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ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING IN TREASURY MANAGEMENT: A SYSTEMATIC LITERATURE REVIEW

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ABSTRACT

Treasury management is becoming more complex with the advancement in the business. The enterprise needs better treasury management for its progress. One of the major functions of the treasury is cash management that requires cash forecasting. This creates the need for artificial intelligence and machine learning because these can help the enterprise in predicting the cash flow. Centralized treasury management can be helpful for providing accurate data to the machine learning model for learning purposes. This paper proves the importance of artificial intelligence and machine learning for treasury management. Different machine learning prediction models are discussed that can be helpful to the enterprise in predicting the cash flow.

Key words: artificial intelligence, machine learning, treasury management, cash forecasting

1. INTRODUCTION

Management of the cash is very important for any organization. Every organization wants to earn more profit. Treasury management includes the management of the holdings of an organization. Financial goals of an organization can be achieved through the treasury management department because it plans, organize and controls the cash assets. Treasury management is a separate function from the accounting (Mulligan, 2001). One of the key function of treasury management is to make the important decisions regarding the investment. Treasury management in a broad sense can be considered as the group of planning, availability, profitability, and financial risk with liquidity management (Khan et al., 2020). Artificial intelligence and machine learning are using in different fields to help in different tasks. The tasks can be performed more efficiently with the AI and machine learning. Artificial intelligence can also be defined as making the machines that can perform the tasks that are performed by the intelligent human beings. These machines will be able to make a good decision or prediction according to their learning (Donepudi, 2018).

The treasury management has a vital role in any organization whether the organization is smaller and bigger in size. The increased complexity of the business has made cash management and forecasting more important (Phillips, 1997). The organizations need the better forecasting to succeed in the future. The large organizations face the difficulty while managing the transactions across different locations and time zone while working with a number of outside banks. This makes the tracking and accessing cash flow information difficult. Cash management is going to be more difficult in the future that's why there is the need of AI and machine learning to perform these tasks efficiently. The organizations want more accuracy in the cash forecasts. A human being cannot perform this task efficiently. There is a need of machine learning prediction algorithms for this purpose. Researchers in (Müller et al., 2019) said that the enterprise needs the machine learning based applications to perform the different tasks. They have applied different machine learning algorithms for this purpose. These algorithms will learn through the given dataset called train dataset. These algorithms will give the prediction that will be helpful for the organization.

In the past, different researchers have worked to show the importance of AI and machine learning algorithms for the organizations. Due to the importance of machine learning, different organizations are using it because it can help in reducing the cost of product and service as well as speeds up the business processes (Donepudi, 2017). Artificial Intelligence technologies can be used to help in performing the different tasks in the business. Cash flow problems can be solved by automating this process through the artificial intelligence (Mendling et al., 2018). Machine learning algorithms can be proved helpful for dealing with different risks because these algorithms can provide the prediction. These can be the different type of risks such as the financial risk for an organization. The organizations can centralize the treasury activities to track and manage the cash flow activities (Ahmed, 2016).

This systematic literature review will be showing the use of artificial intelligence and machine learning for treasury management. It will be discussed how the centralized treasury management can be proved helpful for the organization. The work of different researchers will be discussed to show how the machine learning algorithms prediction can be helpful in treasury management.

Further sections of this literature are as follows: Section 2 shows the methodology for this literature review, research questions are given in the section 3, section 4 contains the search process, section 5 shows the result and discussion, and the conclusion is given in the section 6.

2. METHODOLOGY

The methodology that is chosen for this literature review is the systematic literature review. Different research papers are studied to answer the research questions.

2.1. Inclusion and Exclusion

Different research papers were found against the search string. Not all that research papers were included in this literature review. The papers that are included show the use of artificial intelligence and machine learning algorithms for treasury management. One of the criteria for the inclusion was also that the research paper should be written in the English language.

Fifty one papers were found from different databases. These papers were then analyzed according to the inclusion criteria. Twenty nine papers fulfilled the criteria so these were included.

2.2. Quality Assessment

The quality of the papers was assessed through the research work presented in each paper. Papers with good research on the artificial intelligence and machine learning algorithms are included in this literature review.

3. RESEARCH QUESTION

The research questions are created to make the literature review more understandable. These research questions will be answered in the result and discussion section. The answers will be based on the arguments that will be taken from the different research papers. This literature review will answer the below given research questions.

RQ 1. Why cash forecast is important for the organization and how the machine learning algorithms can be proved helpful in cash forecasting?

RQ 2: How to use the artificial intelligence effectively for the treasury management and how it helps the enterprise?

4. SEARCH PROCESS

The papers for this literature review are collected from different databases such as the ACM, Elsevier etc. In these databases, there were different research papers against the search string. To find the most relevant research papers different steps were followed. The search process model is given below.
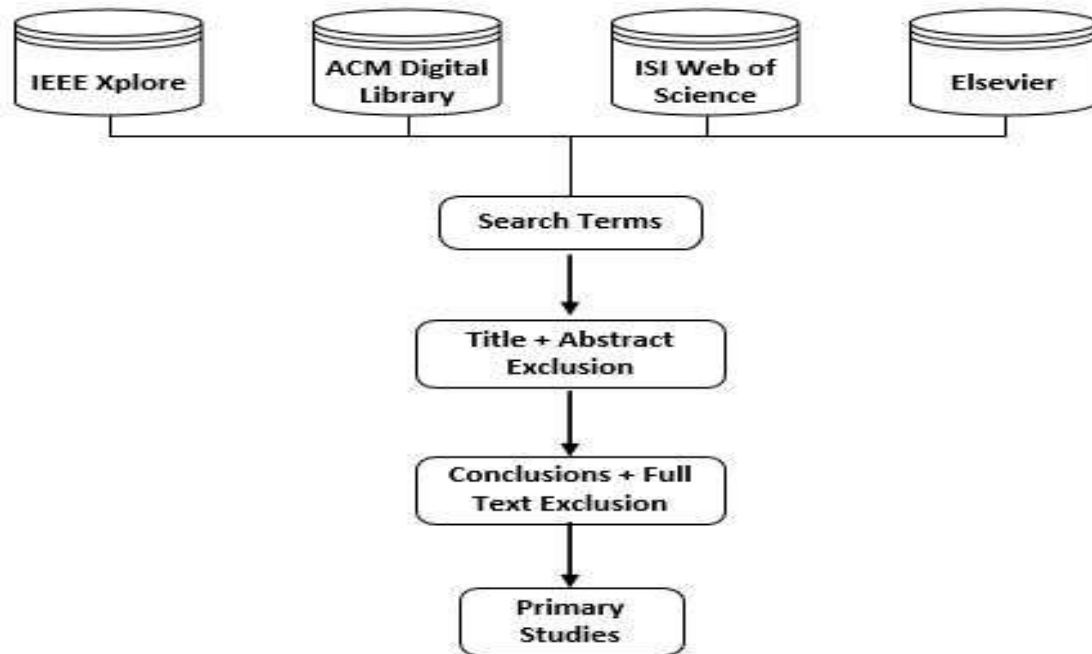
Figure 1 Search Process Model

In the first step, the papers were excluded by reading their title and abstract. In the second step, papers were excluded on the basis of text and the conclusion.

5. RESULT AND DISCUSSION

A number of papers are published in the past that shows the importance of the use of Artificial intelligence and machine learning. Every organization is trying to keep itself updated with the latest advancement of technology. Donepudi (2018) said that the advancement in computer science has made the management of information easy for the organization. Information for every organization is one of the important thing. Every organization wants to store and manage the information in a better way. This information can be of different types. For example, this can be information about the customers, cash flow etc. The organization can use this information for making the important decisions. The artificial intelligence is one of the most advance technologies that must be adopted by every organization because it has a number of advantages. The organization can increase its productivity through the use of artificial intelligence. In the past few years, the use of artificial intelligence is increasing for performing the different tasks (Donepudi, 2017). Researchers in (Arslanian & Fischer, 2019) said that it is now easy for the organization to use artificial intelligence because different tools of artificial intelligence are easily available. Nowadays different organizations use the artificial intelligence for the risk analysis. Researchers said that the organizations can use the artificial intelligence for the cash flow management and this is one of the good benefits of artificial intelligence.

RQ 1. Why cash forecast is important for the organization and how the machine learning *algorithms can be proved helpful in cash forecasting?*

In the treasury sector, one of the important function is the cash management. For an organization, the cash is the one of the important assets that must be managed in an efficient way. Treasury management aims to achieve different objectives and of them is the cash management (Moubariki et al., 2019). If the cash is not managed well it can create the various financial difficulties for the organization.

Cash forecasting is required for the better cash management. This is the perfect way to predict or estimate the monetary position in the future. This is based on different factors. The cash forecast will be helpful for the manager to understand how the cash can be utilized for more profit and how he can secure the organization from the funding issues (Rahman et al., 2020). Ahmed (2016) provided a model with a better accuracy in cash flow forecasting. Because the wrong estimation can be the cause of failure for an organization in achieving its objectives.

Machine learning can be used for a better prediction about the cash. Instead of simply reporting the number and statistics, the machine learning tools and techniques can be used for the prediction and analysis. Machine learning algorithms can be trained through a data set so that it can make the accurate predictions over the new data set (Rafi et al., 2020). The main aim of the machine learning is to make the models more intelligent so that they can learn without the assistance or intervention of a human being. Researchers in (Zylius et al., 2015) compared the different machine learning models for the cash flow prediction. The organization must have to use the model that provides the more accuracy.

The researchers in (Gardin et al., 1991) proved that the support of computer is necessary for the liquidity management. With the advancement and complexities of business, it is now mandatory to adopt the new technologies for the progress of the business. Therefore there is a need of machine learning algorithms to forecast the cash because a human being cannot predict this accurately. Researchers in (Agrawal et al., 2019) said that machine learning is the prediction technology that helps in decision making. Machine learning algorithms predict on the basis of a large data set that is used to train the algorithm. Machine learning algorithms can be categorized as follows:

Table 1 Major categorize of machine learning algorithms

Supervised machine learning algorithms	Unsupervised machine learning algorithms	Reinforcement machine learning algorithms
These algorithms require a labelled training dataset. The output of these algorithms can be in the form of any category or real value. For example, health prediction for a person can be "healthy" or "sick" and height can be predicted in real values.	The training dataset provided to these algorithms does not contain labelled data. These algorithms provide output in the form of probability. For example the probability of buying egg if a person buys bread.	These algorithms are trained in a way to act according to the situation. An example of this algorithm can be a person in a video game who moves toward coins to collect them. In short, we can say that these algorithms learn from the environment.

According to the need of an organization, it can choose the model. A problem or confusion arises while choosing the model for cash management. In (Salas-Molina et al., 2018) researchers have presented a method known as Receiver operations Characteristic analysis that will be helpful for the decision makers while selecting the model. The main focus of the most of the cash management models or approaches is to minimize the cost. However, the decision makers also consider the risk as an important factor. Researchers in (Salas-Molina et al., 2018) proposed a model that allows the decision makers to choose the best, less uncertain and stable policies in terms of risk and cost.

Researchers in (Salas-Molina et al., 2017) said that the prediction accuracy is connected with the cost savings. It means that a little improvement in the accuracy of the model can be very beneficial for the organization. Below are some of the popular predictive models that can be used for the cash forecasting.

Table 2 Predictive Models

Autoregressive model	Radial basis function model
Regression model	Random forest model
Seasonal interaction model	Gradient boosted model

Autoregressive model

This model is used to predict the future behavior on the basis of past behavior. It is better to use this model for forecasting when there is a relation between the future value and past value. For example, this model can be used to predict the future prices of stocks on the base of its past performance.

Radial basis function model

This model can also be used for prediction or forecasting. In (Hemageetha & Nasira, 2013) researcher said that this is the best model for prediction because it provides more accurate results. They have used this for predicting the price of vegetables. RBF value depends on the distance that is between the input and fixed point that can be a center.

Regression model

This is a predictive model used to find the relationship between the variables. These can be the two type of variables known as the dependent variable and independent variable. This model can be used for two purposes. First, it can be used to predict the value of a dependent variable. Estimating effect of the explanatory variable on the dependent variable is its second use.

Random forest model

This model can also be used for prediction purpose. It consists of a number of decision trees and each decision tree gives a class prediction. The class with more votes is the final prediction of the random forest model.

Seasonal interaction model

Researchers in (Miller et al., 1985) proposed a model for the purpose of forecasting the daily cash flow. This model has a variable known as the seasonal indicator. The value of this indicator is one when the given seasonal condition is true. Otherwise, the value of this indicator is zero.

Gradient Boosted Model

The prediction of this model is also based on decision trees. But it is different from the random forest model. It uses the "boosted" technique of machine learning. All the trees are not created at the same time. Instead, this creates one tree at a time and each tree helps in correcting the errors that are made by previously trained tree.

RQ 2: How to use the artificial intelligence effectively for the treasury management and how it helps the enterprise?

With the passage of time treasury management is going to be more and more important for the progress of an enterprise. Treasury management has to become forecast based so that it can deal with different risks. One of the major responsibility of the treasury departments is to minimize the financial costs of different resources and increase the profit. In a broader perspective, treasury management covers three main aspects. It is shown in the figure given below.
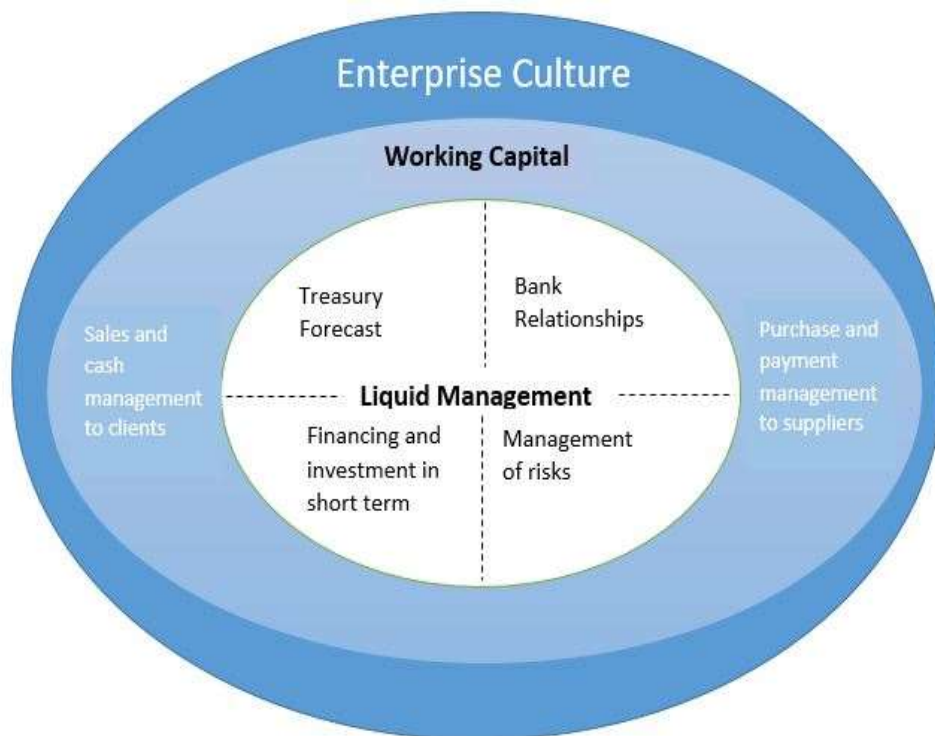
Praveen Kumar Donepudi, Mst. Hasna Banu, Wahiduzzaman Khan, Taposh Kumar Neogy, ABM Asadullah and Alim Al Ayub Ahmed

Figure 2 Treasury management in Enterprise

Artificial intelligence and machine learning are using in treasury management for different purposes. These are performing the different tasks in an efficient way. This can be the task of cash flow forecasting, checking balances, and auto investment solutions etc. Artificial intelligence can be used in the enterprise to automate the different tasks that are previously doing by humans. This will save the time as well as the work done by the machine will be error free. Artificial intelligence makes the machine capable to do the task that is performed by humans. Machine learning helps the machines to learn from the previous data so that they can work according to their learning. Researchers (Metaxiotis et al., 2003 Begum et al., 2012) said that the decision making is one of the major issues for an enterprise because this is a complex task. That is why the enterprise is using the artificial intelligence to help in decision making. Artificial intelligence can also help the enterprise in detecting the cybercrimes. This can be in the form of detecting the unusual transactions. Researchers in (Liu & Zhang, 2010) in proposed a machine learning algorithm to detect the abnormal transactions. Another benefit provided by the artificial intelligence is the accuracy in forecasting. One of the major activity performed in treasury is the cash management that heavily relies on the forecasting of cash flow. Treasurers with incomplete and inaccurate information were unable to predict or forecast the cash flow. Artificial intelligence is helpful to collect and store the data for cash flow prediction. Machine learning models are trained with the collected data and then these models perform prediction over the new data. A huge amount can be saved by collecting, storing, analyzing and verifying the information programmatically.

Artificial intelligence network neural system are widely using in many fields such as the early warning about the crisis, financial risks diagnosis, mining the hidden data etc. These experts systems can solve the different complex problems that are faced by the enterprise (Polak et al., 2019). A centralized treasury management system can be more helpful for the forecasting. If the system is centralized then all the information will be saved at that single place. The information required for the machine learning models learning can easily be fetched from that single location. If the information is stored in different locations, it makes it

difficult to access the accurate information. Storing the information on a single location also saves the cost of the enterprise.

Researcher (Donepudi, 2016) said that artificial intelligence applications can increase the progress of different organizations. Artificial intelligence applications are not restricted to one field only. These can be used in banking, hospitals etc. These applications help in dealing with the complex task that is difficult to be performed by a human. Artificial intelligence applications not only perform these tasks, they rather perform it in the best way.

Khan et al. (2020) said that the pressure on the banks is increased because of the financial crisis of 2008. Many banks started using the artificial intelligence to make better decisions. It also helped in the automation of operational activities. One of the major issues in the bank is making a decision about giving credit to a person. Machine learning algorithms can help the banks in taking this important decision. The loan can be given to a person with the help of the prediction given by the machine learning model (Boughaci et al., 2020).

6. CONCLUSION

Treasury management has become a difficult function in the enterprise that must be performed in a better way. This paper proves the importance of artificial intelligence and machine learning for treasury management. Different machine learning prediction models are discussed that can be helpful to the enterprise in predicting the cash flow. Prediction through these machine learning models is accurate. Moreover, these models can easily be trained with the previous data. Accuracy in the prediction can save the enterprise from different crisis and risks. Different tasks in the enterprise can be performed with automation by the artificial intelligence. This will saves the cost of the enterprise. In the banking sector, machine learning predictive models can help to decide whether to the person will be able to return the loan or not. On the basis of this prediction, the banks can grant the loan. This will be helpful to the bank in utilizing the cash in a way that can be profitable. Future work can be the study on the impacts of artificial intelligence on the labors of an enterprise.

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