Mitigation Model for Climate Change Effect on Supply Chain

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ABSTRACT

The objective of this paper is to provide a fundamental assessment of the impacts of climate change on supply networks, as well as an analysis of the implications of climate change for supply chain management in terms of strategic and operational planning, both in the short and long term. In addition, a road map of effective research approaches is offered. The weather conditions, such as the lowest temperature, maximum temperature, precipitation rate, wind speed, pressure, and other meteorological factors, play a variety of important roles in the supply chain's study of the weather conditions.

To show climate change effect, first we have shown weather forecasting results by using multiple linear regression and then we have mentioned climate change effects on supply chain, In this paper we are predicting visibility from set number of independent variables.

KEYWORDS

climate change, impacts of climate change, supply chain design and operations management

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1 INTRODUCTION

Climate Change has arisen in recent years as one of the most pressing issues facing practically every organization. Various levels of decision-making, both private and public, are involved. When compared to the general public's perspective only a few years ago, this is a significant shift. Climate Change, which is a result of global warming, is a universally acknowledged reality that has an impact on the lives of human communities, corporate activities, and the environment itself in a variety of ways. As a matter of fact, businesses must conduct their climate change-prone operations in a more vigorous and risky environment in which the perspectives of institutional actors as well as resource-based actors, supply chain actors, and stakeholder actors are all important in characterizing and understanding corporate strategic responses to sustainability issues. The characteristics that make weather forecasting a dangerous activity are that it is an ongoing, multidimensional, effective, disorderly process that uses a large amount of data or information and searches for helpful insights into topics such as climate change and supply chain management. The authors develop a paradigm for systematically measuring the implications of climate change on supply chains and their management, and they make recommendations for further investigation. An increase in the number and severity of legislation, market forces, and stakeholder demands are paving the way for decarbonization of supply networks, which will have obvious consequences for supply chain management. Supply chain managers should pay close attention to the effects of climate change on their organizations' supply chains, and academics should continue to investigate the interrelationships between climate change and supply chain design and operations. Climate change and supply chain design and operations In the field of weather prediction, a variety of methodologies have been employed. For weather prediction in recent years, machine learning approaches have gained popularity as more accurate methodologies, and they have been widely employed as an alternative to traditional methods. The purpose of this study is to construct a regression model that can be used to forecast the rate of precipitation in a given area.

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2 DATA COLLECTION

The dataset used in this paper is obtained from a *Kaggle* which is a subsidiary of Google LLC, is an online community of data scientists and machine learning practitioners. Kaggle allows users to find and publish data sets, explore and build models in a web-based data-science environment, work with other data scientists and machine learning engineers, and enter competitions to solve data science challenges.Data consist 12 variables and 96452 observations which are both numeric and categorical in nature. For modelling relevant variables have chosen based on past study and domain based criteria, hence total variables step down from 12 to 8.

3 RELATED WORK

Thomas K. Dasaklis, Costas P. Pappis in their paper *"Supply chain management in view of climate change: An overview of possible im- pacts and the road ahead"* they have mentioned the purpose of this article is to give a broad overview of how climate change affects supply chains and to examine the implications of climate change for supply chain management in terms of strategic and operational planning. A road map of successful research methods is also pro- vided. The research uses a broad assessment of the relevant litera- ture to explore for useful insights into climate change and supply chain management concerns using a systematic classification of the findings. The authors develop a paradigm for systematically measuring the effects of climate change on supply chains and their

management, as well as giving recommendations for further research.

Hiyam Abobaker Yousif Ahmed 1 , Sondos W. A. Mohamed 2 in their research paper *"Rainfall Prediction using Multiple Linear Regressions Model"* mentioned several weather characteristics used as independent variables, a multiple linear regression model was developed to predict the rate of precipitation (i.e., rainfall rate) for Khartoum state. The mean temperature, maximum temperature, lowest temperature, Dewpoint, sea level pressure, station pressure, mean visibility, and wind speed are the weather parameters in question. During the training and testing phases, the average of the mean square error between the actual and predicted value was calculated.

Govind kumar Rahul, Saumya Singh, Saumya Dubey in their paper *"Weather Forecasting Using Artificial Neural Networks"*, they have mentioned use of Artificial Neural Networks for weather fore- casting, their research paper includes information like the realm of agriculture, meteorological conditions such as minimum tem- perature, precipitation rate, wind speed, maximum temperature, pressure, and so on have an essential effect. Having precise weather predicting technologies in a country like India will allow farmers to increase agricultural yield. Weather information may have a direct or indirect impact on the industrial sector, not just farmers. Artificial Neural Networks, a soft computing technology, are a step forward in the development of an intuitive system capable of in- terpreting nonlinear weather circumstances and making forecasts. The proposed study focuses on developing an intuitive system that can anticipate weather with the least amount of inaccuracy and a more acceptable architecture.

T. Dananjali, S. Wijesinghe , J. Ekanayake in their paper *"Forecasting Weekly Rainfall Using Data Mining Technologies"*, they have used models for data mining, Rainfall data gathered in the Badulla district of Sri Lanka from 2002 to 2017 was used to train linear regression, SMO regression, and the M5P model to forecast weekly rainfall for the next five months. Mean Absolute Error (MAE), Root Mean Squared Error (RMSE), Root Relative Squared Error (RRSE), Root Absolute Error (RAE), Direction Accuracy (DA), and resid- ual analysis were used to assess each model. In comparison to the linear and SMO regression models, the M5P model tree gave the lowest error value, maximum direction accuracy, highest correla- tion between actual and forecast rainfall quantities, and improved unpredictability of the error values.

C.M. Godde,D. Mason-D'Croz a, D.E. Mayberry a, P.K.Thornton b, M. Herrero in their research *"Impacts of climate change on the livestock food supply chain; a review of the evidence"*, they have men- tioned about Climate change's potential consequences on current livestock systems around the world are a serious issue, although the matter is only briefly addressed in global assessments like those produced by the Intergovernmental Panel on Climate Change. We examine the danger of climate-related consequences along the land- based cattle food supply chain in this study. Although it is beyond our current understanding to quantify the net impacts of climate change on the livestock sector, there is strong evidence that there will be impacts throughout the supply chain, from farm production to processing operations, storage, transportation, retailing, and hu- man consumption. Climate-related risks vary greatly depending on the context, but they are predicted to be higher in areas that are already hot and have inadequate socioeconomic and institutional resources for adaptation.

4 MULTIPLE REGRESSION

Many independent variables can be used to investigate the relationship between a single dependent variable and several independent variables, which is known as multiple regression. The goal of multiple regression analysis is to predict the value of a single dependent variable by using the values of the independent variables that have been determined previously. Each predictor value is given a weight, with the weights indicating how much of a contribution they make to the overall forecast. Y is the dependent variable, while X1,..., Xn are the n independent variables in this equation (1). When calculating the weights, a, b1,...,bn, regression analysis assures that the dependent variable can be predicted as accurately as possible from the collection of independent variables. This is commonly accomplished through the use of least squares estimation. When one of the variables is dependent on a set of other variables, this approach can be used to analyze multivariate time series data, which is a situation that occurs frequently. On the basis of the set of independent variables, we can model the dependent variable Y. When we are given the values of the independent variables, we may forecast the value of Y from Eq. 1. This can be done at any point in time.

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5 ATTRIBUTES SELECTION FOR WEATHER FORECASTING

Temperature (C):- It is an ambient temperature.

Apparent Temperature (C) :- The perceived temperature in degrees Fahrenheit derived from either a combination of temperature and wind (Wind Chill) or temperature and humidity (Heat Index) for the indicated hour.

Humidity :- Humidity is the amount of water vapor in the air. If there is a lot of water vapor in the air, the humidity will be high. The higher the humidity, the wetter it feels outside.

Wind Speed (Km/h) :- It is a speed of wind in Kilometer per ho

Wind Bearing(degrees):- It indicates the direction toward which an object is moving.

Pressure (millibars) :- Pressure in a millibar is 1/1000th of a bar and is the amount of force it takes to move an object weighing a gram, one centimeter, in one second.

6 DEPENDENT VARIABLE :- Visibility(Km)

7 MODEL DEVELOPMENT

7.1 Data Preprocessing :- The data is cleaned and preprocessed at first to ensure that there are no flaws in the data, such as noise, redundancy, or missing data, that could impair the model's overall performance.

7.2 Exploratory Data Analysis(EDA) :-

EDA is necessary before actual model fitting for better selection of variables.

Below figure is showing heatmap of the correlation between independent variables and dependent variables, it is shown variability have higher correlation with temperature.

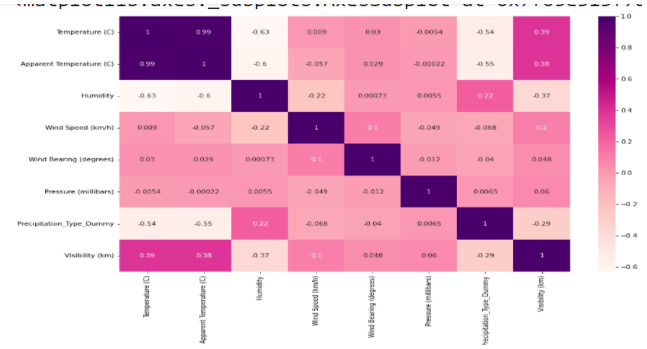

Figure 7.2.a: Heatmap of correlation of variables

Below figure shown scatterplot of Humidity and Visibility(Km), there is a negative correlation between Humidity and Visibility.

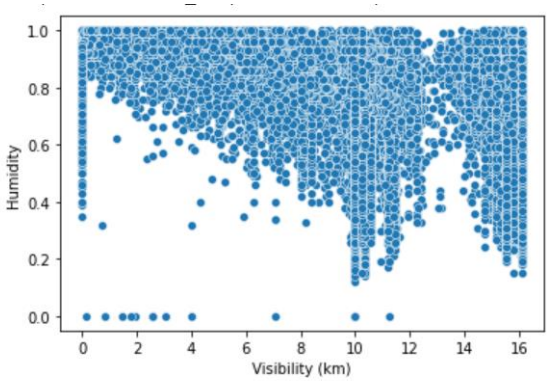

Figure 7.2.b: Scatterplot between Visibility and Humidity.

Hence from above two figure we concluded that both the variables are correlated with Visibility, but one of them is positively correlated and other one is negatively correlated.

Data splitting :- 75 percent data were chosen for training the model using a random sampling method, and 25 percent were used for modeling analysis. A bigger fraction of the dataset is used to train the classification model in order to improve its accuracy.

Algorithm selection :- The algorithm selection is the second step in the model generation. In this paper, we selected supervised multiple linear regression because our dependent variable is numeric and there are multiple independent variables which are also numeric and continuous. The selected model is then trained and the performance of the model is evaluated.

8 MODEL VALIDATION

To evaluate the performance of our model, we have shown result of below measures.

R square:- R-Squared is a statistical measure of fit that indicates how much variation of a dependent variable is explained by the independent variable(s) in a regression model.

MAE(Mean Absolute Error):- In statistics, mean absolute error (MAE) is a measure of errors between paired observations expressing the same phenomenon.

MSE(Mean squared error:- The mean squared error (MSE) tells how close a regression line is to a set of points.

9 RESULT:-

R square :- 0.20 **= 20%**

Mean Absolute Error :- 3.05

Mean Squared Error :- 3.75

10 CLIMATE CHANGE IMPACTS ON SUPPLY CHAIN

Below are the potential risks that can disrupt supply chain due to climate change[1].

Manufacturing:- • Asset damage or total destruction • liability risks • plant and production line interruption • Carbon emissions regulation • changes in the efficacy or efficiency of manufacturing processes • increased energy and maintenance costs • increased cost of upstream operations and product quality • encouragement of investments in renewable energy and energy efficiency projects Demand for bio-fuels and renewable energy sources in the energy sector • Demand for pharmaceuticals • Stimulation of Demand for Non-Emitting Products • Market leaders' adoption of lower carbon intensity operational practices creation of varied products based on lower GHG emissions.

Transportation:-• Increased number of bowed rails and rutted roads • Delays resulting in compensation payments to operators and causing problems for customers • Overhead cables brought down by strong winds • Coastal defence issues • Drainage issues • Landslip caused by excessive rainfall • Securing structural stability

Warehousing and storage:-• Infrastructure, personnel, communications, supply, and other systems are vulnerable; extreme weather occurrences may cause disruption.

11 CONCLUSION

The purpose of this article is to investigate the interrelationships between climate change and supply chain operations, specifically the consequences of the former on the latter. Climate change's potential consequences on certain supply chain operations were identified, and the implications of climate change drivers for supply chain strategic and operational decision making were investigated. The conceptual backdrop offered in this paper may serve as a starting point for future research efforts that challenge academics and researchers to investigate the interrelationships between climate change and SCM further.

Also, R square is 20 percent which shows model accuracy is not good, which indicates that to predict variable these of features selection is not an good option. Also our error is not so high between predicted and actual valus., that indicates.

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