Risk Assessment of a Wind Farm in a Coastal Areas of Baluchistan- Pakistan

By

Zia Ahmad Khan

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Supervised by

Prof. Dr. Muhammad Bilal Khan

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National University of Sciences and Technology (NUST)

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Certificate

This is to certify that work in this thesis has been carried out by **Mr. Zia Ahmad Khan** and completed under my supervision in Renewable energy laboratory, Centre for Advanced studies in Energy, National University of Sciences and Technology, H-12, Islamabad, Pakistan.

Supervisor: _____

Dr. Muhammad Bilal Khan
Centre for Advanced studies in Energy
NUST, Islamabad

GEC member # 1: _____

Dr. Majid Ali
Centre for Advanced studies in Energy
NUST, Islamabad

GEC member # 2: _____

Engr. Rashid Wazir
Centre for Advanced studies in Energy
NUST, Islamabad

GEC member # 3: _____

Engr. Waqas Cheema
Centre for Advanced studies in Energy
NUST, Islamabad

HoD-CES _____

Dr. Zuhair Khan
Centre for Advanced studies in Energy
NUST, Islamabad

Principal/ Dean _____

Dr. M. Bilal Khan
Centre for Advanced studies in Energy
NUST, Islamabad

Dedication

To my Parents and friends who have been supporting everything all the clock.

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Abstract

Renewable energy resource utilization can address the both most emerging issues of the world in the current era: rapid depletion of conventional fossil fuel reserves and drastic climate changes. The main theme of this work is an analytical and simulation analysis of Wind Power generation of Pakistan, a country facing disastrous power and gas shortfalls. For this techno-economic assessment of wind energy generation is performed 50 MW wind farm at Gwadar districts, (Gawadar, Jiwani, Pasni, Ormara) Baluchistan –Pakistan. To explore the best wind power potential, four years wind speed data is analyzed and forecasted through the ARIMA model using Minitab Software. Accuracy of ARIMA model is evaluated with Mean Absolute Percentage Errors of Mexico city literature work. Based on this it is concluded that all four cities have less than 19% error which is satisfactory. On the forecasted wind speed various rated rotary engines were examined at different hub heights (60m, 80m, 100m and 117m). The Annual Energy Generation from all rotary engines at different hub heights are calculated through mathematical calculation by considering all possible losses, i.e. roughness coefficient, temperature and pressure effect, wake up effect, the for percentage of energy absorbed to the grid etc. and different wind rotary engine availability fraction at different cities. Furthermore, through numerical methods using Minitab, Stats Graphics, and EViews it is concluded that the most suitable hub height for wind rotary engines in Gwadar district is 117m and highest capacity factor found at Ormara on this height is 3 percent with annual wind energy production of 167 GWh/year. The Pasni has Capacity factor 21 percent with annual energy production is 88/year GWh. Gwadar Capacity found 13.5 percent with annual energy production is 58 GWh/year and Jiwani Capacity Factor has been found 6.54 percent with annual energy production is 22 GWh/year. Moreover, from the financial point of view Ormara is giving best Internal Rate of Return that is 18 percent maximum and its payback for period is 7 years, which shows it's a very good site from an investor's point of view. While Jiwani is giving worst result and its Internal Rate of Return is 3 percent by assuming very high per unit monetary value of energy.

Keywords: Autoregressive moving average, Box and Jenkins, Capacity Factors differencing, Moving Average

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List of Abbreviations

ARIMA……Autoregressive Integrated Moving Average

M.A……..…….Moving Averages

C.P……...Conditional Probability

P.D.F……..Probability Density Function

C.D.F……Cumulative Probability Function

C.R…….…….....Correlation

D.F…….……..Differencing

A.C.F……Autocorrelation Function

P.A.C.F…….....Partial Autocorrelation Function

N.P.G……...Normal probability Graph

M.A.P.E…….Mean Absolute For percentage Error

P.M.D…….Pakistan Meteorological Department

I.P.P……..Independent Power Plant

A.M.S.L……Average Mean Sea Level

Chapter 1

Introduction

1.1 Background

For protection of environment and reduction of fossil fuel resources wind farm development in the developed countries has been arisen in the EU countries. Commonly wind energy is known as non-displaceable for its irregular nature which brings almost a larger effect on power system consistency and eminence. Such a big scale integration of wind energy demands same tools and methodologies to assist in the wind farm development, formation and in the management task. The experience of 1970's and 1980's has led to an idea of energy demand study for future generations with a sustainable solution. The main purpose of this idea was to reduce greenhouse gas emissions from burning of fossil energies. Consequently, since 1970's various studies has been gone through under this scenario using various forecasting techniques. In maximum belongings, energy request fields have accepted two unrelated varieties of demonstrating; namely, condensed form prototypical also ''organizational form prototypical''. The preceding is a request archetypal below which thermodynamic quantity is likely to be a straightforward procedure of energy cost and actual revenue [1].

Pakistan has a big resource of wind energy. It has 800 km coastal lines in Baluchistan and 250 km in Sindh. 40% and 35% of Baluchistan and Sindh complete area can be used as centralized grid connection (CGC) area for wind power generation. The predicted CGC for this area is almost 121 TWh for an year. Which is 2.15 spells greater than the whole power cohort of Pakistan [2].

To save the environment from pollution of the conventional fossil fuel usage, wind energy is the best choice to exploit because of its low Operation and Maintenance monetary value, less environmental impact and high capacity factor. As wind speed is accidental in nature and has a straight effect on wind energy generation, therefore it is best practice to predict wind speed with minimum possible MAPE (mean absolute for

percentage error) at a particular site for better understanding either it is going to be the best solution in near future or not. The accuracy of wind power forecasting is not accurate enough and different prototypical have been applied to get best consequences.

For the development of large capacity wind farms, long range wind power forecasting is necessary which is based on clock horizon. Wind power forecasting tools are useful for independent power producers (IPP's), transmission and distribution system operators and energy service providers [3].

The forecast is divided into four groups. They are named as very small term, undersized term, intermediate term and lengthy term. The clock width changes in every category.

The short term forecast is done for wind rotary engine controller applications. Medium term forecasting is done for load increment and decrement decision. The intermediate term is used for wind power generation online/offline decision and long term forecasting is done for large wind power development.

Predicting approaches may be classified into two groups according to approaches and principals

i. Physical Approach

It is used to enhance actual answer of Numerical Weather Estimation Prototypical for accurate weather prediction.

ii. Statistical Approach

It transforms the input variables into breeze power production in a solitary stage. It comprises numerous linear and non-linear copies, keeping minimizing mean absolute for percentage error. Many artificial intelligence methods are also very good at prediction and have good development prospects.

1.2 Problem statement

The methodology adopted for estimation of variability of wind speed can be calculated through various tools which are very useful for this energy generation and its prominent status has been admired and evaluated in the countries which have greater potential of wind [4].

In this study autoregressive prototypical is used for wind speed prediction keeping minimizing its error.

After the wind speed prediction, there is another point that which projected height would be suitable for the best wind energy generation and which rating and manufacturer of the rotary engine would be best at that specific height giving best ROI.

1.3 Objective

This research work seeks to:

- Forecast the wind speed
- Statistical Prototype calling
- Power density of forecasted wind speeds
- Calculation of Wind power density of low, low to medium , medium to high wind potential
- Optimized Wind rotary engine class determination (IEC I, IEC II, IEC III)
- Optimized Rotary engine hub height Selection
- Calculation of Annual Energy
- Simulation Analysis
- Economic Analysis
- The impact of forecasted wind speeds on projected feasibility

1.4 Methodology

The data was obtained from Pakistan Meteorological Department (PMD) Islamabad. The data comprised of mean monthly wind speed data from 2009 to 2012 of the coastal cities of District Gwadar i.e. Gwadar, Pasni, Ormara and Jiwani. The data was measured at 29.86m, 9m, 2m, and 56m at average mean sea level, respectively. This data was analyzed carefully either it has cyclical trends, seasonal behavior, trended upward or downward or random behavior. Usually wind speed data have such components of clock sequence, if it really exists, then it must be removed before forecasting.

After predicting its parameters carefully wind energy can be generated and estimated using Weibull parameters of predicted wind speed.

1.5 Significance/Importance

Since, there is no published work on the implementation of autoregressive prototypical for predicting wind speed, so this work will serve as a foundation of knowledge both in the field of a clock sequence analysis and use of Minitab, EViews statistical software. It will also serve as a basis of further study and uses of other methods in this field.

1.6 Organization of Thesis

This study will be structured into five chapters.

Chapter 1 gives the Introduction to the study and answers of pre-requisites required for starting research and describes background of the study, problem statements, objective, methodology, significance and its importance.

Chapter 2 gives relevant literature review from starting point describing clock sequence analysis, their consequences and discussions and Box and Jenkins (B&J) methodology.

Chapter 3 is concerned almost detailed description of the methodology. The thesis thoroughly deliberates the forecasting technique in this chapter.

Chapter 4 is devoted to analysis of the wind speed data and discusses the result obtained through simulation analysis.

Chapter 5 this chapter discusses energy generation procedure and its implementation on the all four districts of Gwadar. It also cover the conclusions and findings.

Summary

This chapter introduces almost initial pre-requisites required for starting research work i.e. motivation, what to do in this work, objectives to be attained and work methodology adopted for current study. The following chapter is concerned almost the literature study of constituent parts of system to be developed and studied in current work. It will also serve as a basis for further study and uses of other methods in this field.

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Chapter 2

Literature Review

2.1 Past Background

The energy extracted from Air had been cast-off for previous centuries for crushing cereals, having the power of impelling water and other motorized drive uses. The Wind mill power generation plant is not an innovative thought. First acknowledged formation of practice of wind power generation was in the 10^{th} period in Iran [1]. Nowadays, there are numerous hundred thousand wind mills in procedure almost everywhere in the world. Modern wind mills have a habit to be named wind rotary engines moderately for the reason their practical resemblance to the vapor and gas rotary engines and moderately differentiate them of their old-style forbears [2].

Wind energy park establishment was the wildest rising energy engineering since the start of nineties century, price of measurement of annually growing associated volume of wind engineering reference is increasing day by day. The development of wind engineering, nevertheless, is not consistently advancing almost the world. In the close of 1999, almost 69% of the universal wind engineering volume was associated in Europe, afterwards nineteen percent in North America and almost 10% in Asian continent and the Pacific Ocean areas [3]. Wind engineering projects are projected to bring a progressively significant character in upcoming countrywide power division [4] [5].Air rotary engines transform the energizing energy of the wind into electrical domain through revolving the edges. The energy consultant company Greenpeace, says that almost ten percent of electrical energy can be provided through the wind aside the time 2020 [6].

2.2 Price of Air Rotary Engines

Towards 1990s, monetary values for industrial Air rotary engines weakened by almost 20% all clock the number of factory-made wind rotary engines repeated. Presently, manufactures of big-exfoliation, power grid-associated wind rotary engines repeats

nearly every 3 years. An identical monetary value step-down was attained on the very first year of oil utilization almost hundreds of years ago. The another energy expert company department envisages, an additional monetary value reduction of 50% can be attained till 2020, and the Europe Union Command evaluations shows the power monetary value from air power generation would be abridged by any rate 30% among 1998 and 2010 [8].

An over-all assessment of electrical energy generation prices nevertheless, is very problematic as construction charges vary meaningfully among countries, for the reason of the obtainability of capitals, unlike taxation arrangements or additional details. In accumulation, market guidelines can touch the electrical energy values in dissimilar republics. The modest request procedures for inexhaustible power generation in United Kingdom and Wales nevertheless, allows for a best equivalence of power yield costs. Within this request procedure, active scheme investors for non-conventional energy schemes are requested for constructing new developments. Builder of offer under dissimilar engineering marks, e.g. air or sun energy for an energy inflow pricelist or for the price of monetary inducements can be salaried for per kilo watt hour, induced into the central electrical system by non-conventional energy structures. The finest requester would be bestowed for their request in flow price for a pre-investors clock period [7].

2.3 Ecology Influence and Dependability of Wind Rotary Engines

Wind power projects can be considered as ecologically welcoming; nevertheless, this source may not be considered as a free of radiations. Manufacturing of the edges, the nacelle, the tower, etc., the investigation regarding the physical appearance of apparatus and the transportation of apparatus are indications towards an ingesting of energy capitals; therefore radiations are formed till these energy capitals are grounded on conventional fuels. These radiations are acknowledged as indirect radiations. In summation, the sound and graphic impact of wind rotary engines are significant reflections for public receiving of wind energy engineering, certainly if the wind rotary engines are being positioned near to anthropological colonies. The noise influence could be minimized with expert source, e.g. varying speed or minimized rotary speed. The

randomness influence and graphic effect would have been abridged after suitable placing of air rotary engines in a single view [9].

2.4 Technical Contextual

2.4.1 Subdivision of wind rotary engines

The two major classes of wind rotary engines: the rotary engines whose edges rotation is almost an x-axis orientation and those whose edges rotation is almost a perpendicular axis. Perpendicular-axis wind rotary engines (VAWT) can be classified into two chief clusters: the rotary engines who uses sweptback haul to pull kinetic energy from air generation. Rewards of the VAWTs are they could have the wind from anyway. This shortens their project, and removes the difficulty faced by gyro drives on the rotating part of a convectional engine as the rotary engine trails the wind. The perpendicular rotary motion also used for putting on alternator and cause train at base level [12]. X-axis wind rotary engines (HAWT) are natural wind rotary engines and doubtful the VAWT are not directional. With the time as soon as air fluctuates its way, horizontal axis air rotary turbines must have to alter its way with it. They have some alter paths for setting the rotary motion as compared to the confidential information. In a horizontal axis rotary engines, the alternator alters straight the air which could be excerpted from rotating part [13].

2.5 Structures and Apparatuses of Wind Rotary Engines

The key components of a Horizontal wind turbines are the bounds, the hub, the carrier lines arrangement, the gear case, the author and the yaw and hawk command systems. The boundaries would be crucial to the rotation of the wind rotary engine because of their key role in power system. The 3 roller blades inventions are extreme mutual for up-to-date wind rotary engines. The boundaries of a HAWT are fixed securely to the middle hub. As the rotating part moves, its edges produce an unreal shallow whose forecast on a perpendicular area which is commonly known as swept area. In order to calculate the blades rotating area edges are supposed to unreform by practical piles [14].

Depending on the roller blade invention characteristics, power collection could be evaluated for the purpose of to ward off the rotary engine from being given too fast. For this reason there are 3 primary subdivisions of boundaries:

Hawk Checked Wind Rotary engines: On a hawk checked wind rotary engine the rotary engine electronic restrainer checks the power end result of the rotary engine many clock for second. As soon as air speed becomes too high then it can cause danger to rotor blades and ultimately results to break down of air turbine so avoid this, it sends direction to control panel to stop the blades movement by stopping the generator which straightly moves the rotor edges somewhat out of the air.

Stall Checked Wind Rotary engines: (Passive) stall checked wind rotary engines may have rotor edges fastened into center at an immovable outlook. Spatial space of roller blade profile, nevertheless it has been planned to make sure that at the time the air velocity becomes very high, it makes unstable flow of air on the other side of the rotor roller blade.

Active Stall Checked Wind Rotary engines: Strictly the active stall apparatuses look like hawk checked machines, since they could have hawk able edges. For this purpose getting a sensibly huge turning drive at less air velocity, the automobile would usually be planned to hawk their edges much like a hawk checked automobile at low air velocity. It is said that at least one compensations of alive stall is that, one can master the power end result more precisely than with passive stall, thus as to dodge exceeding the nominal power of automobile at start of a gust of wind. The extra benefit is that the machine can be work faster equal to precisely at nominal power at all large wind speeds [15].

2.6 Dynamics of Wind Rotary Engines

The drive in air velocity is complete obtainable at energy per clock unit. The drive in air velocity is changed over into machinery-rotatory energy of the wind rotary engine rotor, which consequences in a condensed speed of the wind stack. The drive in the wind could not be removed altogether by a wind rotary engine, as the atmosphere volume can be shut down in a no time while stopping rotor area. This would cause a congestion' of the cross-sectional area for the following wind masses [16].

Wind rotary engines for consumed by the natural process of the comparative wind. Comparative wind is a mixture of natural wind plus wind triggered by rotary movement and the rotational induced flow. The effect of the comparative wind is the streamlined drives which are being produced on the rotating edges. These streamlined drives are called haul and lift drives [17].

Haul drive is the main reason that could be in parallel with the way of the air current. A plane plate in a wind current, maximum haul drives with the way of the air velocity flow that is vertical to the plane side of the shell; when the direction of the wind stream is in telephone circuit with the flat side of the shell, the haul drives are at a lower limit. The lift drive is the constituent that is at 90 angle direction to the centering of the wind flow. Lift drives acting along a smooth plate are lowest when the organization of the wind stream is at a zero angle to the plane surface of the shell [18].

2.7 Classification of Wind Supremacy Predicting

Organization is based on clock horizons. The forecast is divided into four groups. They are keyed out as very small term, undersized term, medium term and extended term. The clock width changes in every category.

Table 2.1: Estimating groups with clock limits [10].

	Clock Horizon	Range	Application
1	Precise undersized for period (in minutes)	Rare instants to thirty minutes ahead	Wind rotary engine controller
2	Very small for period (in hours)	Thirty instants to 72 hrs. ahead	Charge increment/decrement decision
3	Intermediate for period (in days)	72 hours to single week forward	Generator online/offline decision
4	Lengthy for period (in years)	single week to single year or more forward	The viability study for the proposal of wind farm

2.8 Different Forecasting Tools

Multivariate ARMA process is usually used for diurnally non-stationary series hourly based wind speed example. [20].

Simple Autoregressive moving averages model process can be used to prediction 10 h in advance of the clock series [21].

Fractional Autoregressive moving average models can be used to forecast wind speed on the day ahead (24 h) and two day ahead (48 h) of the day [22].

Neural network describes two wind power forecasting methods i.e. is radial based and fuzzy reason based [23].

The real multilayer for neural network (RMPL) presents a four layer of RMPL system and stretched kalman filter founded on backpropagation done with clock algorithm was used to train the RMLP networks [24].

The focus clock delay neural network (FTD NN) didn't require clock delay back propagation to calculate the system incline. It is qualified quicker than the other network gradient [25].

Adaptive Neural Fuzzy Interface System model (ANFIS) it is very novel approach to forecast wind clock series [26].

2.9 ARIMA Model

Figure 2.1 shows the main methods of B&J methodology.

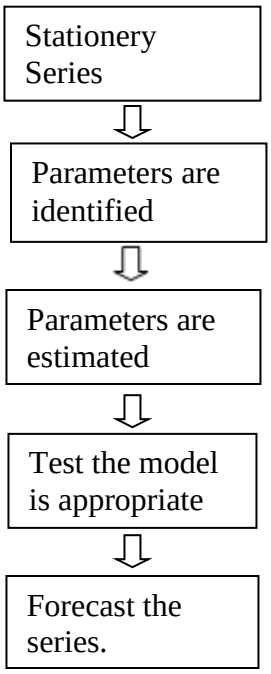

Figure 2.1: The B&J Methodology.

This approach is usually divided into 4 phases

i. Identification

Usually the wind speed has seasonality using this model we need to remove this. This is the stage of preparation of data, in which we check either clock series data is stationary or not i.e. constant mean and variance.

ii. Estimation of the parameters

Parameters are identified using ACF and PACF plot.

iii. Testing

Normality test is applied in order to fix either there is white noise or not.

iv. Prediction

Prediction is done when parameters are justified [19].

Summary

This chapter briefs almost literature study of wind energy system. The basic theory of wind power systems starts from its history, subdivisions of wind rotary engines and its physics. The basic components of wind power systems, i.e. edges, hub height, transmission system and its classification is introduced. Wind rotary engine capital monetary value plays a vital role in the complete project monetary value and it is decreasing with the passage of clock for the reason advancement in rotary engine engineering. The noise influence as well as the graphic impact has also been discussed and it can be condensed with the suitable siting of wind rotary engines in the landscape. On the Classification of wind rotary engine it has been concluded that

- Horizontal axis has large roller blade rotation space than perpendicular Axis. Its wind resistance capability is lower than perpendicular axis.
- For the current study, horizontal axis wind rotary engines are selected for its high rotation speed and variable roller blade hawk.

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Chapter 3

Methodology Adopted for Time Series Forecasting

3.1 Introduction

In this chapter, we shall first evaluate the methods applied to detect outlines in the for period sequence analysis data we would have been describing in overall session that could be applied and signify for period sequence data prediction. In the last stage, we evaluate some modest but typically applied methods and predicted practices focus on undeviating regression analysis.

3.2 For Period Sequence Analysis

With this idea, we shall analyze methods which can be handful in examining for period sequence information these are arrangements of dimensions that monitor irregular instructions. Not like the studies of irregular samples of observances are spoken almost cutting-edge of the background of utmost other figures, the examination of period sequence is grounded on the supposition that following beliefs in the information file epitomize successive quantities occupied at correspondingly for period interims.

3.2.1 Two Key Areas

Here the key areas for period sequence examination:

- Keying out the environment of physical process signified by chronological succession thoughts
- Envisaging (estimating upcoming standards for period arrangement flexible).

Together these aims need the outline of detected for period sequence statistics is named and formally described. In one case invention stay recognized, we can integrate it with extra information irrespective of complexity of mind and legitimacy of understanding of the wonder, we conclude the acknowledged invention to estimate upcoming actions [1].

3.2.2 Asymmetrical Noise

Furthermost, other investigation, in the period sequence examination, it is expected that information contain of methodical invention and irregular mistake pattern that commonly marks the invention problematic to detect. Usually period sequence analysis approaches include some filtering irregular invention to get the invention most noticeable.

3.2.3 Two Common Characteristics of Period Sequence Configuration

Maximum period sequence configurations can be eminent in relations of two common grades of constituents: its tendency and cyclical behavior. The preceding tells almost common organized lined or un-lined constituent that gives variations in excess for period and fixes not duplicate or at smallest amount does not replicate inside the period runs apprehended by our material. The preceding may have an officially alike quality, nonetheless, the re-appearances in methodical pauses in period. Two overall sections of period sequence constituents may co-occur in actual numbers. In case, trading in business can quickly increase on the ages, nonetheless they even trail steady cyclical inventions [2].

3.2.4 Movement Study

On that opinion, there is not any confirmed way for the detection inclination constituents in the period sequence numbers and wherever the numbers are continuously increasing and decreasing that specific portion of the sequence is not a problem. In the Condition for period sequence statistics contain significant faults, then commencement stage in procedure of tendency credentials are even.

Flattening of period Sequence: Flattening usually takes into account more or less kind of local be a round of data in this way, the irregular constituents of the separate thoughts cancel out to one another. Most public method is M.A which substitutes every component of the sequence. Key benefit of averaged as far as M.A is concerned is that its consequences are fewer wind within the range. Key drawback of average flattening is that nonappearance of significant points may become "sharp" arcs than M.A and it is not allowed for increment.

3.2.5 Examination of Cyclical Behavior

Cyclical components reliance is an additional common constituent of the period sequence shape. The connection reliance of some order among every component of the sequence dignified by AC is normally known as dawdles. In case the numerically solved mistake is not big, cyclical components can be seen and named in the sequence which replicate every constituent.

A.C Representation: Cyclical components arrangements of period sequence could be observed via plots. The plots shows explicitly, mathematically the A.C function, that is, sequential association constants four successive dawdles in quantified sequence of dawdles. Sequence of two typical mistakes for dawdles are typically noticeable in plots but classically scope of auto association is of additional attention than its dependability since we are typically attentive individually in exact sturdy A.Cs.

Conditioning, the very first factor is associated to next, and the moment to the next, and lastly the firstly part too slightly associated to the third one, etc. This suggests that the shape of sequential enslavements can be modified significantly after reading these patterns of association.

Partial A.Cs Function (P.A.C.F): Alternative valuable technique to check sequential dependencies is for investigation of partial A.C.F - an addition of A.C, at that point requirement on the in-among constituents is detached. In addition, partial A.C is similar to A.C, excluding when we manipulating it, the A.C with all the agents in the league are separated. If dawdles of 1 is stated, then the partial A.C is equivalent to A.C. In the manner, the partial A.C gives a "clearer" image of sequential addictions for distinct dawdles [3].

3.2.6 A.R Integrated M.A Technique

The demonstrating and estimating measures almost the mathematical prototypical of the procedure. Nevertheless, from the real lifespan investigation and rehearsal, profiles of the information are unclear, separate thoughts include substantial mistake, and we at that clock need to uncover the concealed rules inside the information and also produce predictions. Box and Jenkins procedure for permits in order to select them. This procedure has gained huge admiration in many areas and research rehearsal favors its

power and elasticity; this is considered as not a very handful technique as it needs a countless experience though it frequently harvests satisfactory consequences. The subsequent units will validate the basic opinions of this rehearsal.

3.2.7 A.R Process

Maximum for period sequence be made up of fundamentals such that they are successively reliant on the wisdom that you can approximate a constant or a set of constants that define successive constituents of the sequence from precise, for period-dawdles (preceding) constituents.

Putting them into arguments, every thought is widespread with irregular blunder constituent (irregular shock, epsilon) and a lined mixture of preceding thoughts.

Stationary Obligation: An A.R procedure happens to be constant if influence are lined up in a specific limitation; just in case, if there is only one A.R factor, then it is necessary to fall in the breaks or else, preceding belongings would gather into infinity, the arrangement would not be motionless. If there are additional A.R factor, alike limits on the factor standards can be well-defined [4].

3.2.8 M. A Procedure

Self-governing of the A.R, for component in the sequence could also be pretentious by the past fault that couldn’t be described by the A.R constituent, that is:

By putting them into words, for thought is complete of an irregular mistake constituent (irregular shockwave,) and a lined mixture of prior irregular shudders.

Irrevocability obligation: Lacking into very much arguments, it is find that a "duality" among the m.a procedure and the A.R method the m.a calculation for paragraph could be redrafted into autoregressive form. In contrary to motionless ailment labeled overhead, it could be complete if an influence trail convinced situations, if the theoretical account ascetical account is Invertible. Otherwise, the sequential for periodical will not be stationary.

3.2.9 A.R Integrated M.A

Methodology: Generally, this prototypical includes A.R and m.as terms determined by the A.C.F and PA.C.F plots also includes the differencing terms in the development of

the desired prototypical. In the precise way, it can be stated that there are three terms, usually in the prototypical that is an A.R term (p), m.a term (q) and differencing term (d). So, autoregressive prototypical is generally described as (p, d, q) prototypical if a prototypical is (1, 2, 1) its mean it has one A.R term and one m.a term which is computed after second order differencing of the period sequence once.

Recognition: It has been said that in the period sequence analysis, the sequence should be stationary that's mean it must have stable mean, variance and A.C standards at all for periods. Therefore, there is a need of differencing of the period sequence up to the order till we are able to get stationary sequence. The number of periods we differentiate the sequence can be shown indifference factor (d). For better getting the standards of differencing, A.C plot should be examined carefully at every value. If any value is extremely upward or downward from the significance line, then it should be considered as a significant value at that specific lag. Very strong abruptly changes require second order non-cyclical components differencing. If the data for period sequence has a cyclical components pattern, then usually cyclical components differencing is required. If the data has longer gradually decreasing or increasing pattern, then usually first order differencing is required. In some occasion for period sequence is required less or no differencing and some for periods over differencing gives less stable coefficients.

In this phase, which is known as identification phase, we usually need to identify the number of A.R, m.a and difference factor estimation. So that we could be able to get better factor estimation. Generally, it is rarely greater than two.

Approximation and Predicting: This estimation process, parametric quantities are assessed by minimization process, so that the SS remaining mistake could be diminished. This estimation procedure is applied on differenced sequence, if it is stationary, then the forecasted sequence is generated with the appropriate influence. This forecasted sequence is then integrated, which is the reverse order of differencing so that forecasted sequence is compatible with the original sequence. This function is shown with a Capital I in the autoregressive prototypical.

For persistent in B&J Methodology: In calculation of the A.R and m.a terms in the prototypical, it has also a constant term. The interpretation of the constant term of that it could fit the prototypical significantly. If there is no any A.R term in the prototypical,

then the constant term would be the average of the sequence. Secondly, if there exist an A.R term for persistent term would be size of the sequence. If the sequence is dissimilar, this for persistent term signifies the interrupt of the minus arrangement.

In case, if structure have no A.R term and is differenced once, then the constant term would be the average of the minuses structure and the lined tendency incline of the un-minus structure [5].

3.3 Model Estimation Stage

Number of factor estimation**:** before the estimation can begin, there is a need of autoregressive prototypical factor estimation.

The major tools applied for this are plotting of the sequence, for performing Runs test on the sequence, plotting of A.C function, Plotting of Partial A.C Function. The decision is not straightforward, it is required not only experience but also a great deal in using alternate techniques. Nevertheless, on the basis of for period sequence there are usually five different subdivisions of techniques can be judged by A.C plot and Partial A.C plot. Also, it is a frequently practice to try the substitute practices on the similar records. , meanwhile the amount of aspects for thoughtful is nearly becomes on no occasion greater than two**.**

Cyclical components Prototypical: Increasing cyclical components autoregressive prototypical is a simplification, addition of data in preceding paragraph which shows cyclical components invention replications after regular for period intervals. In adding to the non-cyclical components influence, cyclical components influence also need to be estimated at a specific lag. Homologous to autoregressive prototypical, all such parameters are cyclical components influence, cyclical components misusing and cyclical components m.a terms [10].

3.3.1 Factor Estimation

Several altered approaches have been proposed for estimating the influence. Many of them have been produced alike evaluations, but they might be extra or less well-organized in case of any assumed particular prototypical. Commonly, through factor guesstimate stage a role minimization procedure is applied to increase the probability of said sequence, assumed the factor standards. In exercise, this supplies control of sums

of squares of errors, specified the individual influence.

3.3.2 Validation of Prototypical

Restriction guesstimates: we would describe projected standards, calculated from the factor standard mistakes. If it is non-important, individual factor could in furthermost belongings be released from the prototypical lacking moving considerably.

Supplementary eminence conditions: Additional forthright mutual degree of reliability of prototypical is precision of predictions produced constructed on incomplete information so the predictions could be associated with acknowledged explanations.

Though, a decent prototypical should not only deliver adequately precise predictions but it could be stingy, harvest statistically self-governing errors that covers only noise and not at all methodical ingredients (e.g., the A.C.F of errors should not disclose any sequential additions). A respectable assessment of prototypical is (a) to invention the errors and examination them for any meticulous trends, and (b) to scrutinize the A.C.F of errors (not at all sequential dependency among errors)

Examination of errors: The big anxiety here is errors are meticulously dispersed across sequence or they could cover some sequential addition which gives that the auto regressive prototypical is not good in this sense.

Limitations: The auto regressive modus is only suitable only for period sequence that is motionless and it is suggested that there should be at any rate 50 data values are required in data. It is expected that standards of projected restrictions remained continuous during sequence [6].

3.4 The Box-Jenkins Method of Period Sequence

The Box-Jenkins procedure is an arithmetical cultured way of examining and building a predicting prototypical which gives best representation of a period sequence. The first phase is the identification of the suitable ARIMA techniques through the reading of the A.C and partial A.C graph plot. For instance if the partial A.C nicks off after lag one and the A.C function decays then it is named as

The following phase is to guess the influence of the ARIMA prototype chosen.

The third stage is the analytical checking of the prototypical. The test-statistic is used for the exemplary competence check.

If the prototypical is not satisfactory then the predictor goes to phase one to identify another prototypical and it is tested for adequacy and if adequacy then the estimation goes into the final phase of the procedure.

The fourth phase is where the examination uses the prototypical chosen to predict and the process ends.

3.4.1 Identification Techniques

Identification approaches are uneven events applied to a set of data at the kind of representational prototypical that will be further examined. The goal here is to get some idea of the standards and wanted in the general linear autoregressive prototypical and to obtain initial approximations for the limitations. The mission here is to find out a suitable subclass of technique from the common autoregressive prototypical family which could be used to show a specified for period sequence. The method will be as follows:

i. To difference as many spells as is needed to crop stationary, reducing the

ii. Procedure under reading to the mixed m.a process

iii. To classify the resulting ARMA process

The key implements for putting (i) and (ii) into effect are the sample A.C function and the prototypical partial A.C function. Distinctly from helping to guess the usage of the prototypical, they are reprocessed to obtain assessed estimates of the parameters of the prototypical. These approximations are valuable at the estimates stage to provide initial standards for repetitive events working at that phase [7].

3.4.2 Use of the A.C Function in Identification

A stationary mixed A.R moving average procedure of order. The A.C function fulfils the difference equation. The answer of this difference equation for the k_{th} A.C is, supposing distinct roots, of the form.

Demonstrations in the scenario of a stationary technique in which none of the roots lie close to the boundary of the unit circle, the A.C function will rapidly “die out” or decline for moderate and large values presume that a single real root, say methods unity.

3.4.3 Identifying the Resulted Stationary ARMA process

The A.C function of a regressive process of order tails off, its partial A.C function has a die off after lag. The A.C.F of m.a process of order cuts off after lag and its partial A.C ends. Additionally, the A.C function for a varied process, covering an order A.R constituent and q order m.a constituents, is a combination of exponentials function and damped sine waves function after the first pause [8].

3.4.4 Akaike's Information Criteria (AIC)

The AIC which was planned by Akaike practices the maximum likelihood method. In the application of the approach, a range of potential ARMA techniques are projected by maximum likelihood method, and for, the AIC is intentioned.

3.4.5 Schwarz's Bayesian Information Criterion (BIC)

The BIC executes a better consequence for the number of assessed prototypical limitations than does AIC.

Use of least prototypical selection consequences in a chosen prototypical whose number of considerations is fewer than that chosen under AIC.

3.4.6 Estimation of the Parameters of the Prototypical

As soon as prototypical is recognized the next stage of the Box-Jenkins method is to estimate the parameters. In this study the estimation of the constraints was completed using a statistical package called the Statistical Package for Social Scientists (SPSS).

3.4.7 Testing the Prototypical for Adequacy

Afterward ID an appropriate prototypical for a for period sequence statistics, it is very significant to check that the prototypical is acceptable. The mistake terms are examined and for the prototypical to be acceptable the mistakes should be unplanned.

3.5 Forecasting

The fourth phase of the Box-Jenkins method is to predict the prototypical suggested. Presume the prototypical chosen to fit a theoretical data is performed. There is a need of care while performing the forecasting of the series is that it should have minimum mean absolute percentage error i.e. it should be in resemblance with the original time series of

the wind speed at particular city. For this purpose different parameters can be used according to the analysis that which would be perfectly fit for minimum error percentage. There is another point that if the original series has upward trended direction then the forecasted series should also have trended upward and should have high average mean value of wind speed and if the original series have trended downward direction then forecasted series would have also trended downward direction and with low average wind speed as compared to original value [9].

Summary

In this chapter main topic theme and project overview is analyzed and stated that how parameter estimation can be identified

We shall first evaluate the methods applied to detect outlines in the period sequence analysis data we would have been describing in overall session that could be applied and signify for period sequence data that could be predicted. In the last stage, we evaluate some modest but typically applied prototype calling and predicted practices focus on undeviating regression analysis.

Not like the studies of irregular samples of observances are spoken almost cutting-edge of the background of utmost other figures, the examination of period sequence is grounded on the supposition that following beliefs in the information file epitomize successive quantities occupied at correspondingly for period interims.

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Chapter 4

Simulation Analysis

4.1 Introduction

In this chapter we take into consideration of the wind speed data and will apply box and Jenkins methodology on it.

The data is obtained for the year 2009 to 2012 for analysis. The wind speed data is in meter per second obtained from Pakistan meteorological department, Karachi for four districts of Gwadar i.e. Ormara, Pasni, Jiwani and Gwadar.

4.2 Initial Investigation

This introductory examination contains the calculation of the expressive statistics related to the data. The consequences are showed in the table below for all four districts**.**

Table 4.1: Descriptive Statistics of wind speed of Gwadar Districts

Cities	**N**	**Smallest**	**Largest**	**Mean**	**Sd. Deviation**
Gwadar	48	0.93	3.923	2.238	0.743
Jiwani	48	1.1318	3.5239	2.3605	0.6754
Pasni	48	1.363	4.501	2.858	0.855
Ormara	48	1.801	5.968	3.690	1.186

According to above table it is clear that among all Gwadar Districts, only Ormara has higher mean wind speed and it can gives better result in terms of power generation and capacity factor as well. These are mean wind speed at 29.86m, 56m, 09m and 02m at annual mean sea level, respectively.

In figure below 4.1 it can be seen that this clock sequence has random pattern and for periodic cyclical pattern in this sequence which is repeating itself after regular clock intervals i.e. every after twelve months. Furthermore it also has an increasing trend that’s mean, the stationary condition is not meet there.

So appropriate differencing is required to remove all these patterns [1] [2].

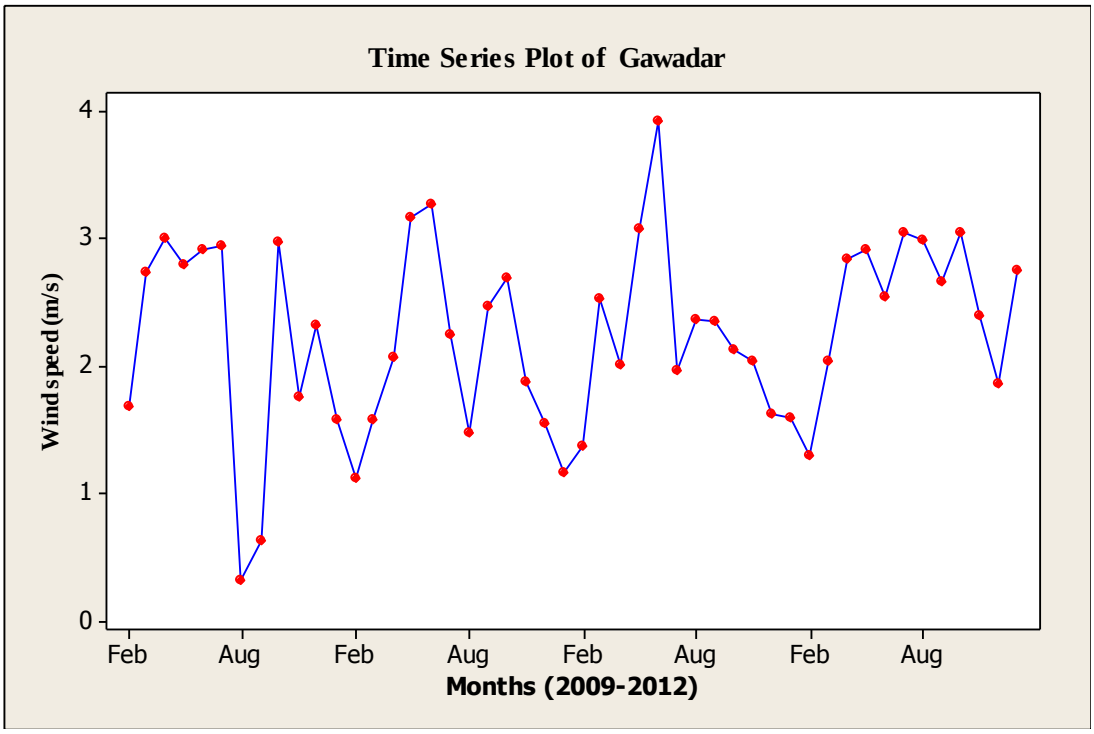

Figure 4.1: District Gwadar wind speed at 29.86m a.m.s.l

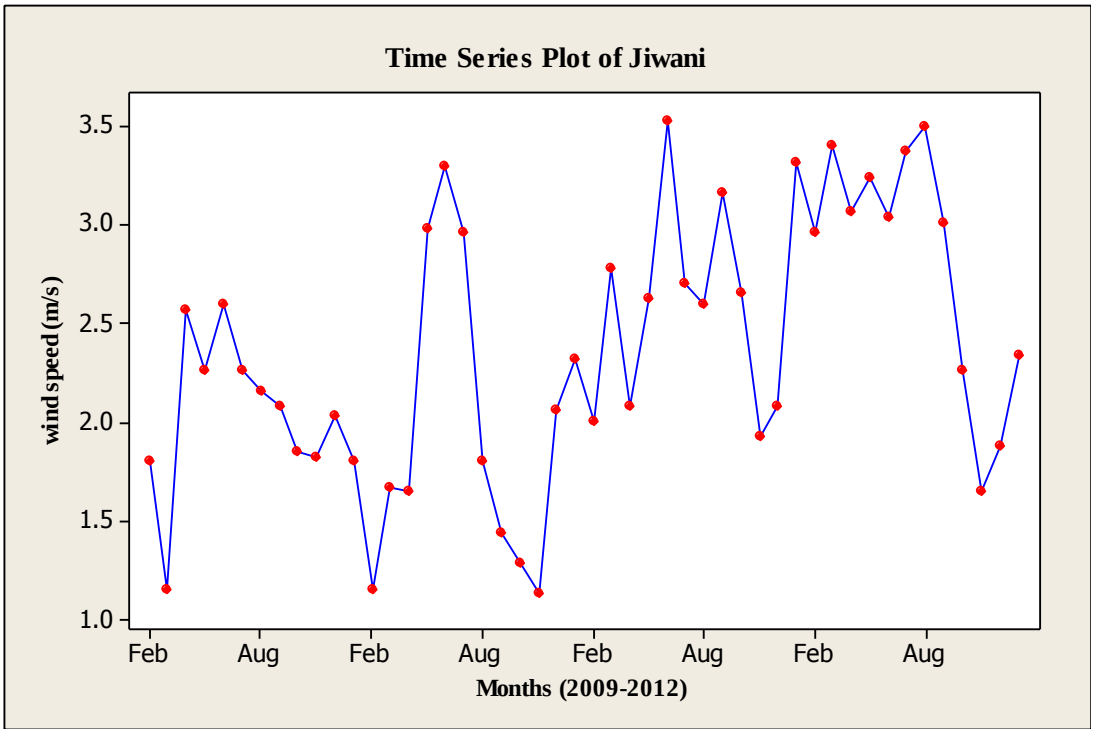

Figure 4.2: District Jiwani wind speed at 56m a.m.s.l.

In above figures it can be seen that this clock sequence has random pattern, cyclical pattern across a trended line and for periodic cyclical pattern in this sequence which is

repeating itself after regular clock intervals i.e. every after twelve months. Furthermore, May to October months have trended downward directions the reason is if the wind direction South to East is within 20 degrees to 50 degrees then we get an increasing trended pattern and if its direction South to East is less than 20 degrees and greater than 50 degrees then we get downward trended pattern. It also has an increasing trend that's mean, the stationary condition is not meet there. Moreover, the outliers in the clock series graphs can produce un-satisfactory consequences so for the reason this it can be handled and minimized by taking trimming factor 1 or 2 by using Minitab Software.

So appropriate differencing is required to remove all these patterns.

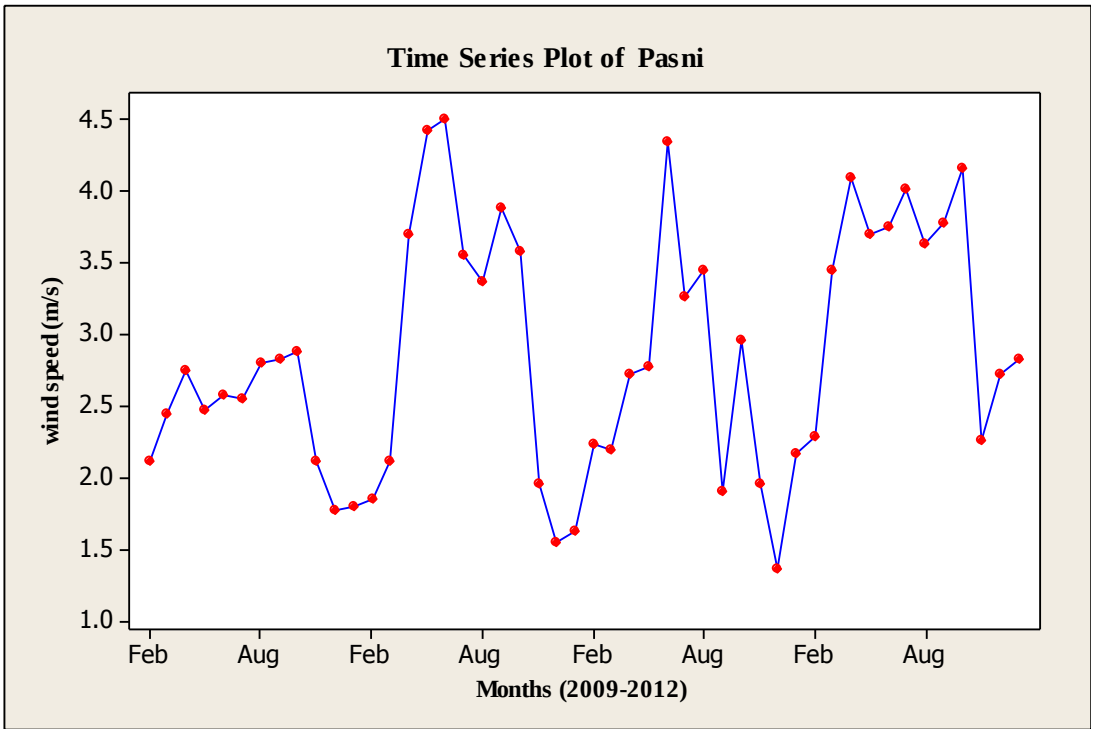

Figure 4.3: District Pasni wind speed at 9m a.m.s.l

In this figure it can be seen that this clock sequence has random pattern, cyclical pattern across a trended line and for periodic cyclical pattern in this sequence which is repeating itself after regular clock intervals i.e. every after twelve months. Furthermore, it also has an increasing trend that's mean, the stationary condition is not met there [3]. So appropriate differencing is required to remove all these patterns. In figure 4.4 it can be seen that this clock sequence has random pattern, cyclical pattern across a trended line and for periodic cyclical pattern in this sequence which is repeating itself after

regular clock intervals i.e. every after twelve months. Furthermore, it also has an increasing trend that's mean, the stationary condition is not met there. So appropriate differencing is required to remove all these patterns.

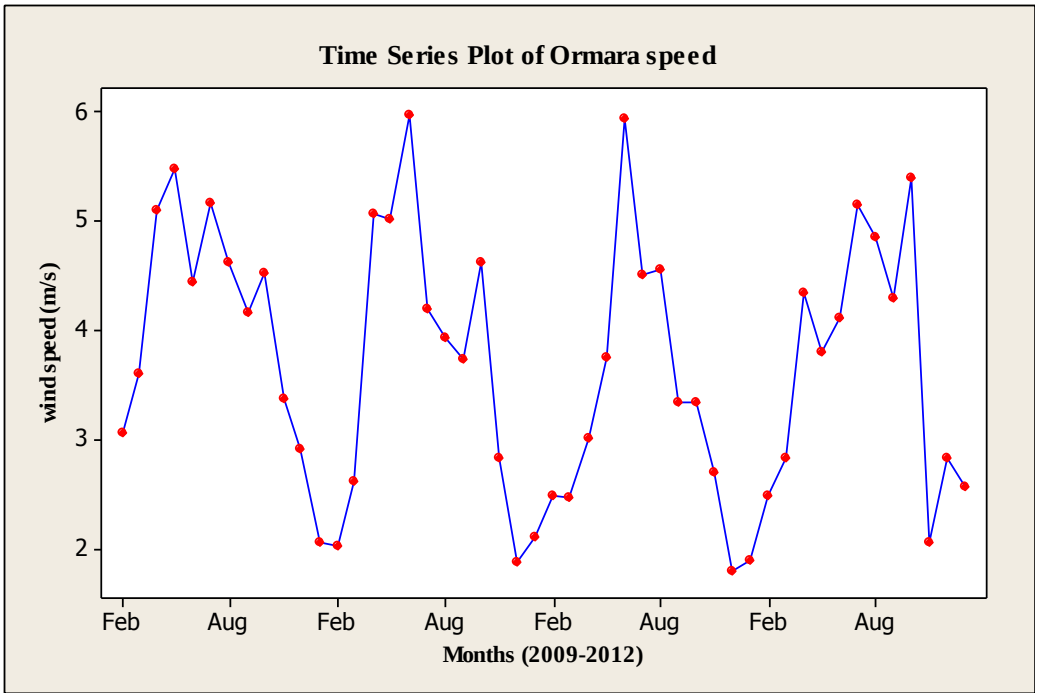

Figure 4.4: District Ormara wind speed at 02m a.m.s.l

4.3 Prototypical Identification

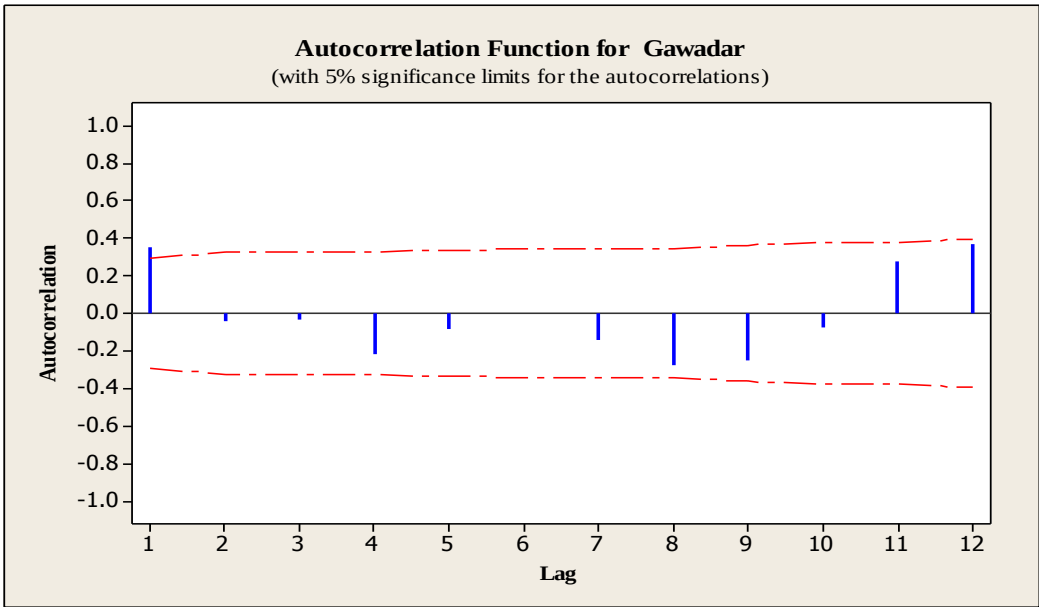

Figure 4.5: A.C.F for Gwadar wind speed without differencing

The A.C function fulfils the difference equation. For large values, the A.C function will not expire out rapidly and will fall off gradually and very closely to linearity. Likewise, if more than one root touches unity the A.C function will decline slowly. Therefore, if the A.C function dies out slowly it suggests there is a root which approaches unity. As a result failure of the estimated A.C function to croak out rapidly might logically propose that the original probability procedure is non-stationary in but likely stationary in or in some higher difference [4].

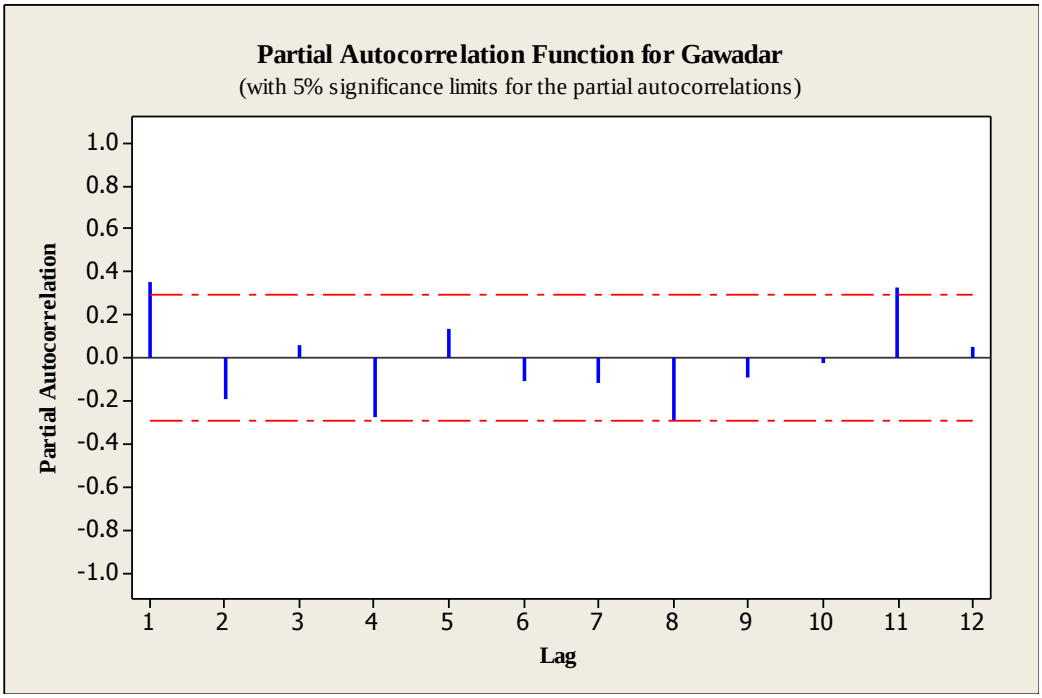

Figure 4.6: P.A.C.F for Gwadar wind speed without differencing

In Fig 4.6 and 4.7 we can see that A.C.F and P.A.C.F plot dies out very slowly. Although it is minor in trend but it exists so it shows the trended and non-Stationary behavior of the wind speed sequence. A.C is an important parameter in case of forecasting the time series as its analysis is very crucial for determining number of parameter value of the ARIMA modelling. If it is not known then it is very difficult to forecast wind speed time series and there are various software from which it can be solved easily and number of blue lines above then ninety five percent significant limit indicates that the no. of autoregressive parameters chosen while performing forecasting of time series.

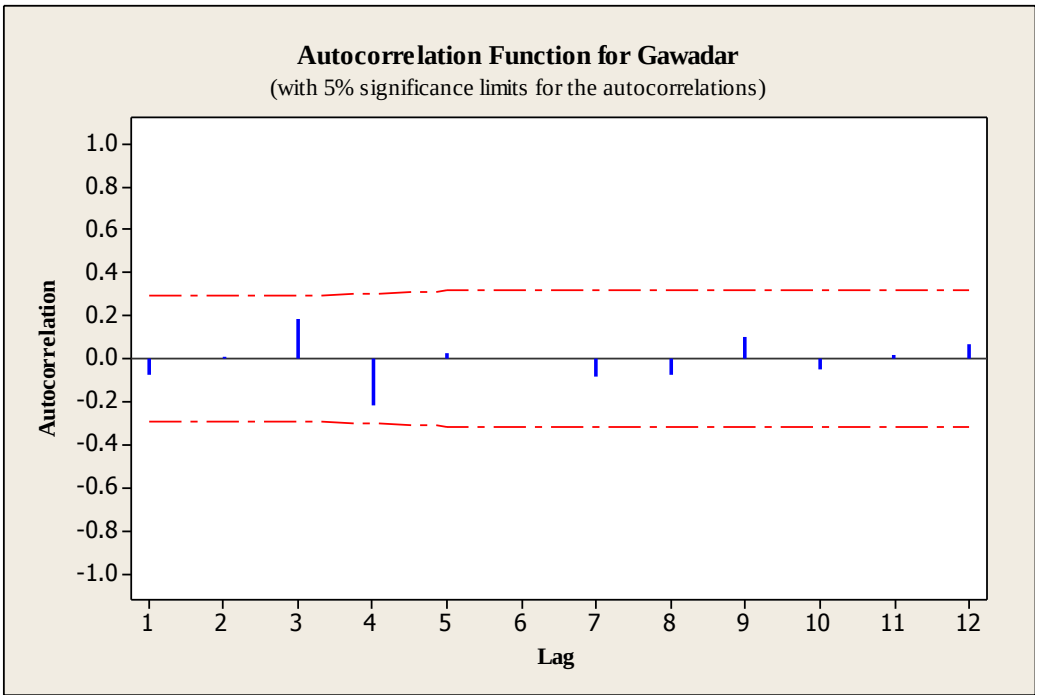

Figure 4.7: Gwadar A.C.F plot after second order differencing

The AC (Autocorrelation Function) is used for testing the random behavior of the data and to identify an appropriate model to test random behavior.

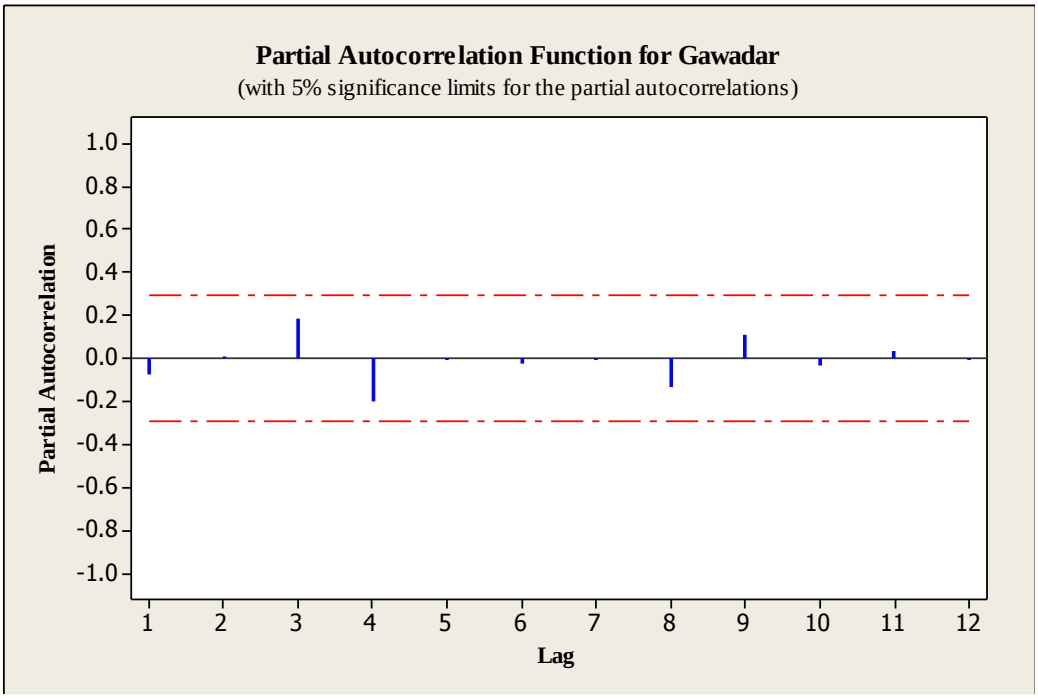

Figure 4.8: P.A.C.F for Gwadar after second order differencing

From the pictures above, both A.C.F and P.A.C.F dies out since the first lag so. Autoregressive second order prototypical would be best suitable for this.

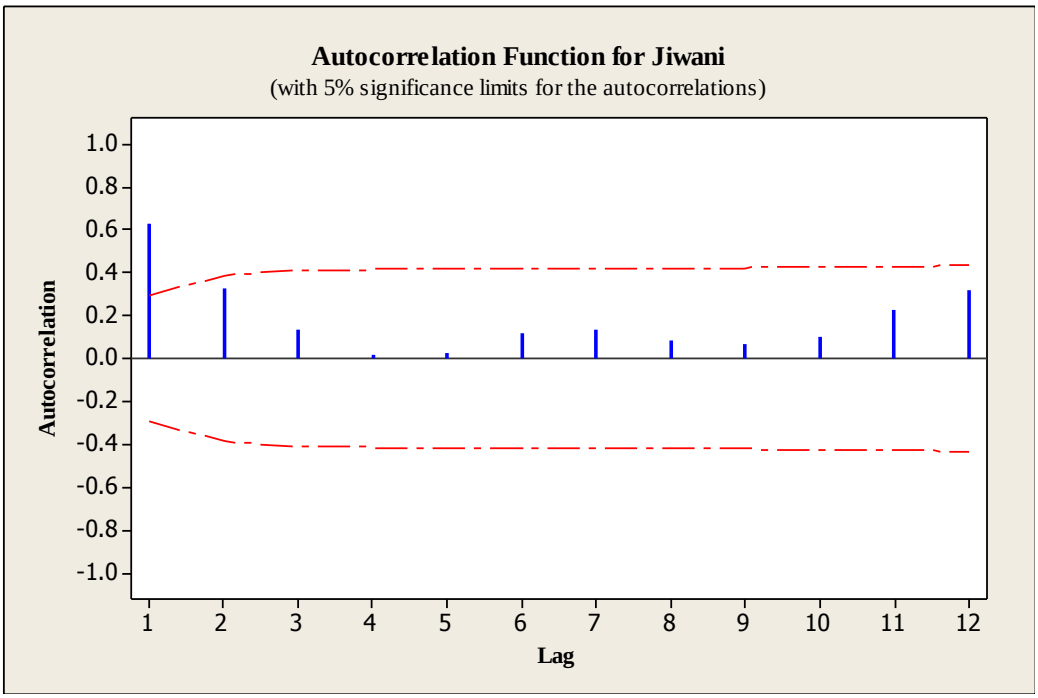

Figure 4.9: A.C.F for Jiwani wind speed without differencing

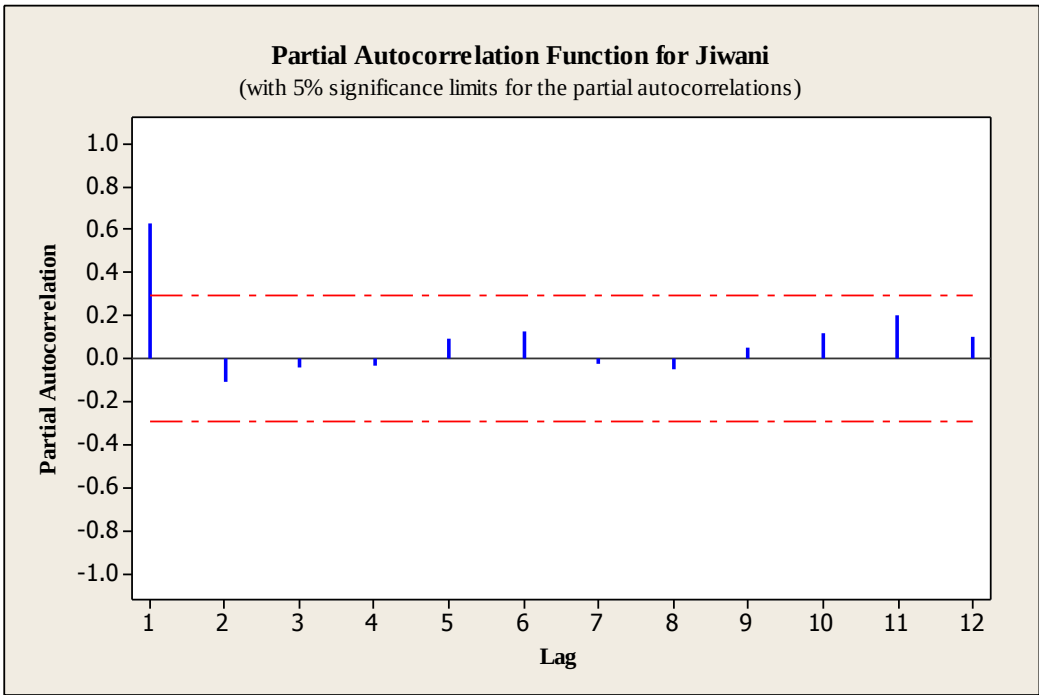

Figure 4.10: P.A.C.F for Jiwani wind speed without differencing

The partial Autocorrelation function (PACF) is used only for the detection of model identification of Box and Jenkins Methodology. In Fig 4.10 and 4.11 we can see that A.C.F and P.A.C.F plot dies out very slowly. Although it is minor in trend but it exists so it shows the trended and non-Stationary behavior of the wind speed sequence [5].

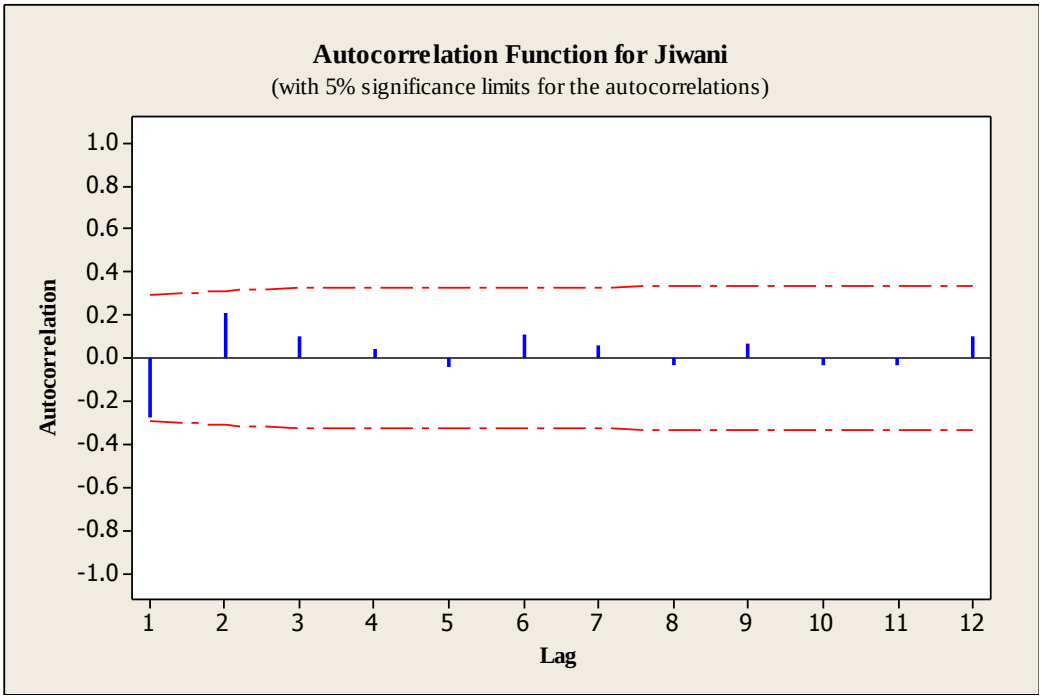

Figure 4.11: A.C.F plot of Jiwani after second order differencing

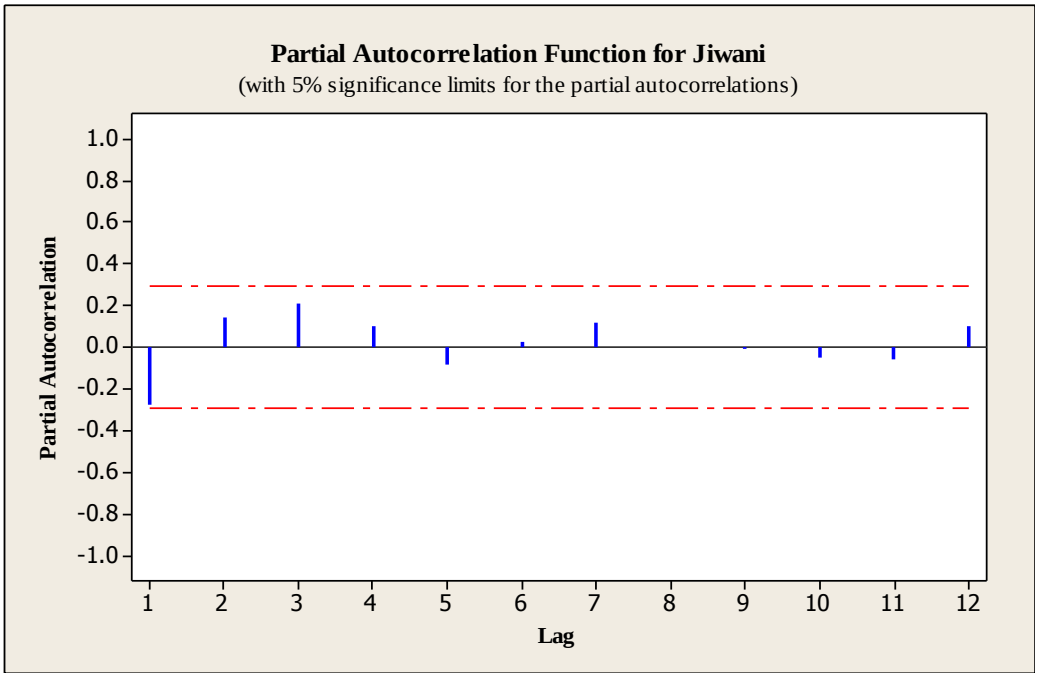

Figure 4.12: P.A.C.F for Jiwani after second order differencing

From the pictures above, both A.C.F and P.A.C.F dies out since the first lag so, Autoregressive second order prototypical would be best suitable for this.

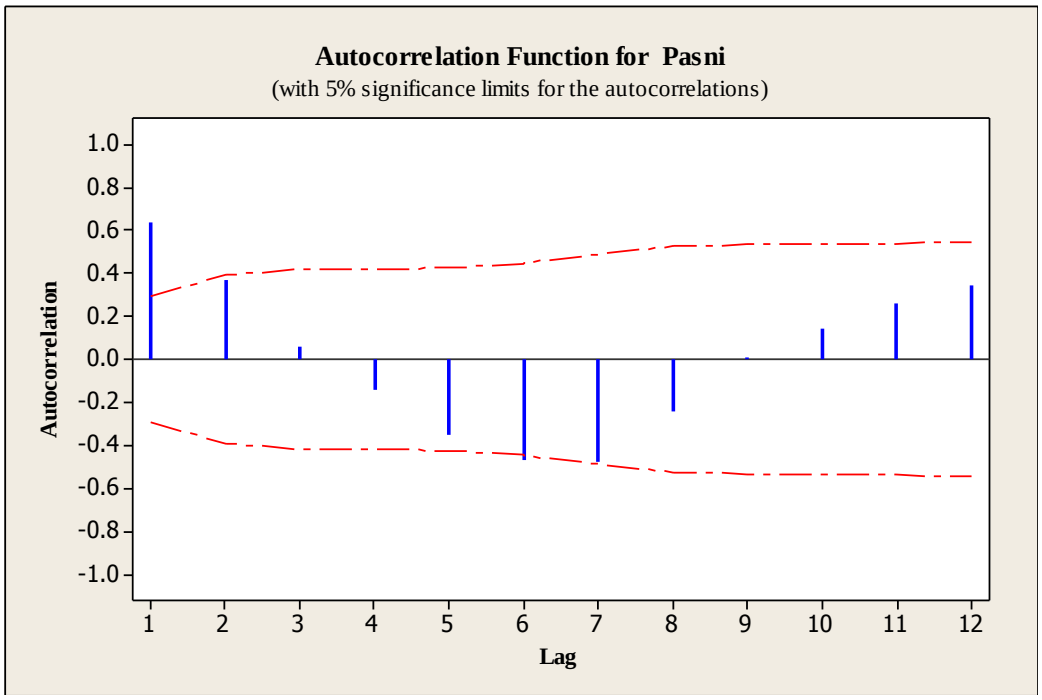

Figure 4.13: ACF for Pasni wind speed without differencing

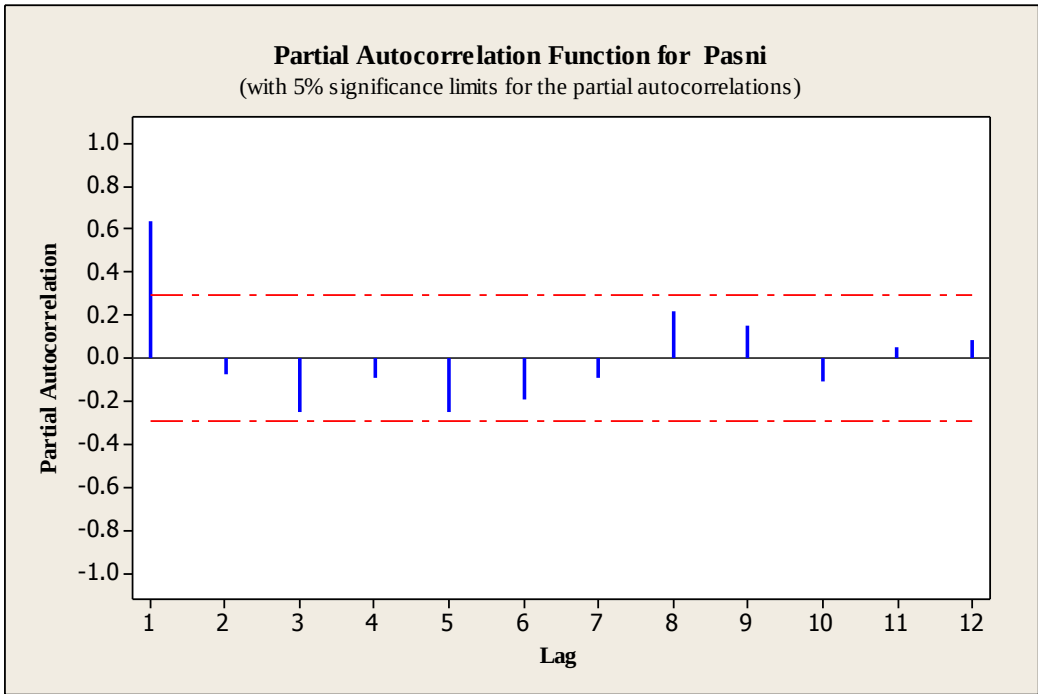

Figure 4.14: P.A.C.F for Pasni wind speed without differencing

In Fig 4.13 and 4.14 we can see that A.C.F and P.A.C.F plot dies out very slowly. Although it is minor in trend but it exists so it shows the trended and non-Stationary behavior of the wind speed sequence [6].

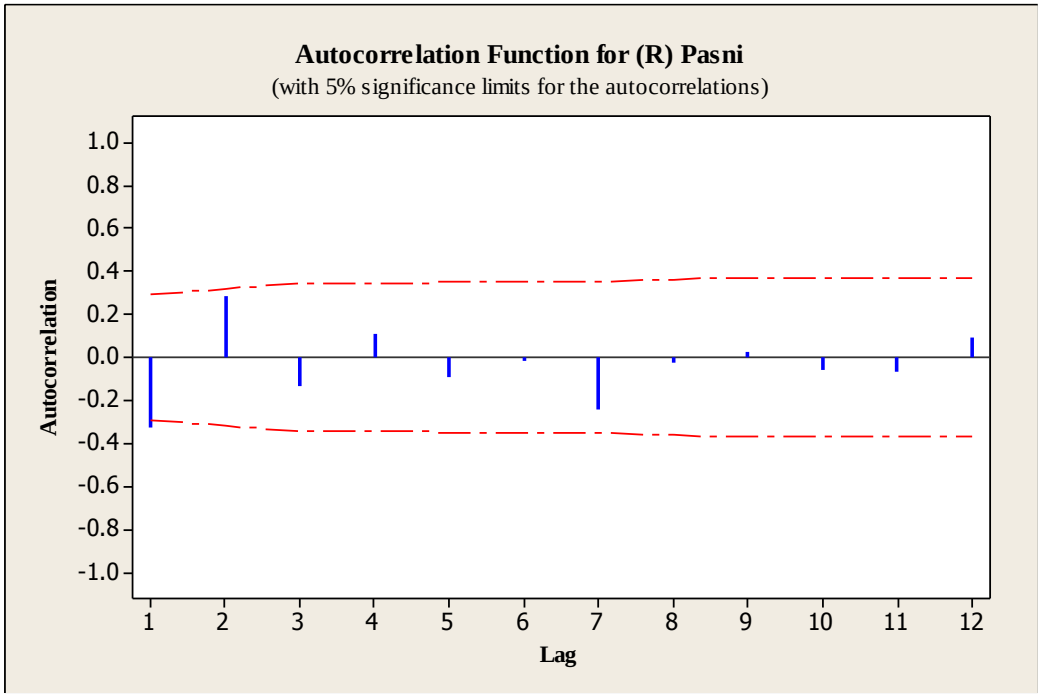

Figure 4.15: A.C.F plot of Pasni after second order differencing

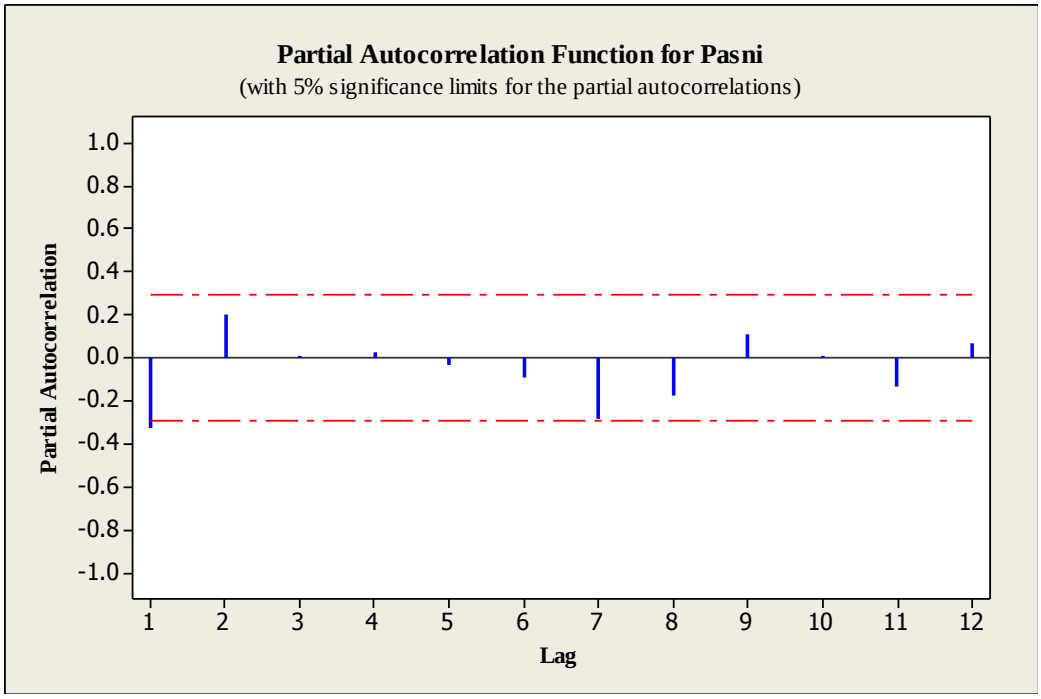

Figure 4.16: P.A.C.F for Pasni sequence after second order differencing

From the pictures above, both A.C.F and P.A.C.F dies out after the first lag so, Autoregressive second order prototypical would be best suitable for this.

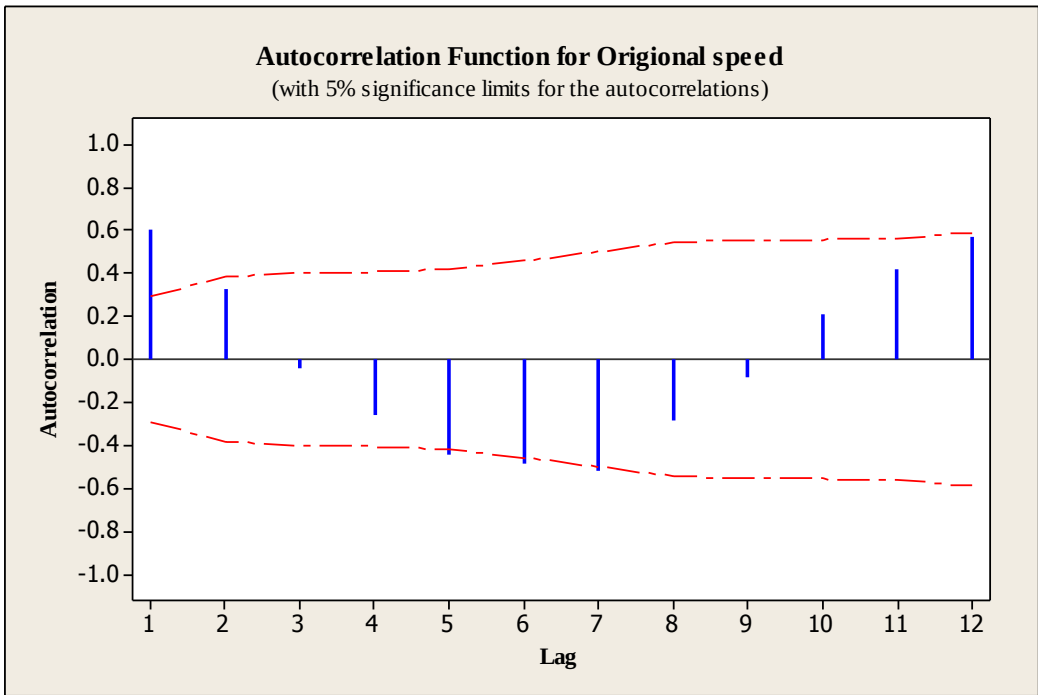

Figure 4.17: A.C.F for Ormara wind speed without differencing

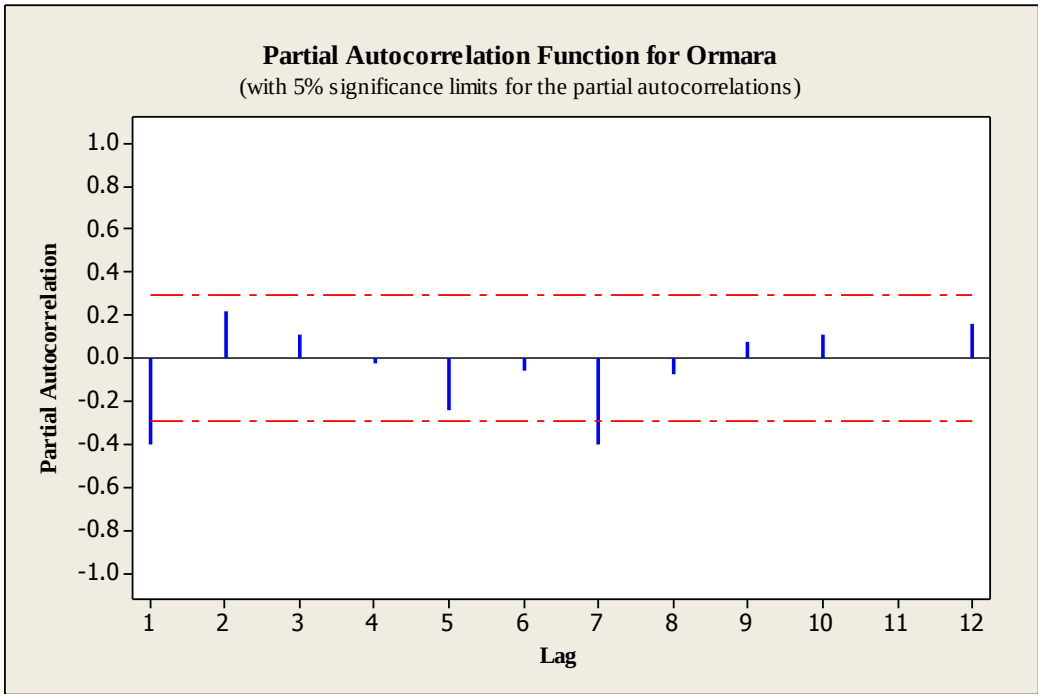

Figure 4.18: P.A.C.F for Ormara wind speed without differencing

In Fig 4.17 and 4.18 we can see that A.C.F and P.A.C.F plot dies out very slowly. Although it is minor in trend but it exists so it shows the trended and non-Stationary behavior of the wind speed sequence.

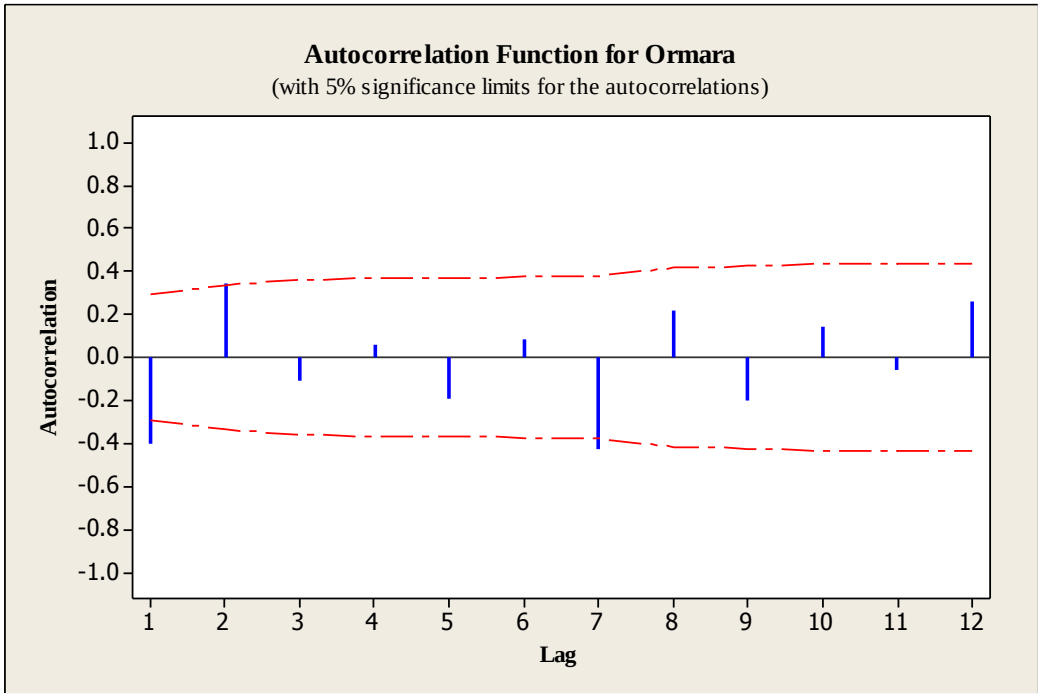

Figure 4.19: A.C.F plot of Ormara after second order differencing

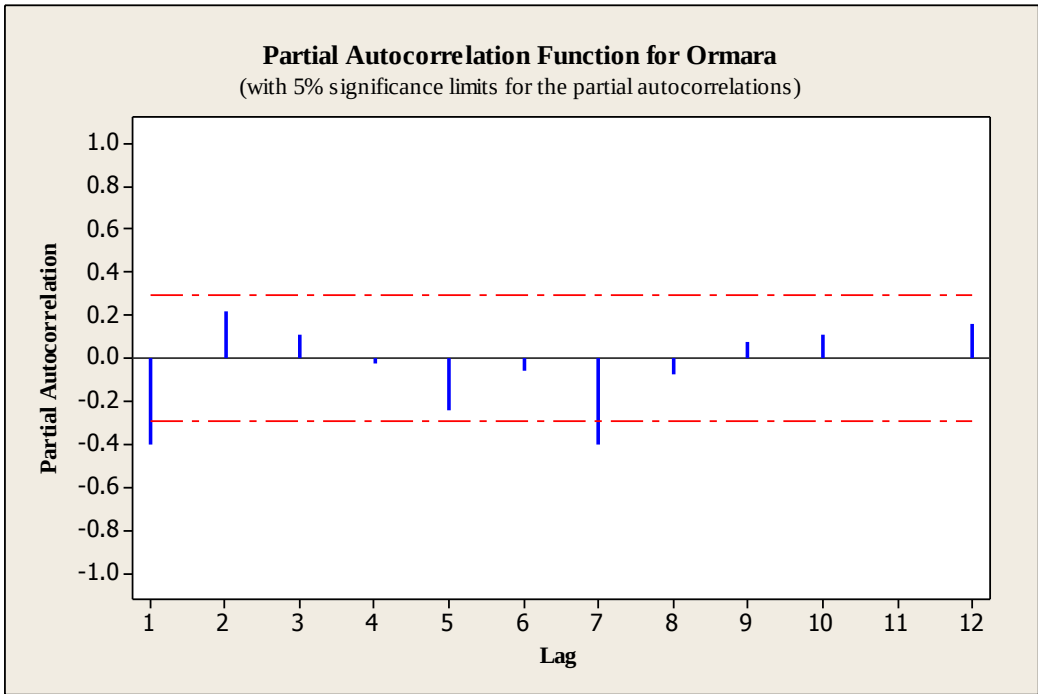

Figure 4.20: P.A.C.F for Pasni sequence after second order differencing

From the pictures above, both A.C.F and P.A.C.F dies out after the first lag so, Autoregressive second order prototypical would be best suitable for this [7].

4.4 Prototypical Selection

The autoregressive prototypical (2,2,0) is identified as best prototypical for Ormara district of Gwadar with respect to other prototypical i.e. (0,2,1), (0,2,2), (1,0,1), (2,2,1), (1,2,2), (2,2,2).

Table 4.2: Model Identification of Ormara

Prototypical	MAPE
Autoregressive prototypical (0,2,1)	3.551
Autoregressive prototypical (0,2,2)	2.995
Autoregressive prototypical (1,0,1)	2.316
Autoregressive prototypical (2,2,1)	3.001
Autoregressive prototypical (1,2,2)	4.347
Autoregressive prototypical (2,2,2)	3.937

Similarly, for other districts

The autoregressive prototypical (1,0,1) is identified as best prototypical for Pasni district of Gwadar with respect to other prototypical i.e. (0,2,1), (0,2,2), (1,0,1), (2,2,1), (1,2,2), (2,2,2).

Table 4.3: Model Identification of Pasni

Prototypical	MAPE
Autoregressive prototypical (0,2,1)	7.846
Autoregressive prototypical (0,2,2)	7.251
Autoregressive prototypical (1,0,1)	5.047
Autoregressive prototypical (2,2,1)	7.192
Autoregressive prototypical (1,2,2)	7.263
Autoregressive prototypical (2,2,2)	6.987

The autoregressive prototypical (1,0,1) is identified as best prototypical for Gwadar with respect to other prototypical i.e. (0,2,1), (0,2,2), (1,0,1), (2,2,1), (1,2,2), (2,2,2).

The autoregressive prototypical (1,0,1) is identified as best prototypical for Jiwani with respect to other prototypical i.e. (0,2,1), (0,2,2), (1,0,1), (2,2,1), (1,2,2), (2,2,2) [8].

Table 4.4: Model Identification of Gwadar

Prototypical	MAPE
Autoregressive prototypical (0,2,1)	19.759
Autoregressive prototypical (0,2,2)	18.899
Autoregressive prototypical (1,0,1)	19.981
Autoregressive prototypical (2,2,1)	19.584
Autoregressive prototypical (1,2,2)	19.129
Autoregressive prototypical (2,0,2)	18.765

Table 4.5: Model Identification of Jiwani

Prototypical	MAPE
Autoregressive prototypical (0,2,1)	13.759
Autoregressive prototypical (0,2,2)	12.899
Autoregressive prototypical (1,0,1)	11.463
Autoregressive prototypical (2,2,1)	12.584
Autoregressive prototypical (1,2,2)	13.129
Autoregressive prototypical (2,0,2)	12.765

The M.A.P.E error shows the accuracy of the forecasted series with respect to their original series. M.A.E is also used for calculating the accuracy of the forecasted time series. It is clearly shown in above tables that best accuracy that is achievable is 2.316 in case of ormara city. Its mean the original ormara speed was strongly non-stationary. It is noticed that as the M.A.P.E increases it means the original time series of wind speed was correspondingly goes into stationary behavior [8].

Summary

In this chapter we take into consideration of the wind speed data and will apply box and Jenkins methodology on it.

The data is obtained for the year 2009 to 2012 for analysis. The wind speed data is in meter per second obtained from Pakistan meteorological department, Karachi for four districts of Gwadar i.e. Ormara, Pasni, Jiwani and Gwadar.

In all four districts only Gwadar has stationary sequence so it is up to us either we can use this sequence as it is for generating the forecast or we can apply differencing on this sequence as well.

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Chapter 5

Results and Discussions

5.1 Energy Generation:

The energy due to movement of the body in the wind is a very useful cause of an energy in numerous portions of the world. The energy captured by wind rotary engines very much depends on the average wind speed. Normally the most attractive regions for wind energy are located near coastal areas

The unadjusted energy production from wind rotary engines is the energy that one or more rotary engine would yield at usual temperature and pressure conditions. The energy curve data is the complete amount of energy a wind rotary engine will produce over a range of annual wind speed. The gross energy production is the complete annual energy produced by the wind energy equipment before any losses [2] [4].

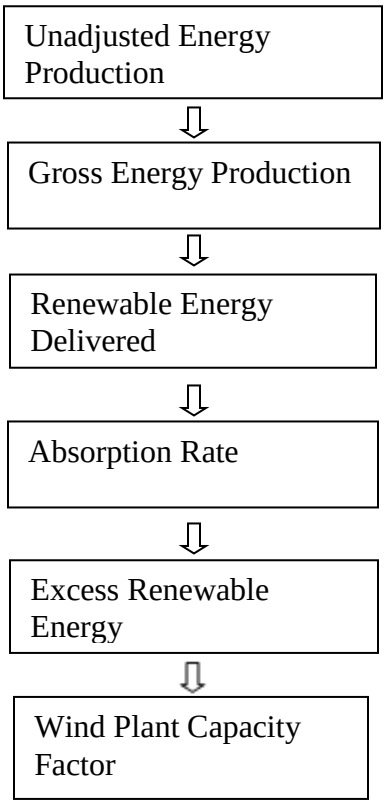

Figure 5.1: Wind Energy Generation Model

5.2 Capacity Factors of Districts Gawadar

Plant Capacity Factors: (For Ormara with Annual Energy 167 GWh)

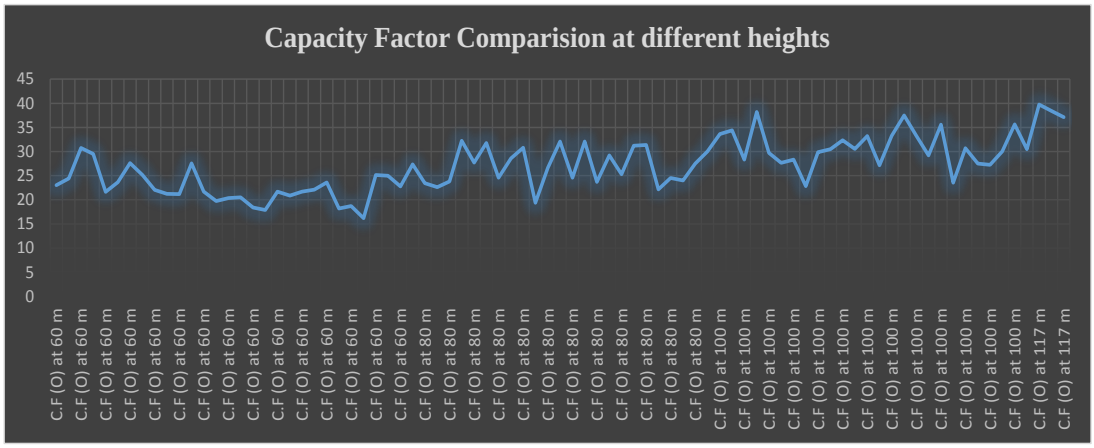

Figure 5.2: Capacity factor of Ormara district

Capacity factor is a portion of how often an electric generator runs for a specific for period of phase. It is calculated after considering all losses i.e. Array losses 5%, Wind foil losses 2%, rotary engines availability 95%, miscellaneous losses 2%, temperature and pressure adjustment (0.96, 0.93) and surface roughness coefficient 0.20. This capacity factor specifies how much electrical energy a generator really yields comparative to the maximum it could produce at nonstop full power procedure during the same for period. Fig 5.2 shows the capacity factor chart of Ormara at different heights and it is going to increase as the height increases. The maximum capacity factor that is attained is 41%. Wind speed increases with the heights, probability density function shifts towards higher wind speed side at higher heights and that's why able to get best result with this [5][6].

Plant Capacity Factors: (For Pasni with Annual Energy 88 GWh)

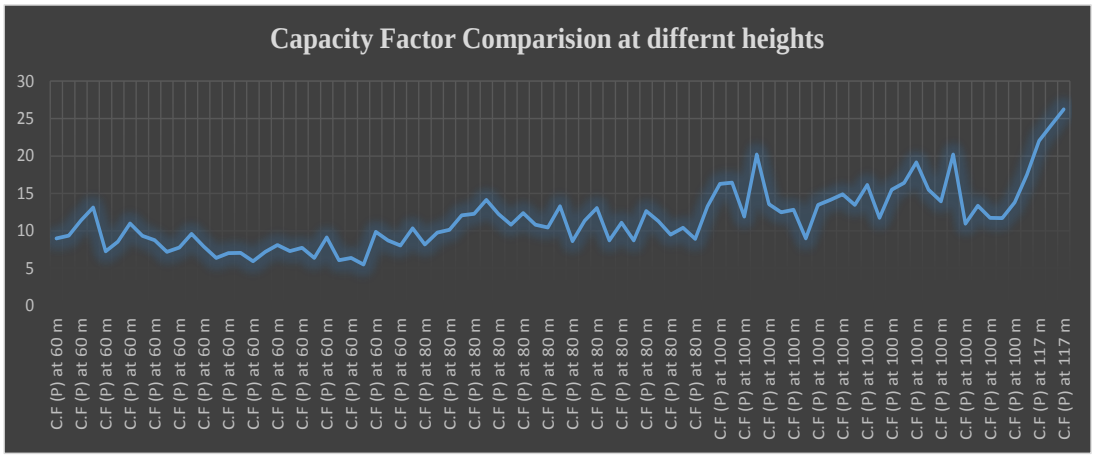

Figure 5.3: Capacity factor of Pasni district

This is the capacity factor chart of Pasni at different heights and it is going to increase as the height increases. The maximum capacity factor that is attained is 25%. The ups and downs in the peaks is mainly for the reason different wind speed density function and rotary engine rating. Wind speed increases with the heights and that's why probability density function shifts towards higher wind speed side at higher heights and we are able to get better with this result [5] [6].

Plant Capacity Factors: (For Jiwani with Annual Energy 29 GWh)

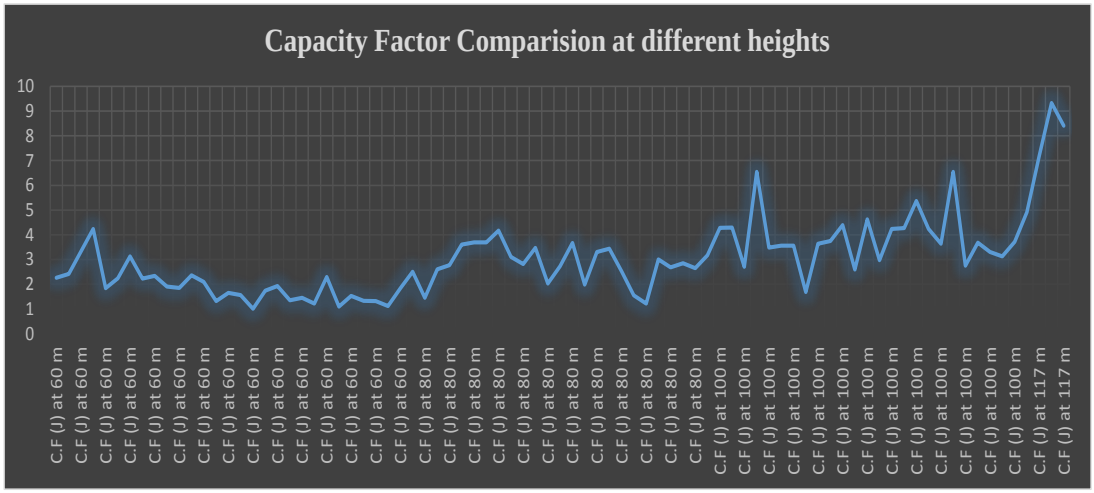

Figure 5.4: Capacity factor of Jiwani district

Similarly, this is the capacity factor chart of Jiwani at different heights and it is going to increase as the height increases. The maximum capacity factor that is attained is 9%. The ups and downs in the peaks is mainly for the reason different wind speed density

function and rotary engine rating. Wind speed increases with the heights and that's why probability density function shifts towards higher wind speed side at higher heights and we are able to get better result with this [5] [6].

Plant Capacity Factors (For Gwadar with Annual Energy 58 GWh)

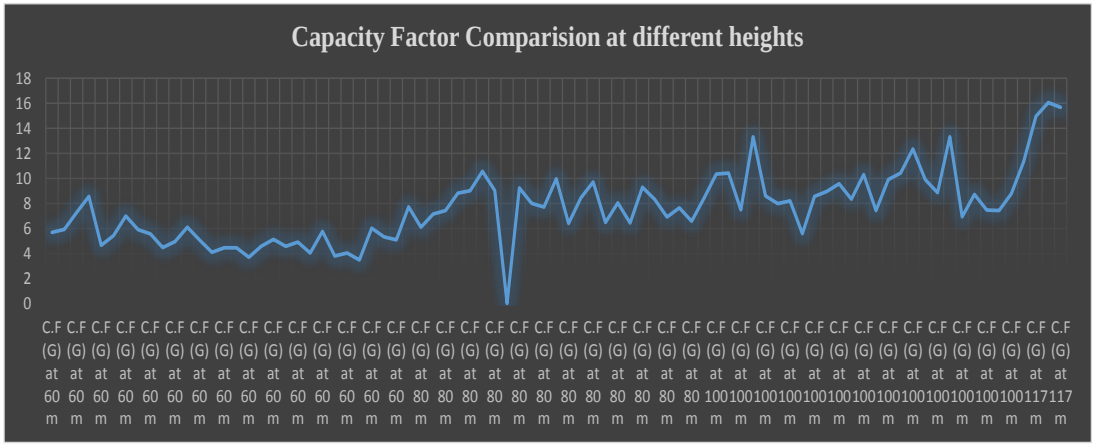

Figure 5.5: Capacity factor of Gwadar district

This is the capacity factor chart of Gwadar at different heights and it is also going to increase as the height increases. The maximum capacity factor that is attained is 16%. The ups and downs in the peaks is mainly for the reason different wind speed density function and rotary engine rating and Weibull parameters chosen. The lower peak in the middle is for the reason the lesser power curve of that rotary engine even at higher heights. Wind speed increases with the heights and that's why probability density function shifts towards higher wind speed side at higher heights and we are able to get better with this result [5] [6].

5.3 Financial Analysis

This is the economic analysis of all four districts of District Gwadar- Baluchistan for the viability of the wind power generation project.

Table. 5.1: Economic Analysis of all four districts of Gwadar

	Ormara	**Pasni**	**Jiwani**	**Gwadar**
B.C.R	1.22	1.10	0.59	0.80
Payback For period	5 Years	7 Years	18 Years	13 Years
I.R.R	18%	12%	2%	6%
Sensitivity Analysis				
10% increase in price	15%	10%	0%	5%
10% decrease in price	20%	15%	3%	8%

Financial Analysis is the key analysis for determining which site is favorable for wind power project and which site is not. Looking at this chart, we can say that Ormara district is very favorable for such kind of projects because of its high internal rate of return which is a maximum 20%. The Gwadar is also a good site after Pasni and Jiwani is not being recommended for such kind of projects because of its low revenue generating for percentage [1].

5.4 RETScreen Analysis

RETScreen International software was developed by Natural Resources Canada's CANMET Energy diversification Research Laboratory (CEDRL) in called as Canada Energy Centre.

It works as a decision making tool that could help planners in implementation of energy projects especially renewable resources related.

This Software's examines the feasibility of wind projects on the basis of capacity factor calculation. Technical analysis of Wind Power system is for performed using RETScreen simulation program to figure out the viability of the system installation for electric power generation. All parameters affecting the financial viability of wind power systems and their role in making the project feasible or not in Gwadar district are presented in the table 5.1

By considering all losses (Array losses 5%, Wind foil losses 2%, rotary engines availability 95%, miscellaneous losses 2%, temperature and pressure adjustment (0.96, 0.93) and surface roughness coefficient 0.20) and keeping all the parameters same, this software analysis is for performed in four cities of district Gwadar and capacity factor of various cities were found;

For Ormara 44%,

For Pasni 28%,

For Gwadar 19% and

For Jiwani 12%.

The variations of these Capacity factors with original values are mainly for the reason variability of the 'c' and 'k' parameters.

Summary

This chapter signifies the energy production from all four districts of the Gwadar-Baluchistan. As Ormara had already high mean wind speed value at 2m average mean sea level so when we project it to 117m height its mean wind speed has been very high as compared to 2m height so energy production will also be high at this height. RETScreen software has slight difference consequences than calculated values so its simulation can be used as reference study for wind power projects. As stated above it is concluded that Ormara district is producing best energy as compared to other cities. After this Pasni district moving towards project feasibility state from an investor's point of view.

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Conclusions

The wind speed forecasting is modelled using ARIMA Model in Minitab and wind energy generation is for performed through RET Screen simulation as well as numerical calculations for Gwadar district-Baluchistan location of having latitude 25.1264oN and longitude 62.3225oE to study its energy generation viability and economical behavior respectively. Forecasted wind speed through ARIMA Model for all four cities of district Gwadar after analyzing its parameters. This model for performance is evaluated with Mean absolute for percentage error (MAPE) which allows for better sensitivity and adjustment to wind speed of original sequence and forecasted sequence because both has very slight difference in average wind speed for the reason increasing trend of wind speed in the original sequence. The Energy Generation for performance is evaluated and compared with RET Screen software and it concludes that:

- Ormara city of district Gwadar is more accurate in forecasted wind speed as compared to other cities because of for periodic seasonal values found in clock series. The MAPE obtained for Ormara is 2.316%, for Pasni is 5.047%, for Jiwani is 11.463% and for Gwadar is 18.765%.
- In this direction of wind speed (South to East 20 degrees to 50 degrees) wind speed is found above than average wind speed.
- It is found that Ormara city is giving best energy yield as compared to other cities that's why it has better capacity factor from the rest.
- The best suitable hub height for all cities is found at 117 m because at higher heights wind profile gets smoother and better consequences can be attained.
- Fuhrlander (3 MW) wind rotary engine is considered to be best at for site because of good power curve.
- From investor's point of view Ormara, Pasni and Gwadar cities are better and safe to invest money on this type of project based on internal rate of return and payback for period.
- Wind power engineering is need of clock for the whole world in energy's future concerns especially for those countries where energy field situation is already disastrous as in Pakistan.

Recommendations

The findings of present work show that forecasting of wind speed and its energy generation could be a milestone for fossil fuels savings and green growth of country. The recommendations for future work could be suggested as:

- This work can extended for study of Risk Assessment of wind energy system and power generation in other cities using Minitab and RET Screen methodology.
- Error reduction and energy losses during power production effects can be studied in detail.
- In current work, Weibull parameter is found out using numerical model only. This optimization can be executed experimentally using developed set-up.
- Forecasting is executed using ARIMA Model only. This work can also be extended for studying the for functioning of other methods while doing forecasting in comparison with ARIMA Model.
- Greenhouse gases emission reduction and its analysis can also be performed in future study.

This system can be hybridized with solar irradiance that will completely belittle the conventional fuel requirements