MODEL BUILDING AND FORECASTING OF CLIMATE DATA FOR TOURISM AREA IN BANGLADESH

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2022

MODEL BUILDING AND FORECASTING OF CLIMATE DATA FOR TOURISM AREA IN BANGLADESH

by

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Thesis submitted in fulfillment of the requirements
for the degree of
Doctor of Philosophy

June 2022

ACKNOWLEDGEMENT

At first, I would like to remember the most gracious, the most merciful, the creature of this heavenlier universe the Almighty Allah to give me the capacity to continue and complete my research work successfully.

Next, my reverent gratefulness goes to my respectable supervisor **Mohd Tahir Ismail**, Associate professor, School of Mathematical Sciences, Universiti Sains Malaysia, 11800 Pinang, Malaysia for his beneficial guidance and imperative supervision and I am very glad to him for allowing me to do research work under his supervision. His continuous encouragement, important suggestions, and necessary corrections helped me selecting the content of this study. With his experienced and constructive thoughts and ideas, directions, and sincere guidance, I have been able to conduct this thesis in time successfully.

I would like to express my sincere gratitude to the institutions of BBS (Bangladesh Bureau of Statistics), Bangladesh Agricultural Research Council (BARC), Bangladesh Meteorological Department (BMD), and Bangladesh Parjatan Corporation (BPC) for timely giving me the essential data.

I cordially thank all of my friends and well-wishers, who never hesitated to the extent of their helping hands in completing this research work. The officers and staffs of the School of Mathematical Sciences, USM also deserve my thanks for their cordial co-operation.

Finally, I am especially grateful to my beloved father Late Sayed Mamun Hossen Faruk, uncle Late Khan Towhid Osman and my mother Rabea Khatun for their prayers to the almighty ALLAH. Heartiest thanks to my siblings and my family members for their unconditional love, inspiration, and sacrifice during my study period.

TABLE OF CONTENTS

LIST OF TABLES

Page

LIST OF FIGURES

Page

LIST OF SYMBOLS

d	the number of times the series has to difference
D_1, D_2, D_3	are reference category
e_t	forecast error in a period t
I_t	Income
k	kurtosis
n	sample size
p	is the number of autoregressive terms
q	the number of moving average terms
r	Correlation coefficient
R^2	coefficients of determination
s	skewness
S	the seasonal period
$\boldsymbol{S_{1H}}$	Humidity in cool/winter season
$\boldsymbol{S_{1R}}$	Rainfall in cool/winter season
$\boldsymbol{S_{1T}}$	The temperature in the cool/winter season
$\boldsymbol{S_{2H}}$	Humidity in dry/summer season
$\boldsymbol{S_{2R}}$	Rainfall in dry/summer season
$\boldsymbol{S_{2T}}$	The temperature in the dry/summer season
$\boldsymbol{S_{3H}}$	Humidity in the wet season
$\boldsymbol{S_{3R}}$	Rainfall in the wet season
$\boldsymbol{S_{3T}}$	The temperature in the wet season
u_t	is a white noise error term
Y_t	the actual value in a period t
$\hat{Y}_t$	forecast value for the period t
β_0	Intercept term

$\beta_1, \beta_{2,} \dots, \beta_{11}$	are coefficients
Δ^d	indicates the d th difference of y_t
$\Delta y_{t-1} = y_{t-1} - y_{t-2}$	the first differences of y_t and so on.
$\nabla_{12} y_t = y_t - y_{t-12}$	Seasonal Partial Autocorrelation
$\varepsilon_{t-1}, \varepsilon_{t-2}, \cdots, \varepsilon_{t-q}$	errors in previous periods

LIST OF ABBREVIATIONS

ACF	Autocorrelation Function
ADF	Augmented Dickey-Fuller
AIC	Akaike Information Criterion
ANCOVA	Analysis of covariance
ANFIS	Adaptive Neural Network-based Fuzzy Inference System
ANN	Artificial Neural Network
AR	Autoregressive
ARMA	Autoregressive Moving Average
ARIMA	Autoregressive Integrated Moving Average
BARC	Bangladesh Agricultural Research Council
BBS	Bangladesh Bureau of Statistics
BMD	Bangladesh Meteorological Department
BPC	Bangladesh Parjatan Corporation
DF	Dickey-Fuller
CLRM	Classical Linear Regression Model
EEMD	Ensemble Empirical Mode Decomposition
GDP	Gross Domestic Product
HD	Heat Demand
JB	Jarque-Bera
KPSS	Kwiatkowski-Philips-Schmidt-Shin
LM	Lagrange Multiplier
MA	Moving Average
MAE	Mean Absolute Error
MAD	Mean Absolute Deviation
MAPE	Mean Absolute Percentage Error
OLS	Ordinary Least Square
PACF	Partial Autocorrelation Function
PP	Phillips-Perron
RMSE	Root Mean Squared Error
SANCOVA	Seasonal analysis of covariance
SARIMA	Seasonal Autoregressive Integrated Moving Average

SEM	Structural Equation Modeling
SDTGFM	SARIMA Damp Trend Grey Forecasting Model
SMA	Seasonal Moving Average
SIC	Schwarz Information Criterion
TCI	Tourism Climate Index
UMTS	Universal Mobile Telecommunication System
USM	Universiti Sains Malaysia

LIST OF APPENDICES

PEMBENTUKAN MODEL DAN RAMALAN DATA IKLIM UNTUK KAWASAN PELANCONGAN DI BANGLADESH

ABSTRAK

Pembolehubah iklim seperti suhu, hujan, dan kelembapan mempengaruhi pilihan destinasi dan corak taburan pelancong pada musim yang berbeza. Oleh itu, objektif utama penyelidikan ini adalah untuk memodelkan dan meramalkan pembolehubah iklim tempat pelancongan yang berbeza. Lebih khusus lagi, untuk mengkaji kesan bermusim terhadap ketibaan pelancong dan pendapatan dari pelancongan yang menyumbang kepada ekonomi negara Bangladesh. Di mana, kesan pembolehubah iklim ini dinilai menggunakan rangka kerja pemodelan SANCOVA yang diubah suai dari model ANCOVA, untuk menjelaskan kesan semasa perubahan iklim terhadap KDNK. Model SARIMA telah digunakan untuk pemodelan di tujuh tempat bersiar-siar yang menarik di Bangladesh dan diramalkan sehingga tahun 2050. Dari analisis, kami mendapati bahawa suhu maksimum dan minimum sedikit meningkat pada kira-kira 1^0C tetapi menurun kira-kira 2^0C. Pada bulan Julai, hujan berjumlah 800 mm (31.5 in) di Sylhet, sehingga 750 mm (29.5 in) di Chittagong dan sehingga 900 mm (35.5 in) di Cox's Bazar. Pelawat yang tergolong dalam negara kelembapan yang rendah boleh melakukan perjalanan ke Bangladesh pada musim hujan, dan dari negara-negara kelembapan yang tinggi dapat melawat sepanjang tahun. Dalam analisis, kami mendapati kesan bermusim adalah 91% terhadap ketibaan pelancong di Bangladesh dan mengesyorkan bahawa, jika ketibaan pelancong meningkat seribu setiap musim, maka pendapatan akan meningkat secara purata sebanyak 0.527 juta Taka setiap musim. Juga, jika perbelanjaan untuk pembangunan

pelancongan akan meningkat 0.1 juta Taka setahun, maka pendapatan akan meningkat 0.181 juta Taka setiap musim.

MODEL BUILDING AND FORECASTING OF CLIMATE DATA FOR TOURISM AREA IN BANGLADESH

ABSTRACT

Climatic variables such as temperature, rainfall, and humidity affect the choice of destination and the distribution pattern of tourists in different seasons. So, the main objective of this research is to modelling and forecasting the climatic variable of different tourist spots. More specifically, to examine the impact of seasonality on tourist's arrival and income from tourism that contributes to the national economy of Bangladesh. Wherein, the effect of these climatic variables was assessed using the SANCOVA modelling framework modified by the ANCOVA model, to explain the current contribution of climate change on GDP. SARIMA model was applied for modelling at seven attractive sightseeing diverse places in Bangladesh and forecast up to the year 2050. From the analysis, we have found that the maximum and minimum temperature is slightly increasing at approximately 1^0C but decreasing approximately 2^0C. In July, rainfall amounts to 800 mm (31.5 in) in Sylhet, to 750 mm (29.5 in) in Chittagong, to 900 mm (35.5 in) in Cox's Bazar. Visitors belonging to low humidity countries can travel to Bangladesh in the rainy season, and from high humidity countries can discover all year-round. In the analysis, we found that seasonality has 91% effect on tourist's arrival in Bangladesh and recommends that, if tourist's arrival will increase thousand per season, then income will increase on average by 0.527 million Taka per season. Also, if expenditure for tourism development will increase 0.1 million Taka per year, then income will increase 0.181 million Taka every season.

CHAPTER 1

INTRODUCTION

1.1 Background of the Study

Tourism is a great tool for poverty alleviation. By creating new jobs at different levels and engaging local people in them, the tourism industry supports reducing poverty to a great extent. The outcome in the recent analysis, researchers have found an association between environmental sustainability and economic growth which encourages policymakers to give attention to it (Sun et al., 2019). Climatic variables and the changes in them also affect the overall economy of a country in diverse ways (Siddig et al., 2020).

For their comfort, climatic factors such as temperature, humidity, and rainfall are associated with social entertainment in open spaces (Dillimono, 2015). For outdoor comfort during spring, higher temperature and meteorological pressures correlate with entertaining (Keller et al., 2005). However, higher temperatures bring about more negative attitudes for surpassing comfort during the summer. Seasonal changes have an impact on the relationship between climatic variables and variability in attitude (Beecher et al., 2016).

Due to seasonality, travellers discover the availability and quality of certain open-air recreational activities. Different types of tourism products, such as wintertime sports and water sports are designed for tourism which is highly affected by seasonality such as natural sights and tourism for beaches (C. Liu et al., 2017). Climatic variables have an important effect as well as a significant relationship with the tourism stakeholders to choose the destination and to plan to travel in different seasons (H. Q. Zhang and Kulendran, 2017). So, seasonal variation is an important feature in tourism

demand. Therefore, policymakers considered seasonality as an essential issue and addressed it in planning, decision making, marketing, and operation levels (Li et al., 2018).

In the field of economics, it has been proposed that the impact of climatic changes has significant effects on Gross Domestic Product (GDP) (Wu, 2016). Several researchers asserted that there is a positive relationship between economic growth and environmental concern, as well as ecological modernisation (Knight, 2016). By improving the necessity for tourism prospects, it is a great opportunity for destination countries to lift their economic growth by fascinating tourists through the creation of innovative tourism segments and proper utilization of natural sights (Dogru et al., 2019). It is notable that if investment ensures its profits, normally increases the amount of investment (Komendantova et al., 2019). Otherwise, any investment for improving environmental development causes penalties that reduced profits would defend stockholders to finance (Sroufe and Remani, 2018). The development must be designed and implemented so that the next generations have sufficient resources available to meet their needs (Lior, 2017). There are already more than 170 developed nations who have abundant natural resources; nevertheless, wasteful investment is driven by the weak economic and technology foundations, particularly in building (X. Zhang et al., 2019).

1.2 The motivation of the Study

In the 21st century, the tourism industry has gotten one of the major and quickest developing areas in the world (Hassani et al., 2017). It is a wide variety of activities, services and industries including transport, lodging, food and beverage,

retail stores, entertainment enterprises and other lodging services for guests and gatherings (Konarasinghe, 2016).

The economic impacts of tourism development are noticeable both in the local and global aspects of the financial sphere (Economic and social development, 2017). Residents' advantage by the tourism industry over expanded economic action, upgrade of recreational offices, the opening of eateries, revival of local cultures, and interests in environmental infrastructure. On the other hand, tourist appearances can influence residents' prosperity through genuine experiences (Ivlevs, 2017).

The development of the tourism industry business, for the most part, relies upon the development in the appearances of both local and foreign tourists (Mishra, Rout, & Pradhan, 2018). Their expenditure represents the foundation of the economic impacts of the tourism industry (Smolčić Jurdana and Soldić Frleta, 2017). Revenue from worldwide the tourism industry likewise fills in as the source of tax revenue for governments, that expands the national income (Tiwari et al., 2018).

A range of recreational items motivates tourists, escape from daily life, experience new things, and expand new social relationships (Volchek et al., 2019). Numerous investigations found that individual safety and destination image are additionally the significant determinants of destination decision for guests (Hamadeh and Bassil, 2017). A recent study revealed that tourists are strongly motivated by cultural reasons as well as very interested in realistic features (De Simone et al., 2018).

For productive tourism industry businesses, it is critical to react quickly to up and coming interest, in this manner, making constrained resources accessible for co-inventive assistance creation forms. Tourism demand forecasting may provide important information for successive planning and policy-making (S. Sun et al., 2019).

Therefore, the arrival of tourists forecasting is not only essential for business planning, growth strategies, and operations of travel and tourism companies but in measuring and expecting the region's overall economic activity (Bangwayo-Skeete and Skeete, 2015). Moreover, projections of tourist appearances help governments informing medium and long-haul procedures for local and regional tourism industry improvement and planning (Höpken et al., 2018).

Although due to the coronavirus pandemic the world business enterprise sector already lost $2.0 trillion (1.78 trillion euros) in revenues last year, according to the World Tourism Organization (UNWTO), creating it one in all sectors hit hardest by the health crisis. International traveller arrivals can this year (2022) stay 70-75% low the 1.5 billion arrivals recorded in 2019 before the pandemic hit, the same decline as in 2020, consistent with the body.

1.3 Sustainable Tourism Development in Bangladesh

Sustainable tourism is defined as tourism that appreciates both residents and the traveller, cultural heritage, and the environment. It provides an exciting and educational holiday that is also of benefit to the people of the host country. Influences of Sustainable tourism economically, socio-culturally, and environmentally is neither constant nor temporary (Beech and Chadwick, 2005). Sustainable tourism offers high degree of tourism in the region it is carried out by offering possibilities for the social, economic, ecological, and cultural environments (ICOMOS, 2016). From the descriptions above, sustainable tourism is a business that affects the environment and local culture and contributes to the creation of future jobs for inhabitants (sustainable economic development,2016). In consequence, citizens may make decisions that affect their life and influence the conservation of the natural and cultural heritage positively.

Bangladesh is an ideal destination for sustainable tourism. It has tremendous geographic advantages and an ecologically beautiful landscape with green valleys, large forests, long beaches, hills, lots of lakes, and rivers that help the country to be an ideal ecotourism destination. In Bangladesh, there are many ancient mosques, temples, churches, pagoda, shrines, historical and archaeological sites. The ethnic lifestyle of indigenous people of hill tracts and various religious and cultural shows are good forms of cultural diversity that might act as a powerful component of developing sustainable tourism in Bangladesh.

The Ministry of Tourism structures national approaches for advancing and promoting the travel industry and keeps up the Beautiful Bangladesh crusade. In order to safeguard local and international visitors easier and to take care of regular attractions and of natural life in major tourist locations, the Bangladesh government has created a Tourist Police Unit.

Tourism is a vital industry for developing countries since it promotes quite a lot to their GDP. Bangladesh is a very well industrialized country and popular as a tourist destination (Lim and Giouvris, 2017). In 2013 the number of arrivals was 277596, while in 2017 this number increased by 778143. Because of the expanding trend, it is significant to conjecture the number of visitor appearances with exactness since it will profit the immediate and circuitous exercises that are identified with the tourism industry. Along these lines, the legislature or related organizations and offices could utilize the projected figure to improve the situation, for example, preserving natural resources and producing appealing open doors for foreign investors.

The more present literature on forecasting tourism industry requests has propelled an assortment of new and imaginative quantitative modelling and

determining approaches (Apergis et al., 2017). Nonetheless, other than long-haul trends, tourist appearances generally follow occasional trends (Wolfram et al., 2017). In Bangladesh, students from different educational institutes receive holidays in June and July for summer and in the month of December-January for a winter celebration. At the end of the year, employees from every public and private organization receive holidays to celebrate the winter season. Religious festivals for the Muslim community are held in different seasons in different years and festivals for the Hindu community usually held in the rainy season. Besides these, national days are celebrated all year round. People make their plan for traveling at the very beginning of the year based on holidays. Therefore, seasonality is an essential issue that should be addressed at policy, marketing, and operation levels (Li et al., 2018).

1.4 Problem statement

Tourists want to travel to a wide diversity of environments, including urban and isolated regions (Priego et al., 2015). It is dangerous and unpleasant to hike or involve in energetic hard work during high temperatures (Hoogendoorn and Fitchett, 2018). But it has a positive impact on the tourists in large numbers and feels enjoyable environments on an outing in cool areas (Jedd et al., 2018). Therefore, climatic resources contribute significantly to tourists' decision-making processes, travel, as well as the related allocation of tourism expenditures (Scott et al., 2016). Different types of tourism, such as tourism for beaches and natural sights are vastly affected by seasonality as it is considered as an input in designing the tourism product, such as wintertime sports, and water sports (Li, Song and Li, 2017). Therefore, in tourism demand, seasonal variation is one of the important features.

When I do forecast about any specific issue of a country such as war, flood, and pandemic, etc. then people from outside assume that the whole country is under crisis. This is not true at all. Maybe some parts of the country are affected so I cannot say the whole situation is not in favour of traveling. Also, travellers spend their holidays for not a long period, and it is difficult to visits all the attractive tourist spots within a short period of traveling. Besides these travellers from the different parts of the world are not the same in choice. Some like summer, some prefer rainy, and some love the winter season for traveling. More additionally some like beaches, some prefer archaeological sites, some want to spend in nature, and some loves adventure in hilly and forest area. These are the research gap. So, our major aim is to model and forecasting the climatic variable of different tourist spots in Bangladesh that might be helpful for travellers to discover Bangladesh in their convenient time and comfortable climatic variable all year round. This fills up the research gap and makes the wheel of the tourism industry active and profitable all year round.

1.5 Objective

From the view of the tourism industry, it is generally assumed that the climate of places greatly influences the likings and pleasure of tourists (Kovács et al., 2016). Climatic variables have an important effect as well as a significant relationship with the tourism stakeholders to choose the destination and planning to travel in different seasons (H. Q. Zhang and Kulendran, 2017). Due to its seasonality, this issue determines the availability and quality of certain open-air recreational activities (Hewer et al., 2015). Climate change may affect short-term and long-term cost repercussions for the tour operators and economies reliant on tourism (Dube and Nhamo, 2018a). Climate variables such as temperature compete a vital role in tourism flows worldwide. This enhances tourism at the forefront of the economic segments to

be affected by climate change (Pintassilgo et al., 2016). It is identified as a motivator factor for travels, in the area of tourism research (H. H. Liu et al., 2018). Therefore, seasonality is an essential issue that should be addressed at policy, marketing, and operation levels (Li and Huang, 2017).

Therefore, the main objective of this research is to find out the relation between seasonality in climate change and the tourism industry in Bangladesh. More specifically to examine the impact of seasonality on tourist's arrival and income from tourism that contributes to the national economy of Bangladesh. After all, the objective of this study can be summarized as follows:

a. to explore the association between climate changes and the tourism industry in Bangladesh.

b. to construct Seasonal Autoregressive Integrated Moving Average (SARIMA) model to find out the trend and forecast the future of monthly maximum temperature, minimum temperature, rainfall, and humidity of the northern part, in the south-eastern part, in the south-western part, and the north-eastern part of Bangladesh.

c. to develop Seasonal Analysis of Covariance (SANCOVA) model to examine the seasonal effect on tourist's arrival as well as on the GDP of Bangladesh.

d. Also, to focus and compare our proposed model, how it can perform better in the application of seasonal variation.

1.6 The Scope of study

The climate of Bangladesh splits the year usually into three seasons: between May to October is the monsoons or wet season; from October to February is called cool season; and the dry season between March to May. In the sense of comfort, it is better to visit in the cool season to discover Bangladesh. There is heavy rainfall at the time of monsoon season which makes it difficult to travel in some tourist areas (M. T. U. Rahman, 2015). Rahman et al. (2017) have applied the ARIMA model for the future projection of climate change in Bangladesh. Wavelet -ARIMA model has been used by Nury et al. (2017) to measure the temperature of the north-eastern part of Bangladesh (Nury et al., 2017). Primary data has not been used because it would take much time and complicated equipment mental support which is lacking, so secondary data are used in the study. By realizing this I collect data for climatic variables such as maximum and minimum temperature, rainfall, and humidity data for tourists' stations from Bangladesh Agricultural Research Council (BARC) and Bangladesh Meteorological Department (BMD). Monthly Maximum and Minimum temperature, rainfall and humidity data of Dhaka is the capital city, the northern part (Rajshahi), in the south-eastern part (Chittagong, Cox's Bazar & Rangamati), the south-western part (Khulna), and the north-eastern part (Sylhet) in Bangladesh, is the study variables.

At first, I screened the missing values. I exclude the station from the modelling, which includes more than 2% missing value. After checking and passing the above tests of these seven stations containing long-term data (more than 40 years) up to 2018 were used in this research. Therefore, maximum and minimum temperature, rainfall, and humidity data from January 1972 to December 2018 were used for these stations. We collect information about the number of tourist's arrival and income from tourism

from the Bangladesh tourism board and Civil aviation of Bangladesh, to examine the contribution of seasonal effect on tourist's arrival and the GDP of Bangladesh.

The Tourism industry has a significant impact on advancing national and local economic improvement. Forecasting assumes a significant job in the tourism industry, arranging at all levels in both the private and public sectors. Consequently, an early sign of potential tourists' appearance could assume a critical role in the arranging and the board of the Tourism industry. Henceforth, finding suitable forecasting methods is fundamental. I composed secondary climatic data from the Bangladesh Meteorological Department (BMD) and Bangladesh Agricultural Research Council (BARC). The number of tourists' arrival, Expenditure for tourism development, and Income from tourism data have been collected from Bangladesh Parjatan Corporation (BPC), Ministry of Civil Aviation and Tourism, Bangladesh Bureau of Statistics (BBS), different reports, published articles, websites, Daily newspapers. These data will help to examine the relationship between changes in the climate and tourism business.

1.6.1 Climate-Related Variables

Climate condition plays a significant role in the choice of the terminus for visitors. It is one of the unhinged features fluctuating in short intervals for a tourist destination (Mekanik et al., 2016). This issue influences the appeal of a possible vacation region, involves or enables certain kinds of amenities to be offered at the terminus, and has an effect on accessibility, depending on the time of the outing (Braun et al., 1999). Climate change is one of the most important issues with latent influence on tourist behaviour. It is a significant variable to retain tourists. (Eugenio-Martin and Campos-Soria, 2010). A potential traveller decides whether or not to travel based on the advanced forecast and the updated information on the visiting day (Joo et al., 2014).

The climate of several countries is a vital strength for tourism. Although the tourist industry is familiarized with rapid change, climate inconsistency has major implications for the tourist industry (Viner and Agnew, 2006). In this situation, the importance of forecasts is noticeable for planning and choice of leisure events. Climate forecasting predicts the state of the (Taxak et al., 2014) atmosphere for a given place (Abhishek et al., 2012).

A positive climate for a given product (summer and winter) and certain assets that would attract vacationers can influence demand or appearances in traveller destinations. Climatic variables such as temperature, humidity, and wind speed are correlated with human entertainment in open places for their comfort (Dillimono, 2015). Human wellbeing depends to some extent on the physiological and mental responses of the body to local climatic conditions – the way toward adjusting to new conditions when traveling can influence these responses (Szecsi, 2012). Present-day the travel industry (with brisk exchanges to distant destinations with an alternate climate as for the typical local conditions) agreements with visitors to adjust the new atmosphere which their body can absorb physically and psychologically through a temporary lived time (Mayor et al., 2007)(Salata et al., 2017). For outdoor comfort during spring, higher temperatures and meteorological pressures have a positive correlation with entertaining (Keller et al., 2005). However, higher temperatures bring about more negative attitudes surpassing comfort during the summer. Seasonal changes have an impact on the relationship between climatic variables and variability in attitude. Shorter hours of sunshine are led to negative feelings during seasonal changes (Beecher et al., 2016). Bangladesh has a tropical monsoon climate described by wide seasonal varieties in precipitation, high temperature, and high humidity.

Climate has a significant effect on the tourism resources, tourism zone, tourism seasons, tourism supply and demand, etc. (Y. Fang and Yin, 2015). For destination selection, they are not only influential factors but are also important in altering activities and travel plans, during the trip. Temperature is one of the most crucial factors in climatic variables for tourism in summer and bones trembled in winter tourism (Wilkins et al., 2018). Nice weather conditions encourage outdoor tourist and entertaining activities and thus play a key role in the choice of tourism destinations (Grillakis et al., 2016).

Rainfall is one of the most important variables in climate change (Wahyuni and Mahmudy, 2017). It is a key phenomenon in climate systems, muddled nature has a direct impact on tourism (Cramer et al., 2017). Countries with a tropical climate, are highly dependent on rainfall prediction (Wahyuni et al., 2016). Rainfall trend analysis and its prediction are not very easy because of its nonlinear nature (M. A. Rahman et al., 2017). Rainfall forecasting is a climate alteration task where specific structures are used to predict in specific places (Zainudin et al., 2016). Accurate prediction is challenging due to the difficulty of the metrological phenomenon. For its nonlinearity rainfall is caused by the diversity of meteorological conditions and the mathematical model (Kashiwao et al., 2017). Additionally, accurately predicted rainfall data can be used for modeling streamflow and natural disasters (Yaseen et al., 2018).

Humidity is one of the most significant climate factors influencing the decision of destination and the distribution pattern of vacationers during various seasons. These variable influences, not just the benefit of day-to-day travel industry activities yet additionally the arranging and structure of the travel industry facilities to keep up

destination competitiveness later. Thusly, having an early sign of conceivable future humidity levels could assume a noteworthy role in planning the tourism industry.

1.6.2 Economic Related Variables

"Climate defines tourist season duration and quality, influences tourism operations and has a negative effect on environmental conditions which attract and repel visitors." "Recreation and tourism" is one of the world's most important economic events, some even argue that they are the largest. In established and less developed countries, tourism is a magnificent engine of economic growth. The function of tourism is regarded across the world in the economic development of metropolitan neighbourhoods and in delivering some benefit to the district. International tourist numbers grew to 903 million every year in 2007, from 25 million in 1950, and it is estimated that 1.6 billion would be received by 2020 (UNWTO, 2001). But the global tourism sector already lost $2.0 trillion (1.78 trillion euros) in revenues last year due to the pandemic, according to the World Tourism Organization (UNWTO), making it one of sectors hit hardest by the health crisis.

Knowledge of climatic factors, edges, tourism and diversion are essential information on tourism and entertainment options. Actual information and a good information atmosphere is necessary and beneficial, particularly during the preceding time, for tourist sector, tourism coordinators, operators, tourism organizers and investors and opportunities and turnover (Yazdanpanah et al., 2016). Public climate change adjustment directly supports government investment budgets (Bachner et al., 2019). Change in the climate impacts the tourist sector that hit emerging nations that may be predicted to fuse the national economy per capita (Taconet, 2020).

1.7 Summary and Thesis Organization

The thesis is split into six chapters, which are followed by an introduction study of Chapter 2. Chapter 3 methods of models and forecasts, chapters 4 and 5 of results, and the final thesis is chapter 6.

Chapter 1, the introductory chapter, offers the research backdrop, including the problem of research, followed by the aims and relevance of the study. Furthermore, this chapter presents the scope of the investigation describing the variables employed in this thesis.

In the second chapter, the SARIMA, SANCOVA and SEM background definitions are provided, and the benefits of these techniques are examined. In addition, prior research is discussed, particularly on the tourist arrival, on how the common approach is used for modeling the climate change study. Chapter 2 is essential in order to grasp some connected principles in the development of this thesis in the seasonal effect model.

Chapter 3 deals with the statistical or theoretical analysis utilized to describe the statistics and the examination of correlations in this thesis. This chapter also addresses the approach of time series for modeling and tourism arrivals climatic factors. This chapter also contains the step–by-step process for the assessment of the influence of seasonal events and the arrival of tourists in this thesis on the national economy.

Chapter 4 provides an estimate for the model to detect seasonality and the number of tourism arrivals using the SARIMA model for climate variables. This chapter will start with the model identification and then estimate the model in seven attractive tourist stations in Bangladesh for the four climate variables such as

maximum and lowest temperature, rainfalls and humidity. Also, one of the goals of this chapter is the Statistical Trend and Seasonal Mode for each dataset. Then, with SARIMA and SANCOVA, the estimated number of seasonal visitor arrival models and their influence on the GDP are used to assess their success.

Chapter 5 consists of the univariate Seasonal Autoregressive Integrated Moving Average (SARIMA) model to conjecture month-to-month maximum and minimum temperature, rainfall, and humidity for mainstream tourists' spots of Bangladesh up to the year 2050. To find out the impact of different seasons on tourists' arrival and income from tourism, seasonal analysis of covariance (SANCOVA) model was applied. The findings of the present study have significant repercussions for both policymakers and tourists' destinations alike. Results also demonstrate that the tourist's arrival, the tourism industry, and the entire overall economy are vulnerable to seasonal variation.

The last chapter highlights the theoretical and applied conclusion of this thesis. There is also a proposal for more study on the topic of this thesis.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter is especially involved with a general summary of the SARIMA model, the advantage and application of the SARIMA model, the planned SANCOVA model used for empirical investigation. Here, we tend to shall conjointly discuss the importance of global climate change, the relation between climate change and business, tourism in Bangladesh with its climate.

2.2 The SARIMA Model

In the Autoregressive (AR) technique of order p, the cutting-edge commentary is generated via way of means of a weighted common of beyond observations going returned p periods, collectively with a random disturbance withinside the cutting-edge period. I denote this technique as AR (p) and write the equation as,

$$y_t = c + \emptyset_1 y_{t-1} + \emptyset_2 y_{t-2} + \cdots + \emptyset_p y_{t-p} + \varepsilon_t \quad \ldots (2.1)$$

In the Moving Average (MA) technique of order q, every statement is generated via way of means of a weighted common of the random disturbance going returned to q periods. I denote this technique as MA (q) and write the equation as,

$$y_t = \mu + \varepsilon_t + \theta_1 \varepsilon_{t-2} + \cdots + \theta_q \varepsilon_{t-q} \quad \ldots (2.2)$$

Autoregressive schemes with moving average error terms of the form are denoted by-.

$$y_t = c + \emptyset_1 y_{t-1} + \emptyset_2 y_{t-2} + \cdots + \emptyset_p y_{t-p} + \varepsilon_t + \theta_1 \varepsilon_{t-1} + \theta_2 \varepsilon_{t-2} + \cdots + \theta_q \varepsilon_{t-q} \ldots (2.3)$$

This is the Autoregressive Moving Average (ARMA) process (p, q) or shortly ARMA process (p, q). The Autoregressive Integrated Moving Average (ARIMA) method is a widely common procedure in econometric time series. Models of time series presume it is stationary. However, many of the time series are non-static and integrated. If a time series $\mathrm{I}(1)$, i.e., its initial differences $\mathrm{I}(0)$, is stationary, of order one. Likewise, the second difference is $\mathrm{I}(2)$, if a time series is $\mathrm{I}(0)$.

Generally, if a time series is $\mathrm{I}(d)$, then we obtain a series after differentiating it $\mathrm{I}(0)$. So, if we vary in periods of time series and then use the $\mathrm{ARMA}(p,q)$ model, the time series model is $\mathrm{ARIMA}(p,d,q)$ where, is the number of autoregression terms, is the number of times the series is different, and is the number of average movements. The procedure $\mathrm{ARIMA}(p,d,q)$ may therefore be expressed as,

$$\Delta^d y_t = \emptyset_1 \Delta^d y_{t-1} + \cdots + \emptyset_p \Delta^d y_{t-p} + \varepsilon_t + \theta_1 \varepsilon_{t-1} + \cdots + \theta_q \varepsilon_{t-q} \ \ldots (2.4)$$

where, c and μ are constant $\varepsilon_t$is assumed to be a normal random variable with 0 mean and variance σ_t^2

p = number of autoregressive terms and q = number of moving average terms

d = number of differencing

$\varepsilon_{t-1}, \varepsilon_{t-2}, \cdots, \varepsilon_{t-q}$ = errors in previous time periods

$\Delta \mathrm{y_t} = \mathrm{y_t} - \mathrm{y_{t-1}}$, Δ^{d} indicates the d th difference of y_t and $\Delta y_{t-1} = y_{t-1} - y_{t-2}$ are the first differences of y_t and so on.

If the data shows a strong seasonal pattern, this indicates a high correlation between values observed during the same season in consecutive years. The Seasonal ARIMA model proposed by Box and Jenkins (1976) was used for model building and forecasting monthly rainfall. Seasonal ARIMA model can be labelled as ARIMA (p,

d, q) * (P, D, Q)s where (p, d, q) is the nonseasonal part and (P, D, Q)s is the seasonal part of the model which could be written as:

$$\emptyset_p(L)\emptyset_p^S(L^S)(1-\ L^S)^D(1-L)^d y_t = \ \theta_q(L)\theta_q^S(L^S)\varepsilon_t \ \ldots (2.5)$$

Where $\emptyset_p(L), \theta_q$ are as before, S is the seasonal period,

$$\emptyset_p^S(L^S) = 1 - \emptyset_1^S L^S - \emptyset_p^S L^{SP} \ \ldots (2.6)$$

$$\theta_q^S(L^S) = 1 + \theta_q^S L^S + \cdots + \theta_q^S L^{SQ} \ \ldots (2.7)$$

and D is the number of times the seasonal difference operator $(1 - L^S)$ is applied. Building an ARIMA model consists of four systematic stages (identification, estimation, diagnostic check, and application or forecast).

2.3 Advantages and application of SARIMA model

The SARIMA has a direct interpretation in time series modeling and explanatory variables may be indirectly added. In addition, this is a time series modelling system. In addition, in terms of yearly, quarterly, and monthly projections, notably long-term horizons and seasonal data, the SARIMA method also has high performance. The findings are predictable and precise compared to other approaches. Recent applications of this strategy include meteorology, medical, power management, economy, agriculture, sociology, science and management, operational research, geography, engineering, travel, tourism, etc., are considered to be a contribution to SARIMA's application. Table 1 shows several SARIMA Model uses in various areas.

Table-2.1: Application of SARIMA model in different fields

No	Author	Application	Scope
1.	(S. Wang et al., 2013)	In this study, the author uses the seasonal moving average and autoregressive (SARIMA) method to analyze the seasonally periodic precipitation data based on the statistical yearbook of Shouguang City, Shandong Province from 1996:1 to 2009:12.	Meteorological
2.	(T. Fang and Lahdelma, 2016)	Based on real-existence warmth demand (HD) data, the seasonal autoregressive transferring average (SARIMA) version is evaluated on this take a look at for the town of Espoo in Finland.	Meteorological
3.	(Shafaei et al., 2016)	This study tested wavelet, SARIMA, and multi-scale hybrid artificial neural networks (ANN) to see their ability to accurately predict the monthly downfall statistic at the Nahavand lookout in Iran.	Meteorological
4.	(Dritsaki, 2016)	In this article, the author uses the Box-Jenkins method to test the accuracy of the model's prediction of the unemployment rate in Greece.	Unemployment
5.	(Tadesse and Dinka, 2017)	In this study, the Waterval stream flow was forecasted by the SARIMA model victimization Mean monthly flows from 1960 to 2016.	Water management
6.	(Mukaram and Yusof, 2017)	To use seasonal autoregressive integrated moving average (SARIMA), artificial neural network	Power management

		(ANN), and hybrid ANN and SARIMA models to simulate monthly average solar radiation, data were obtained from 3 sites in Malaysia.	
7.	(Mwanga et al., 2017)	The study found that seasonal ARIMA is the best model to meet the 1973-2015 season sugarcane harvest in Kenya.	Agriculture
8.	(Patowary and Barman, 2017)	To solve the health problem, try to fit the seasonal autoregressive integrated moving average model (SARIMA) to study the quarterly tuberculosis detection rate in Dibrugarh, India.	Medical science
9.	(Patowary, 2017a)	In this article, the author developed the SARIMA (Seasonal Autoregressive Integrated Moving Average) model and applied it to the long-term temperature data prediction of Assam Bondi Brugal.	Meteorological
10.	(Kaczmarczyk, 2017)	This article introduces the validity test results of a multi-part model based on the integration of the linear regression model with dichotomous independent variables and the SARIMA model in the short-term forecast of hourly demand for telephone services.	Telecommunications
11.	(Y. Yu et al., 2017)	This paper proposes an autoregressive seasonal moving average trend combined with a dendritic neural network (SA-D) model to predict tourism demand.	Tourism management

12.	(Bozkurt et al., 2017)	In this article, the author uses seasonal autoregressive integrated moving average (SARIMA) and artificial neural network (ANN) to test the current benchmarks of the Turkish electricity market.	Power management
13.	(Moeeni and Bonakdari, 2017)	In this study, a mixed Seasonal Autoregressive Integrated Moving Average (SARIMA) and nonlinear Artificial Neural Network (ANN) are used to model the month-to-month inflow to the Jamishan dam reservoir in West Iran.	Power management
14.	(Hazarika et al., 2017)	This study attempts to use the Box-Jenkins method to create an ARIMA model for Dibrugarh's monthly rainfall data from 1980 to 2014.	Meteorological
15.	(Rusyana et al., 2017)	Seasonal Autoregressive Integrated Moving Average (SARIMA) model was designed to predict the number of tourists who arrived via the Kualanamu International field in Medan, Indonesia.	Tourism management
16.	(J. Zhang et al., 2017)	In this paper, a hybrid technique combining ensemble empirical mode decomposition (EEMD), adaptive neural network-primarily based fuzzy inference system (ANFIS), and seasonal auto-regression incorporated shifting average (SARIMA) is offered for short-time period wind pace forecasting.	Power management

17.	(Q. Xu et al., 2017)	Using a seasonal autoregressive integrated moving average (SARIMA) model, the authors aimed to expect mumps' occurrence and offer theoretical proof for early caution prevention and manipulation in Zibo City, Shandong Province, China.	Medical science
18.	(Yang et al., 2017)	This paper proposes a seasonal ARIMA (SARIMA) model to resolve craft failure rate forecasting.	Transport industry
19.	(B and Meshoul, 2018)	In this study, the authors created a SARIMA model of the potential bioelectric data set to create an infrastructure design for assessing the location of a person in an accurate location.	Medical science
20.	(Hernandez et al., 2018)	To predict the behavior of the primary user and the spectral opportunities for wireless networks, the authors present a comparative evaluation of the ARIMA and SARIMA models.	Telecommunications
21.	(Alencar et al., 2018)	A hybrid model supported by SARIMA and a neural network has been planned to predict the wind speed of multiple passes mistreatment meteorologic information collected from two locations in Brazil.	Meteorological
22.	(Ebhuoma et al., 2018)	The purpose of this research is to develop a predictive model for predicting malaria cases in KZN	Medical science

		using the seasonal autoregressive integrated moving average (SARIMA) time series method.	
23.	(Milenković et al., 2018)	This article uses the seasonal integrated moving average (SARIMA) technique to research the traveller flow on the railway.	Transport industry
24.	(Jayaraj et al., 2019)	To observe the connection between climate predictors and dengue incidence, the SARIMA version turned into used withinside the District of Tawau over 12 years, from 2006 to 2017.	Health issues
25.	(Parmezan et al., 2019)	This study shows that SARIMA is that the solely statistical procedure ready to outperform, to decide on the foremost promising algorithmic program to model and predict a phenomenon.	Forecasting
26.	(S. Xu et al., 2019)	For planning and energy management, the author proposes a new SARIMA-SVR model for predicting the statistical performance of the aerospace industry.	Aviation industry
27.	(Revathy and Balamurali, 2019)	To predict future production based on annual rainfall, this document implements an integrated seasonal autoregressive moving average and neural network model.	Agriculture & meteorological
28.	(Adams et al., 2019)	In this article, a probabilistic time-series modelling method is proposed and used to analyze the	Meteorological

		SARIMA (Seasonal Autoregressive Integrated Moving Average) model of monthly precipitation data.	
29.	(Somboonsak, 2019)	This article shows that the SARIMA version is a useful technique for tracking dengue fever cases in Thailand.	Medical science
30.	(Tena García et al., 2019)	In this study, a SARIMA model was made for a high-powered sample forecast, with a decent performance, whereas for a low-power sample and analyzed a year of the daily energy output of a wind turbine.	Power management
31.	(Cong et al., 2019)	By analyzing monthly data of influenza incidence, the seasonal autoregressive integrated moving average (SARIMA) model was accustomed to predict the influenza changes in China.	Medical science
32.	(X. Yu et al., 2019)	To predict the incidence of schistosomiasis in China, in this study author launch the SARIMA model and NARX models from June 2018 to September 2018.	Medical science
33.	(Musbah and El-Hawary, 2019)	In this study, the seasonal Autoregressive Integrated Moving Average (SARIMA) model is employed to forecast short electrical load data. But, of course, that's littered with weather conditions.	Power management