in more accurate forecasting of both demand and sales [19].

When utilizing ML techniques, it is feasible to uncover previously unnoticed inventory trends that have a major influence on cost savings. This can be a huge time and money saver. We may be able to construct an autonomous inspection system with the assistance of AI in order to reduce the amount of losses that take place within distribution facilities as well as during deliveries made directly to the locations of individual consumers. The management of a company supply chain would not be complete without transportation and distribution, but these two processes might add up to significant costs for a company [20].

The use of machine learning in transportation and distribution systems has the potential to enhance route development as well as research on consumer behavior. Both of these aspects contribute to meeting delivery deadlines and ensuring that consumers are happy with the service they receive. Production planning is yet another aspect of SCM that has been made more challenging due to a number of restrictions imposed on it. It is expected that a production planning system that is up to the challenge will be able to handle these restrictions in an effective and efficient manner. When used to make-to-stock and build-to-order production processes, ML approaches may dramatically improve the accuracy of scheduling and production planning. This is especially true for build-to-order production workflows. The key to doing this is striking an appropriate equilibrium between the constraints imposed by each workflow [21].

Standard procedures, as was said earlier, can be problematic when dealing with issues that include vast amounts of data. Standard procedures also have their advantages. Because of this, academics have lately begun to focus their attention on the application of ML strategies to the control of supply chain processes [23]. This is due to the fact that ML techniques are even more effective than traditional techniques when working with a substantial amount of data. On the other hand, there are two arguments that can be made against the application of ML approaches, and they are as follows: The vast majority of AI-based methods i) collect data from the past in order to make projections for the future, and (ii) employ these projections in order to assess newly collected data. These tactics are not capable of adjusting to the sudden changes and revolutions that take place in challenging circumstances [24].

When confronted with a scenario such as this one, in which the problem situation is experiencing major and unexpected changes, artificial intelligence is shown a condition that bears no resemblance to what it has learnt and experienced in the past. As a consequence of this, it is possible that the usefulness and efficacy of AI technologies will be significantly diminished. The validity and fairness of the methods employed by machine learning are occasionally called into question. The problem arises when machine learning systems select, based on the information they are provided, which models are the best possible ones to employ. Specifically, the problem arises when these systems choose which models to use. That is to say, there is a possibility that they will wind up making the situation much more severe, which is precisely the problem that they intended to solve [25].

As a result of this, it is essential to monitor, evaluate, and manage the outcomes of ML techniques in SCM based on the rational desirability and cultural plausibility of those outcomes. This can be done by taking into account the rational desirability and cultural plausibility of those outcomes. A human agent, also known as an SCM expert, is required to investigate the results produced by AI-based methods in order to ascertain whether or not the results and strategies that are created from these methods are both culturally acceptable and logically desirable. This is essential in order to guarantee that the use of ML in SCM will produce outcomes that are effective, efficient, and adequate.

3. Proposed Method

In the proposed approach to running a business, the production phase takes place in the factory, and the finished goods are then shipped to various retail outlets. As a result of this structure, the retailer is accountable for ensuring adequate amounts of stock. The manufacturer is provided with statistics regarding the sales of the goods as well as the proceeds as soon as they are received from the merchant. The informational divide between the two parties means that the conventional technique has some inherent limitations. It is possible for there to be either an excessive amount of stock or not enough stock if a retailer cannot be relied upon and does not provide the manufacturer with reliable information regarding demand as in Figure 1.

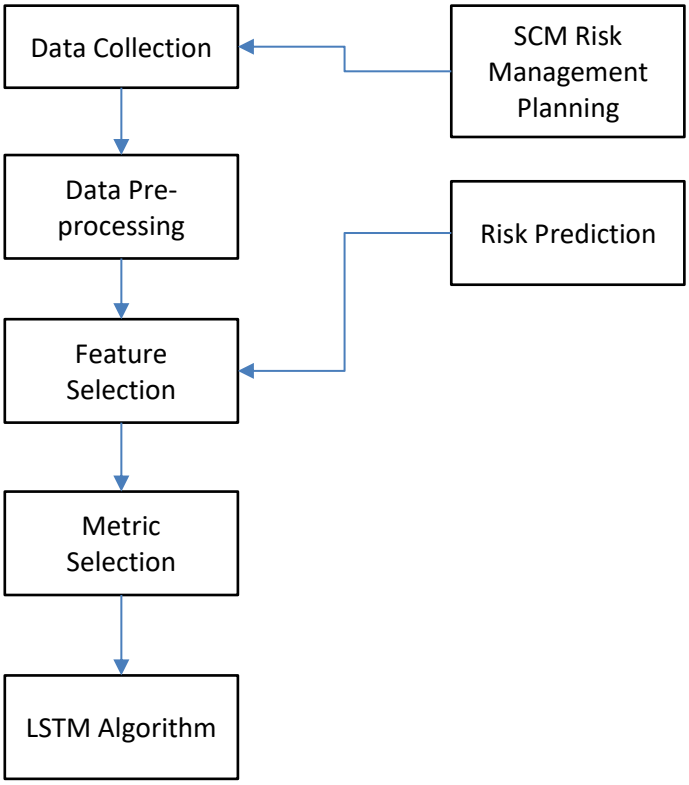

Fig 1: Conceptual Model

Furthermore, according to the legislation, every industry is expected to comply with particular laws that are designed to lessen the amount of damage that they produce to the environment. These laws are designed to limit the amount of damage that industries cause to the environment. An approach known as cap-and-trade has been implemented throughout all sectors of the economy in order to cut down on carbon emissions. This model takes into consideration, as an integral part of the overall strategy, how important it is to ascertain the degree to which anything has an effect on the environment around it. The conventional retail model, the conventional manufacturing model, and the overall expected profit from the conventional retail model are the three components that make up this model.

2.1. Retailer's Traditional Model

The design is depicted in figure 1, which can be found here. The idea of stocking costs, which refers to the amount of money spent by the retailer so that the goods can be kept in stock, is an essential component of the standard model. This cost refers to the total amount of money. After the wholesaler has purchased the entire lot directly from the manufacturer, the products are then made available for purchase by the retailer to the individual who will ultimately use them. As a result, the customer pays the retail for the opportunity to purchase the items, despite the fact that the retail continues to retain ownership of those items. When producers take use of this agreement, they are excused from paying any duty that may be applicable to their goods. After an item has been delivered by a manufacturer to a retailer, the manufacturer is no longer responsible for the holding costs associated with that item. The following is a formula that can be used to determine a retailer demand.

$$D = ab^{\gamma}e_{\eta}^{\beta}$$

The formula specifies that a is a scaling factor, γ and β is a shape, and service delivered to customers, eη is a measurement of the influence on the environment, and e is the form qualities.

If a retail continued to conduct business in the conventional manner, the following would account for the entirety of its profit:

$$E = \begin{cases} pab^{\gamma}e_{\eta}^{\beta} - wQ_r - h - C(L) & ab^{\gamma}e_{\eta}^{\beta} \le Q_r \\ (p-w)Q_r - s\left(ab^{\gamma}e_{\eta}^{\beta} - Q_r\right) - 0.5pe - C(L) & Q_r < ab^{\gamma}e_{\eta}^{\beta} \end{cases}$$

The manufacturer does not acquire correct data on the demand from customers as a result of the retailer inability to offer reliable data to the manufacturer. As a direct consequence of this fact, the prevalent model forecasts that either an abundance of stock or a deficiency of stock will materialize. It is hard to quantify the holding or shortage that happened during the lead time period since we do not have the information regarding the lead time demand. An upper bound lemma can be applied, to readily detect the expected holdings or shortages during the lead time demand even in the lack of distribution information. With the assistance of the upper bound lemma, one is able to accomplish this goal successfully. Following is a list of the logical inferences that can be inferred from this lemma:

Lemma 1.

The amount of surplus inventory that is expected to be present is

$$E_a\left(Q_r - ab^{\gamma}e_{\eta}^{\beta}L\right) \le 0.5\sqrt{\delta^2 + \left(Q_r - ab^{\gamma}e_{\eta}^{\beta}L\right)^2} - \left(ab^{\gamma}e_{\eta}^{\beta}L - Q_r\right)$$

An estimate of the total quantity of merchandise that will be absent from the inventory:

$$E_b\left(ab^{\gamma}e_{\eta}^{\beta}L - Q_r\right) \le 0.5\sqrt{\delta^2 + \left(Q_r - ab^{\gamma}e_{\eta}^{\beta}L\right)} - \left(Q_r - ab^{\gamma}e_{\eta}^{\beta}L\right)$$

Equation (1) can be restated in terms of the retail anticipated profit with the assistance of Equations (2) and (3), as demonstrated by the following expression:

$$E = p\left(ab^{\gamma}e_{\eta}^{\beta}L + Q_r\right)$$

Manufacturer's Model

In the traditional paradigm, the production process is guided by whichever option the producer considers to be the most effective at any given time. A producer income, denoted by the symbol ωQr, is contrasted with the cost of manufacturing, denoted by the symbol kQr, where *k* stands for the unit cost of production. The following sums of money, according to the conventional model of doing business, are those that the maker can anticipate making:

E= $\omega Q_r - kQ_r = (\omega - k)Q_r$.

Total Expected Profit

It is possible to arrive at an estimate of the total profit that may be expected to be made using the standard model by adding the solutions. The following is an example of such an estimate:

$E = E_a^r + E_b$

The derivative with regard to Qr, *L*, *b*, and eη can be utilized in order to maximize one potential financial gain.

Formulation of LSTM

Assume that you have to preprocess a dataset that has the length t_j and contains the time series {i(t1),i(t2),i(t3),⋯,i(tj)}, which stands for i.e Consider for a moment that you have the task of eliminating duplicates from the dataset (t_j).

As a result of applying the normalization, the time series i(tj) looks like this after it has been processed:

$i(t_j)$= [$i(t_j)$ –min(*i*)]/[max(*i*)−min(*i*)]

where, max(*i*) and min(*i*) stand in for the highest and lowest possible values of *i*, respectively.

Before dividing the collected information into a training set and a test set, the data will undergo some kind of modification throughout this stage of the process. The LSTM model is fed the training set, and the test set is what is utilized to evaluate how well the model predicts things based on how well it performs its performance metrics.

In order to obtain the predicted demand at time t_{j1}, the demand $i(t_j)$ is initially fed into the first hidden layer of an LSTM with state h1 serving as the starting state. This step is performed in order to gain the projected demand at time $tj1(t_{j1})$. h1 is the symbol used to signify the output of the first layer (tj). The second hidden layer operates in a manner that is analogous to that of the first hidden layer in that it bases its own output not only on the output of the first layer but also on the projected demand of the first layer. The output of the second hidden layer, represented by h2, is determined by fusing together the results of the evaluation of the first hidden layer, denoted by h1(t_j), and the state of the input. This is done in order to establish the output of the second hidden layer (t_j). When anything like this takes place, the output value h2 and the input demand h2(t_{j1}) are sent on to the hidden layer that comes after it (t_j).

After the time series demand data forecast has been developed, it is then passed from one layer to the next until the very final layer, which is responsible for computing the expected demand and bringing the process to a conclusion. Within the confines of this conversation, the output that is expected to come from the output gate at the point in time tj is denoted by the symbol o(t_j).

4. Results and Discussions

The WDs met to discuss and analyze a variety of approaches concerning the distribution of palliative medications to community pharmacists. Included in them were commercial and quality 'value-added' services to assist WD in acquiring community pharmacy business from competitors using Solus contracts, as well as quality improvements to facilities and infrastructure to assist WD in increasing its stock volume in the market. In addition, these services helped WD in acquiring community pharmacy business from competitors. In addition, the provision of these services assisted WD in increasing the volume of its stock on the market. In contrast to the small-scale wholesalers, which typically offer a more limited selection of medications at a more affordable price, three national distributors offered a full-line service that covered all prescriptions, including palliative treatments. This was in contrast to the small-scale wholesalers. In contrast to the more modest wholesalers, this was a much larger operation. Because there were only three FLs competing for the attention of manufacturers, the competition in the market for branded medications was not as strong as that in the market for generics. There was talk of a dual system or a Solus system, either of which, according to WD, guarantees that there would be a consistent supply available on the market. They also believed that the agreements would provide a more stable environment for the future financial transactions that would follow them.

In spite of the prevalent assumption, certain SLs have argued that the risk of a supply failure is enhanced because the product cannot be purchased from different WDs due to the nature of the Solus contracts. This is contrary to the belief that most people hold. The amount of the discount that pharmacists were qualified for was determined by the volume of merchandise that was purchased from WDs. This allowed pharmacies to save more money. These numbers were determined by professional truck drivers. It likely that because Solus was the only provider, they didn't feel the need to offer competitive pricing on their contracts. This is something that needs further investigation.

When the company was unable to secure sufficient stock levels, it committed a commercial faux pas, which had a negative affect on the company ability to serve its CPs and to generate revenue. This commercial faux pas also caused the company to lose money. Because of this, the company was unable to generate any kind of income. Because the services offered by WDs were so similar to those offered by their competitors, it was difficult for these types of companies to differentiate themselves from the other companies in their industry. Some of the most significant things that WDs can do to keep ahead of the competition and sell more products are to improve the quality of their customer service, IT ordering, storage facilities, and logistical infrastructure. Increasing the variety of products they sell and expanding their geographic reach are also essential approaches to grow their business.

Because a very tight and secure, assured supply chain is made possible by a streamlined supply chain with fewer firms in the sequence of activity, as well as a reduced risk, strategic improvement and control of the supply chain were seen as priorities. This was due to the fact that a streamlined supply chain makes a very tight and secure, assured supply chain possible. The government agency that was responsible for regulating pharmaceuticals was also responsible for conducting routine audits of their partners to ensure that WDs were adhering to the regulations and preserving the safety of their patients. These audits were conducted by the government agency that was responsible for regulating pharmaceuticals. It was crucial to work together with pharmacies to find solutions to the problems that they had with customer service because this may have put strain on any working relationship. In order to find these solutions, it was necessary to work together with pharmacies.

Strategic supply effects that operated as barriers included, among other things, the availability of generic drugs, quotas, and storage space for WDs. On the other hand, this category of influences was not limited to only these three components by themselves. When compared to the system that is utilized for the distribution of branded pharmaceuticals, the mechanism that is utilized for the distribution of generic drugs was viewed by WDs as being more like to a commodity market. It was hypothesized that the high demand for generics was caused by the commissioning and incentive programs run by the NHS, in addition to the purchasing patterns of community pharmacists. This was in addition to the fact that the purchasing patterns of community pharmacists contributed to the high demand. The evidence accumulated lent credence to this hypothesis. On the other hand, manufacturer decisions to pull a generic off the market were attributed to the product low global demand or low profit margins. Both of these factors were blamed on the manufacturers. The decision (figure 2-6) was primarily based on the consideration of these aspects of the situation.

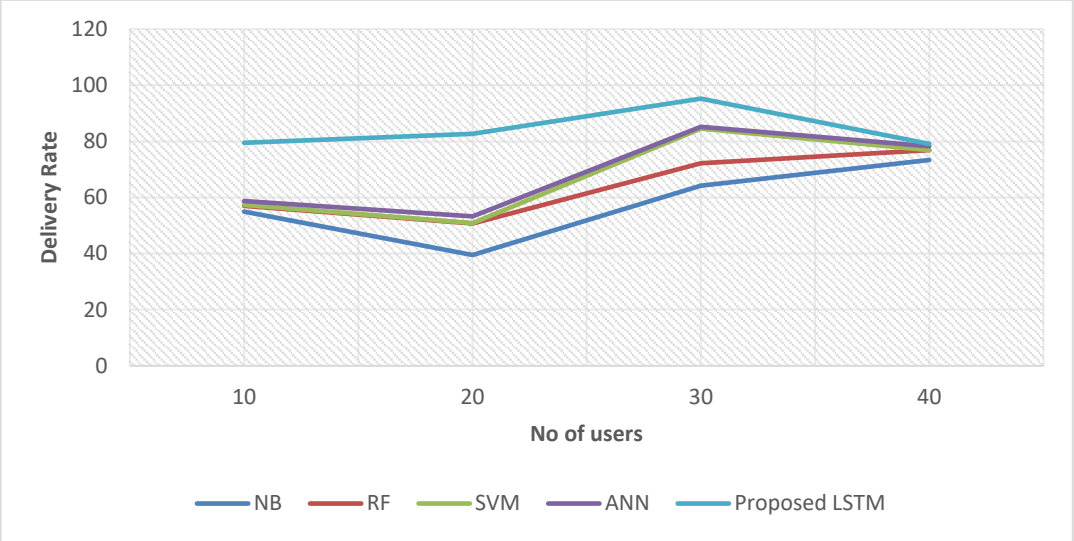

Fig 2: Accuracy of SCM delivered to the end users

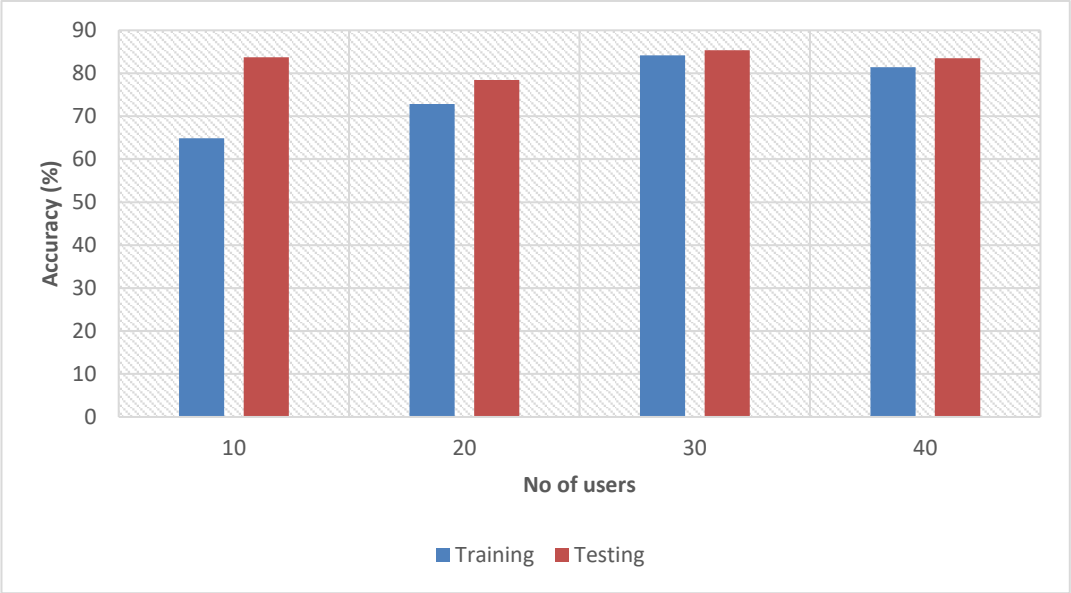

Fig 3: Accuracy of ML during training and testing stage

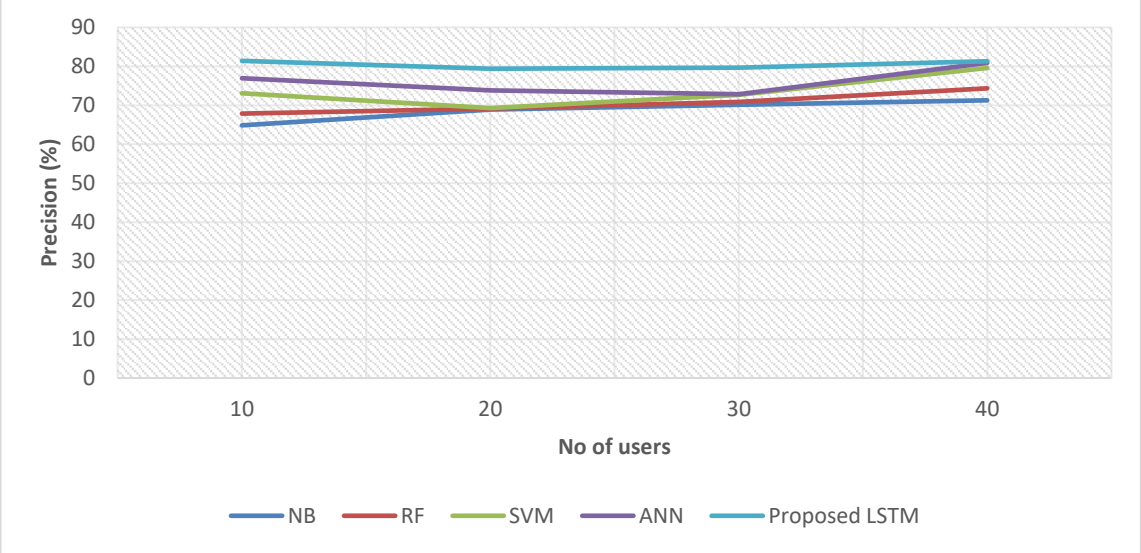

Fig 4: Precision

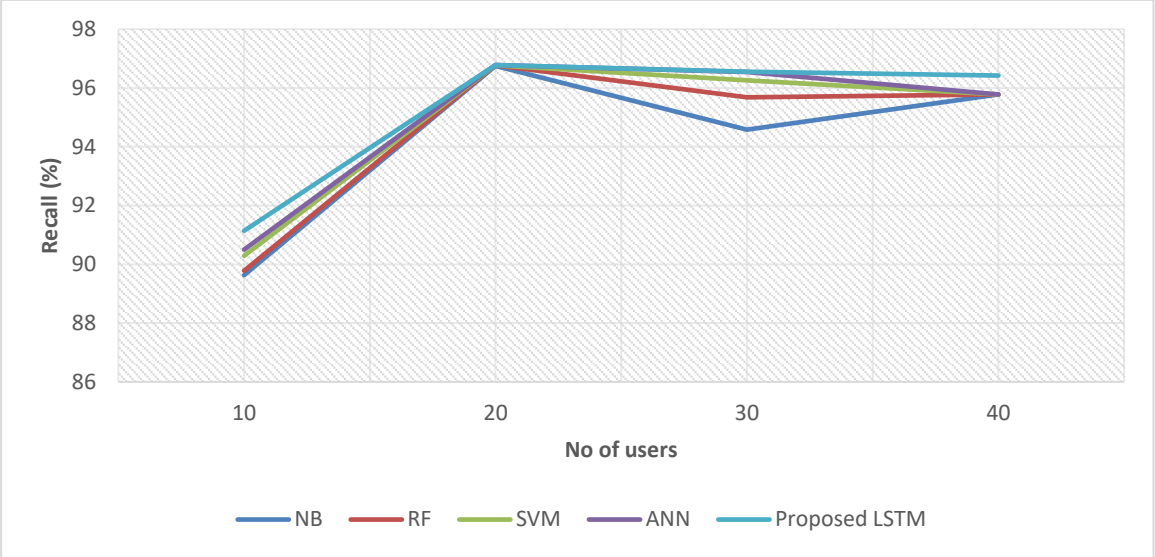

Fig 5: Recall

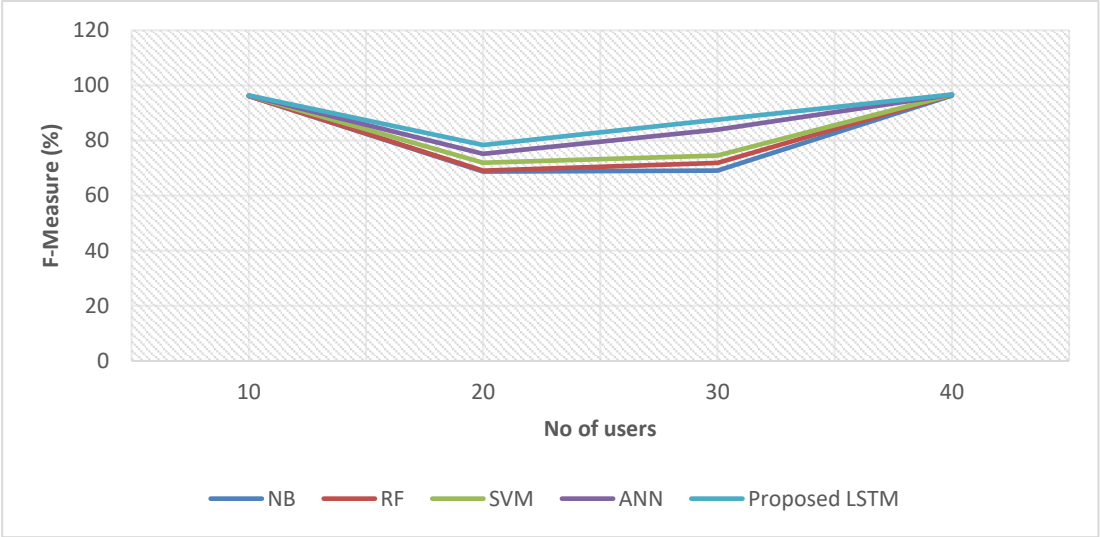

Fig 6: F-Measure

The majority of the discussion was centered on the idea of instituting quotas as a means of rationing drugs and ensuring that they are distributed in an equitable manner through the use of a mechanism. By imposing supply restrictions on the market, governments are able to regulate the amount of illegal medicine that is brought into their country for the purpose of reselling it in another country. This is one of the ways that governments can control the amount of illegal medicine that is brought into their country. It is possible that WDs will seek to impose product quotas in order to prevent pharmacies from placing excessive orders and bartering with one another.

The poor quality of the findings can be attributed to a number of factors, including the absence of participation from manufacturers of palliative care, the relatively low number of WDs who were included in the research, and the fact that the data collection was done in retrospect. All of these factors contributed to the research being conducted in the past. There were many opportunities presented to WD members to reply to invitations to join (directly and through the trade association), but they did not take advantage of these options.

It is quite likely that this was the outcome of the commercial and political sensitivities around drug shortages, as well as the work limits connected to preventing shortages in the wake of Brexit. Both of these factors contributed to the situation. Both of these considerations have the potential to influence how medicine shortages are addressed. In spite of this, we were nevertheless able to glean useful information from a collection of WDs that stood for various nodes in the supply chain. This study contributes to the corpus of work known as supply chain research, presenting both an important and distinctive perspective, by focusing its emphasis on the perspectives of individuals who have impairments throughout the course of its investigation. When it came to the responder profile, the researchers gave greater weight to CPs than they did to WDs. This

allowed them to collect enough data to make their study statistically significant. This is due to the fact that there were a greater number of qualified CPs than there were WDs in their study.

5. Conclusions

The purpose of this research was to explore the use of ML techniques across the various stages of the supply chain by means of conducting a survey to gather this information. As a consequence of this, following a brief introduction to many common supervised, unsupervised, and LSTM approaches, there was a discussion of how each method may be applied to the supervision of various components of the supply chain that came after it. We covered two distinct machine learning approaches in depth in the previous section under a Provider. To begin, we went over an explanation of the LSTM approach and how it may be implemented in the process of evaluating and choosing providers. This was done so that we could get a better understanding of what was being discussed. It is absolutely necessary for managers to exercise caution whenever they are installing new algorithms. When doing so, they should take into consideration the interpretability of the chosen algorithm in the context of the industry as well as the compatibility of the chosen algorithm with the nature of the data. Some business sectors have only lately begun to implement ML strategies in an effort to enhance the operations of their supply chains. Research on this topic include doing interviews with manufacturers and looking at many other forms of community delivery of palliative medicines, such as location-based hubs or quick response teams.

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