CHAPTER FOUR

CHAPTER FIVE

TRAFFIC FORCAST FOR AIRPORTS PAVEMENT DESIGN

4.1 Introduction

Plans for the development of the various components of the airport system depend to a large extent on the activity levels which are forecast for the future. Since the purpose of an airport is to process aircraft, passengers, freight, and ground transport vehicles in an efficient and safe manner, airport performance is judged on the basis of how well the demand placed upon the facilities within the system is handled.

To adequately assess the causes of performance breakdowns in existing airport systems and to plan facilities to meet future needs, it is essential to predict the level and distribution of demand on the various components of the airport system. Without a reliable knowledge of the nature and expected variation in the loads placed upon a component, it is impossible to realistically assess the physical and operational requirements of such a component. For example, a forecast to project the mix of aircraft and the types of aviation activity at an airport site is necessary to identify the critical aircraft which dictates the elements of geometric and structural design, the type and extent of physical facilities, the navigational aid requirements, and any special or unique facility needs at the airport.

An understanding of future demand patterns allows the planner to assess future airport performance in light of existing and improved facilities, to evaluate the impact of various quality of service options on the airlines, travelers, shippers, and community, to recommend development programs consistent with the overall objectives and policies of the airport operator, to estimate the costs associated with these facility plans, and to project the sources and level of revenues to support the capital improvement program.

It is essential in the planning and design of an airport to have realistic estimates of the future demand to which airports are likely to be subjected. This is a basic requirement in developing either an airport master plan or an airport system plan. These estimates determine the future needs for which the physical facilities are designed. A financial plan to achieve the recommended staged development along with required land-use zoning usually accompanies the plan. It should be apparent that an airport is designed for a projected level and pattern of demand and changes in the magnitude or characteristics of this demand may require facility modifications or operational measures to meet changing needs.

Facility planning is necessary to provide adequate levels of service to airport users. The development of accurate forecasts requires a considerable expense of time and other resources because of the complex methodologies which must be used and the extensive data acquisition that is often required. The usual justification for a demand forecast in an aviation plan is that the expected level of uncertainty associated with the estimation of essential variables will be reduced, thereby reducing the probability of errors in the planning process and enhancing the decision-making process. The implication, of course, is that the benefits gained due to a better knowledge of the magnitude and fluctuation in demand variables will outweigh the costs incurred in performing the forecast.

To assess the characteristics of future demand, the development of reliable predictions of airport activity is necessary. There are numerous factors that will affect the demand and planners who are preparing forecasts of demand or updating existing forecasts should consider local and regional socioeconomic data and characteristics, demographics, geographic attributes, and external factors such as fuel costs and quality of service parameters. Political developments, including rising international tensions, changes in security, airline delays and congestion, and travel attitudes, will impact demand. Actions taken by local airport authorities, such as changes in user charges, can also stimulate or hinder the demand and investment decisions made as the result of the planning process itself can also produce change by removing physical constraints to growth.

Over the years, certain techniques have evolved which enable airport planners and designers to forecast future demand. The principal items for which estimates are usually needed include. The volume and peaking characteristics of passengers, aircraft, vehicles, and cargo:

- The number and types of aircraft needed to serve the above Traffic
- The number of based general aviation aircraft and the number of movements generated.
- The performance and operating characteristics of ground access systems

Using forecasting techniques, estimates of these parameters and a determination of the peak period volumes of passengers and aircraft movements can be made. From these estimates concepts for the layout and sizing of terminal buildings, runways, taxiways, apron areas, and ground access facilities may be examined.

Forecasting demand in an industry as dynamic as aviation is an extremely difficult matter, and if it could be avoided it undoubtedly would. Nonetheless

estimates of traffic must be made as a prelude to the planning and design of facilities. It is very important to remember that forecasting is not a precise science and that considerable subjective judgment must be applied to any analysis no matter how sophisticated the mathematical techniques involved. By anticipating and planning for variations in predicted demand, the airport designer can correct projected service deficiencies before serious deficiencies in the system occur.

4.3 Forecast Requirements

To estimate the size of the future air traffic must be knowledge of the following information: -

1- Number of passengers: -
A- Global and local
B- Arrivals and Departures
C- Travelers and transients
D- Short-haul flights and long term.
2- The volume of goods transported by air and classified.
3- The movement of aircraft by type of aircraft.
4- The quality and means of transport to and from the airport (especially vehicles - taxis - public transport - etc.)
5- Average applicants and recipients for each traveler.
6- Average number of bags with every traveler.
7- Number of visitors to the airport from the non-applicants or employees at the airport.

4.4 Khartoum airport data analysis:

Khartoum airport historical data from year 2000 to 2014 are shown below for aircraft movement , number of passengers and tonnage of freight for both domestic and international flights

4.4.1Passenger movement:

Figure 4.1 as plotted for domestic passenger movement the figure shows increasing “between” (2000-2011) and very little decreasing from (2011-2014) and for international passenger movement from (2000-2014) it still increasing and that shows the passenger movement are not touched by the south disunion. This suggests that the movement of passengers to travel the world and local not

effected by the current situation of the country, even with mild decrease in domestic traffic is not significantly.

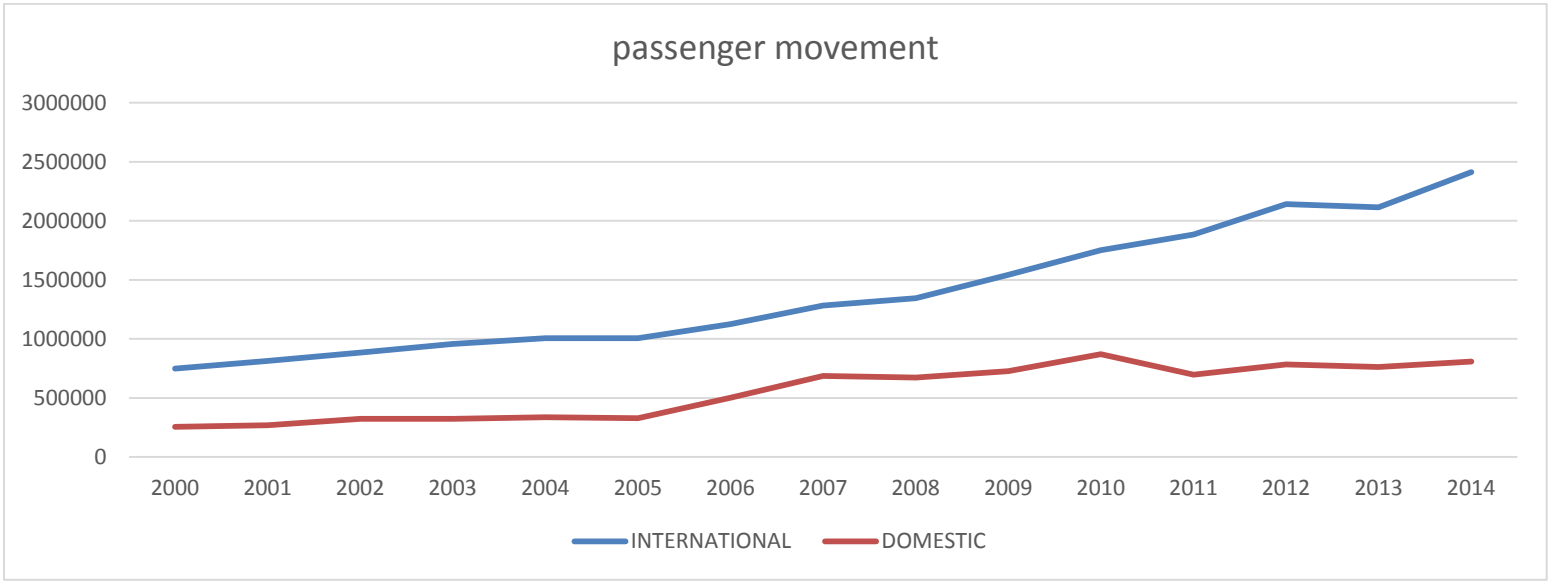

Figure 4.1: passenger movement

Table 4.1: passenger movement

PASSENGERS MOVEMENT SUDAN AIRPORTS															
YEAR	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
INTERNATIONAL	746895	814146	882364	957032	1004823	1004823	1124451	1282331	1345655	1543529	1750103	1883780	2139914	2337938	2554287
DOMESTIC	255463	269010	322426	322426	334908	329238	502165	686964	672193	726804	869969	696214	782634	870533	968304
TOTAL*	**1002358**	**1083156**	**1204790**	**1279458**	**1339731**	**1334061**	**1626616**	**1969295**	**2017848**	**2270333**	**2620072**	**2579994**	**2922548**	**3208471**	**3522591**

4.4.2Aircraft movement:

Figure 4.2 as plotted give a clear increase between 2000 to the start 2012 in aircraft movement, for domestic flight. And this is due to a little calm in the political situation and ongoing peace negation with the southerners, and this gave promise of growth of the economic situation. but after that and so far we note a decrease in air traffic in air traffic and this are two reasons firstly after the separation North Sudanese economy faces various problems that is result of an absence of about 75% of oil production recently the feature of this problem appeared the second is that South Sudan has become a state is a list of self and this means that all travel between Khartoum and Juba has become a global travel and exit airports malakal and waw. For international flights since 2000 the aircraft movement shows clear increasing where it has not touched wih the political situation and economic development of the country. As it also noted a steady increase in the last two years, the spectrum because the travel heading to Juba joined with the world travel.But air movement is beginning to return to their level gradually

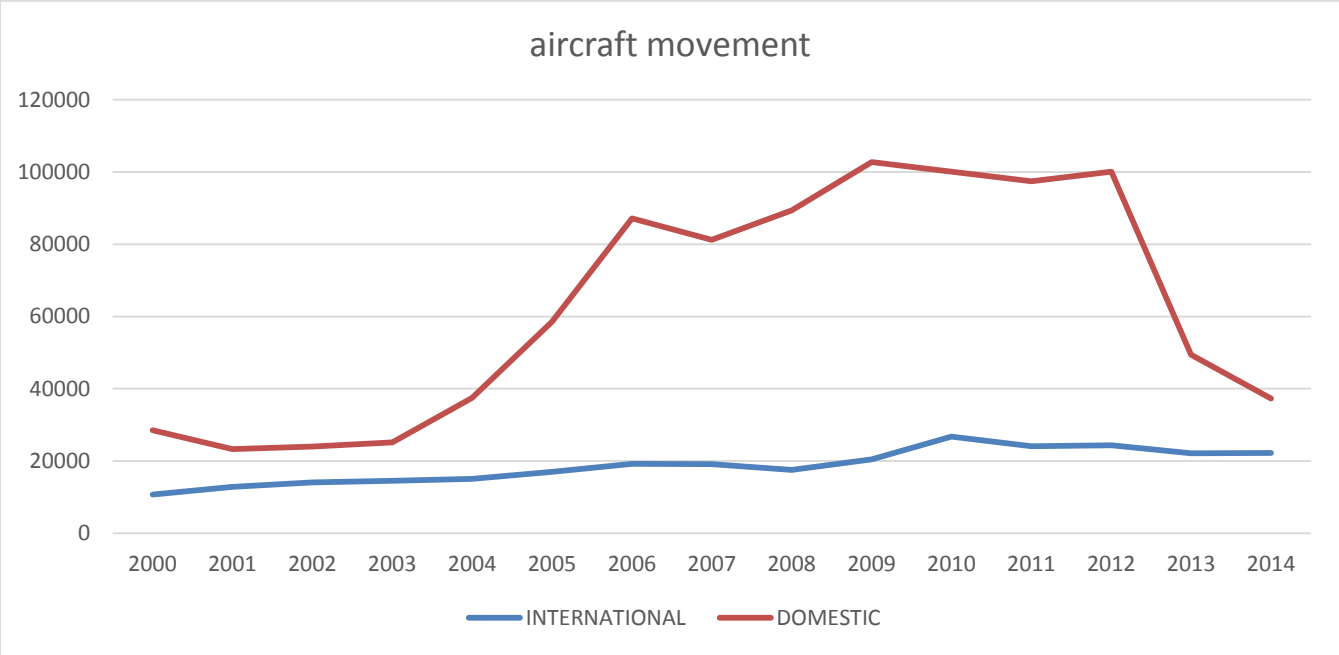

Figure4.2: aircraft movement

Table 4.2: aircraft movement

FREIGHT MOVEMENT (KG)															
YEAR	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
INTERNATIONAL	44462876	45369044	45545304	43737328	36405843	49323311	66594828	78085163	49689662	38902662	29982708	22039472	39810337	41223077	42685950
DOMESTIC	75992226	75772567	119567940	124580602	90050002	113188022	125512226	77377346	35681067	48292828	20866120	28728000	20059557	17721752	14660250
TOTAL*	120455102	121141611	165113244	168317930	126455845	162511333	192107054	155462509	85370729	87195490	50848828	50767472	59869894	59869894	59869894

4.4.3 Cargo movement

Figure 4.3 as plotted give a clear increase between (2000 - 2006) and also clear decreasing from (2006-2014) for domestic movement. For international movement the situation is unstable since 2000. This indicates that the movement of goods since 2007 is unstable and it constant volatility. It is noticeable in recent years that there is a scary decrease for the goods movement, the economy specialists think that as a result of decreasing the value of the Sudanese currency significantly, GDP dropped to below zero, according to the report of IMF, increasing the prices and the lack of services, The size of the state budget has reduced and The government of Khartoum could be unable to pay its external debt.

Figure 4.3: cargo movement

Table 4.3: cargo movement

AIRCRAFT MOVEMENT AT SUDAN AIRPORT															
YEAR	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
INTERNATIONAL	10682	12836	14072	14502	15080	16996	19188	19126	17502	20442	26750	24088	24334	26207	28223
DOMESTIC	28476	23296	24026	25146	37482	58564	87152	81212	89404	102718	100073	97398	100070	113361	128417
TOTAL*	**39158**	**36132**	**38098**	**39648**	**52562**	**75560**	**106340**	**100338**	**106906**	**123160**	**126823**	**121486**	**124404**	**139568**	**156640**

4.5 Merowi airport data analysis:

Merowi airport historical data from year1998 to 2014 are shown below for aircraft movement and number of passengers for domestic flights

4.5.1 Aircraft and passenger movement

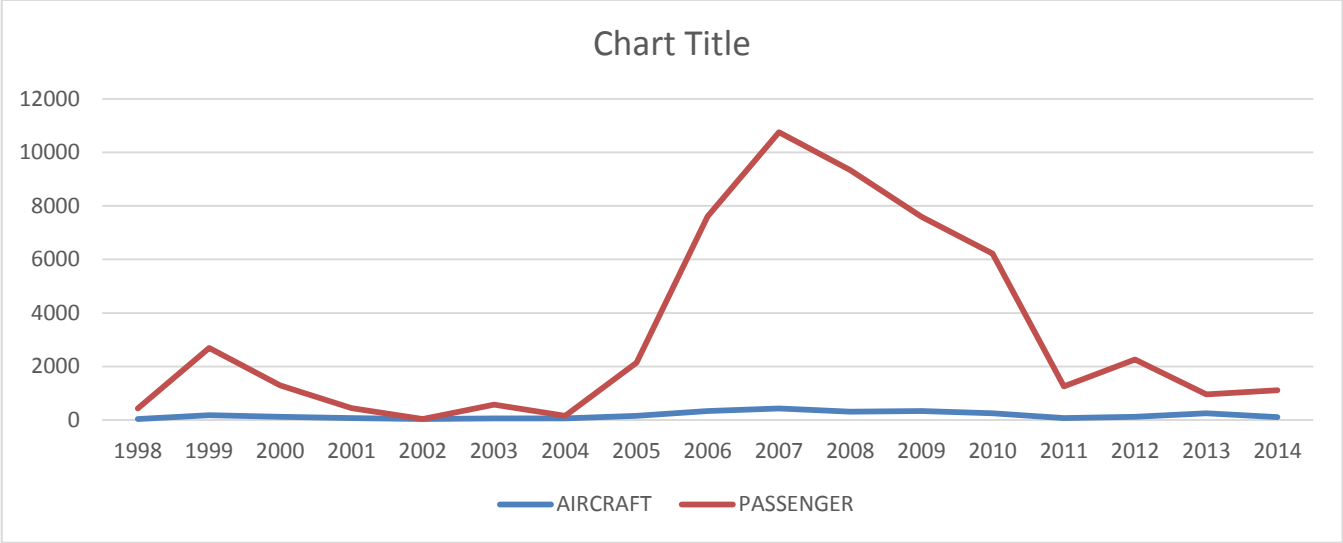

Figure 4.4: aircraft and passenger movement

Table 4.4: aircraft and passenger movement

Years	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Aircraft	36	184	122	66	34	58	64	152	334	434	308	328	248	66	114	254	112
Passengers	426	2689	1293	437	39	579	151	2135	7611	10755	9342	7592	6224	1251	2257	961	1108

4.5.2 Cargo movement

Shipping was very weak because of the high cost compared to land cargo and the lack of domestic consumption and the shipping mostly in the establishment of Merowe Dam equipment dam was in 1998, about 46 tons only .

4.6Forecasting Methods

There are several forecasting methods or techniques available to airport planners ranging from subjective judgment to sophisticated mathematical modeling. The selection of the particular methodology is a function of the use of the forecast, the availability of a database, the complexity and sophistication of the techniques, the resources available, the time frame in which the forecast is required and is to be used, and the degree of precision desirable. There are four major methods:

- Time series method
- Market share method
- Econometric modeling
- Growth rate method

4.6.1 Time series method

Time series analysis or extrapolation is based upon an examination of the historical pattern of activity and assumes that those factors which determine the variation of traffic in the past will continue to exhibit similar relationships in the future. This technique utilizes times series type data and seeks to analyze the growth and growth rates associated with a particular aviation activity. In practice, trends appear to develop in situations in which the growth rate of a variable is stable in either absolute or percentage terms, there is a gradual increase or decrease in growth rate, or there is a clear indication of market saturation trend over time. Statistical techniques are used to assist in defining the reliability and the expected range in the extrapolated trend. The analysis of the pattern of demand generally requires that upper and lower bounds be placed upon the forecast and statistics are used to define the confidence levels within which specific projections may be expected to be valid. From the variation in the trends and the upper and lower bounds placed on the forecast a preferred forecast is usually developed. Quite often smoothing techniques are incorporated into the forecast to eliminate short run, or

seasonal, fluctuations in a pattern of activity which otherwise demonstrates a trend or cyclical pattern in the long run.

4.6.2 Market Share Analysis

This method uses market analysis and industry surveys to conduct empirical analysis of the air transport market and examine how air transport traffic varies between the different sectors of the market sectors, the public, and the airline industry.

This technique may be used in two distinctly different markets: in the developing world and in large metropolitan areas in the United States. For the former the majority of consumers of air transport services belong to a limited number of well-defined sectors of society. The latter refers to well-developed, complex, and mature markets. Domestic air travel forecasts in major U.S. metropolitan areas have been generated using this method. Based on the national travel market surveys conducted in major U.S. cities by market research companies, data are compiled on the air travel propensities of various socioeconomic groups.

The population data (on national, regional, or local levels) are divided into a number of data cells that characterize a specific socioeconomic profile of the population by occupation, income, and education, among other factors. Each cell is identified by a specified trip rate per head of population associated with the particular profile. Relationships are then established, through sophisticated statistical and mathematical techniques, between trip rates for each cell and trends associated with trip frequencies of all the travelers. Forecasts of air travel are then derived by applying these "cell rates" to the corresponding forecast population from demographic databases (e.g., census).

This approach is used typically to analyze the business air travel markets and air travel of population throughout wide metropolitan areas and for forecast of airfreight based on type of trade, commodity and its value per unit weight, and shipping mode. In this technique, rates per group calculated in a given year may be used in future years directly or after adjusting the rate for changes with time of the behavioral aspects and trends of air travel

4.6.3 Econometric Models

Econometric demand forecasting incorporates various causal economic, social, and operational variables in determining, based on historical data, a quantitative relationship between air travel and the variables influencing the level of traffic.

These models have been widely used over the years to predict urban passenger demand. When applied to air transport, an econometric model is established (and statistically tested to validate the model) between rate of passenger air trips and a number of predictive causal variables.

The evaluation uses a variety of multivariate statistical techniques such as correlation analysis, factor analysis, and linear and nonlinear regression analysis to define suitable predictive variables selected as the independent variables of the model.

Future demand levels are developed based on the assumption that the relationship developed through econometric analysis is applicable in the future and valid in the future as it was in the past. However, it is possible to adjust the econometric models if the causal variables change in the intervening years after the models are developed.

The causal variables of econometric models are monitored, any changes observed could be verified, and necessary adjustments are made on the model parameters. This would ensure the continuing adequacy and verification of continuing applicability of the econometric model an econometric forecast of air travel typically involves several steps that include:

- Selecting the relevant and appropriate causal factors to be taken into account in the model
- Collecting data and verifying its accuracy
- Specifying the postulation of the functional relationship existing between air traffic demand and the relevant causal variables
- Conducting statistical analysis and testing of the proposed model and if statistical tests are successful
- Observing the future development of the variables to ensure future applicability before applying the model to forecast future air traffic

Econometric models are constructed to describe the relationship, which uses regression analysis techniques extensively. The typical multiple-linear regression model has the form

$$T = a_0 + a_1 x_1 + a_2 x_2 + \cdots + a_n x_n \qquad \text{(3-1)}$$

Where:

T = number of air trips.
$x_1, \ldots, x_n$= independent predictive variables.
$a_1, \ldots, a_n$= regression coefficients

4.6.4 Annual Growth:

Annual growth % is pointed to year-on-year percentage growth (annual growth %). It uses the prior year as a base for expressing percentage change from one year to the next. Over longer periods of time, compound annual growth rate (CAGR) is a generally accepted metric for average growth rates."

Procedure of method:

Step 1: Calculate the percent change from one period to another using the following formula:

Percent Change = 100 × (Present or Future Value – Past or Present Value) / Past or Present Value

Step 2: Calculate the percent growth rate using the following formula:

Percent Growth Rate = Percent Change / Number of Years

4.7 KNIA Forecast:

The forecast is significant factor that should be available in any project needs to know the total cost and the design life or timeline. If forecasting was built on good basis and efficient methods of calculating, the results in the future according to what estimated.
This chapter shows calculation for forecasting by using time serious method Based on previous information for international and domestic movement for aircraft. Moreover, figures below describe the forecasting from figures (4.5) to (4.10) .
By Annual growth

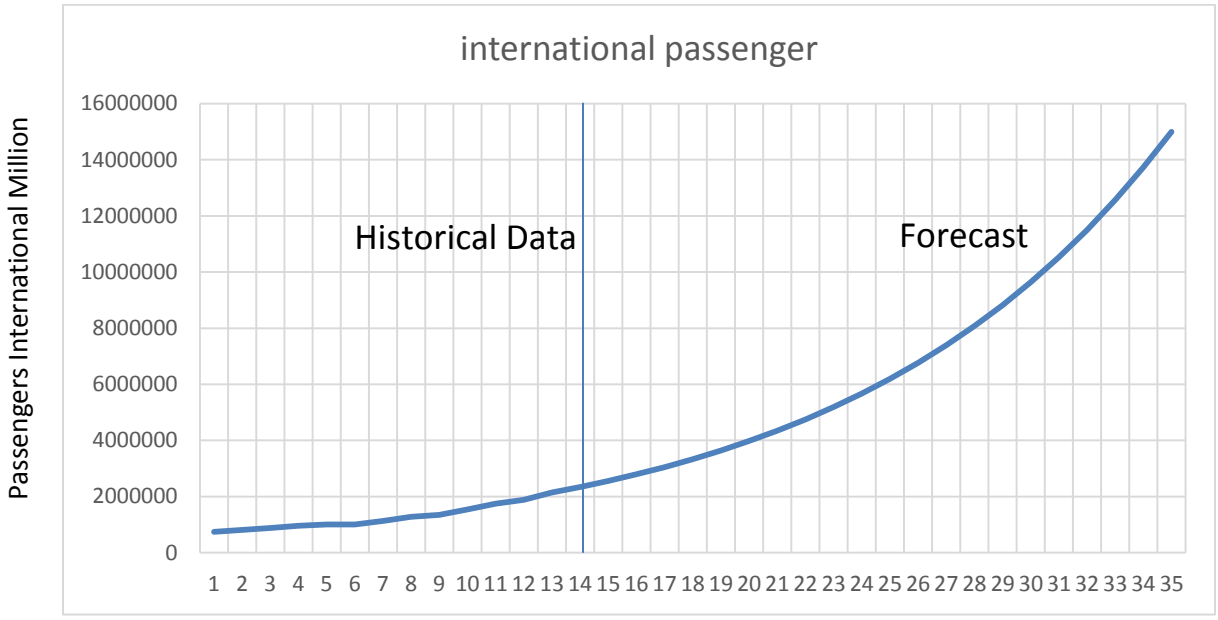

Figure 4.5: forecasting for international passenger

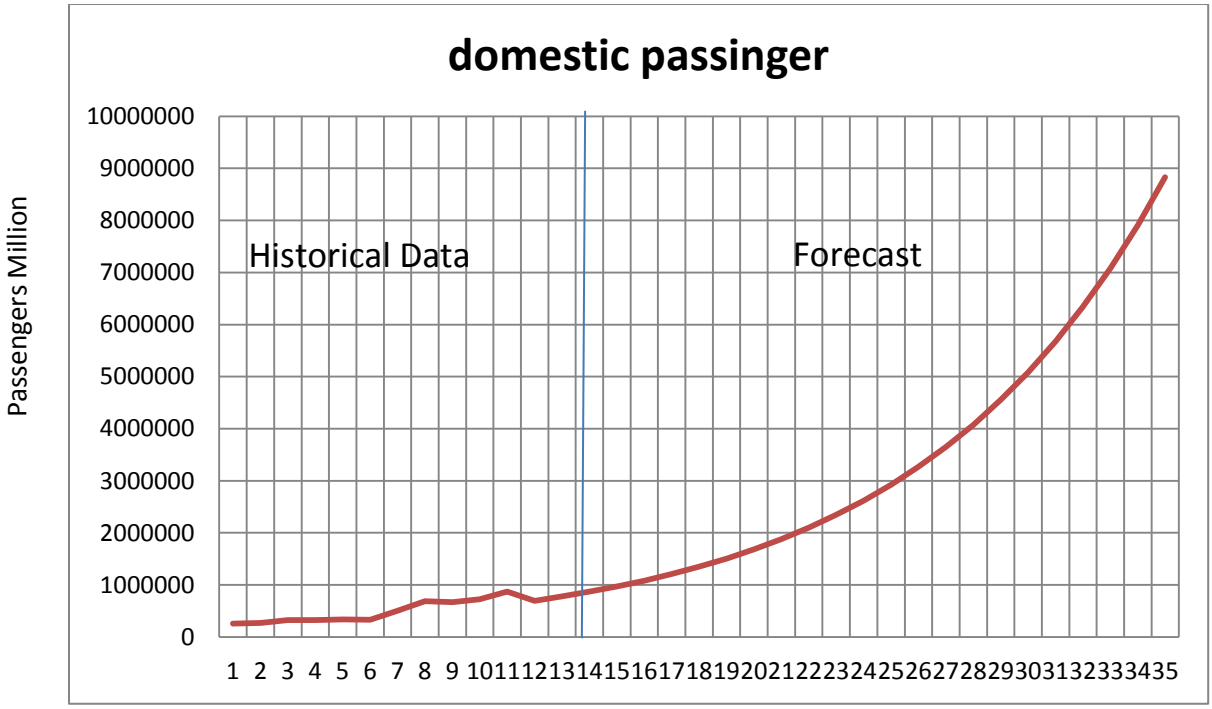

Figure 4.6: forecasting for domestic passenger movement

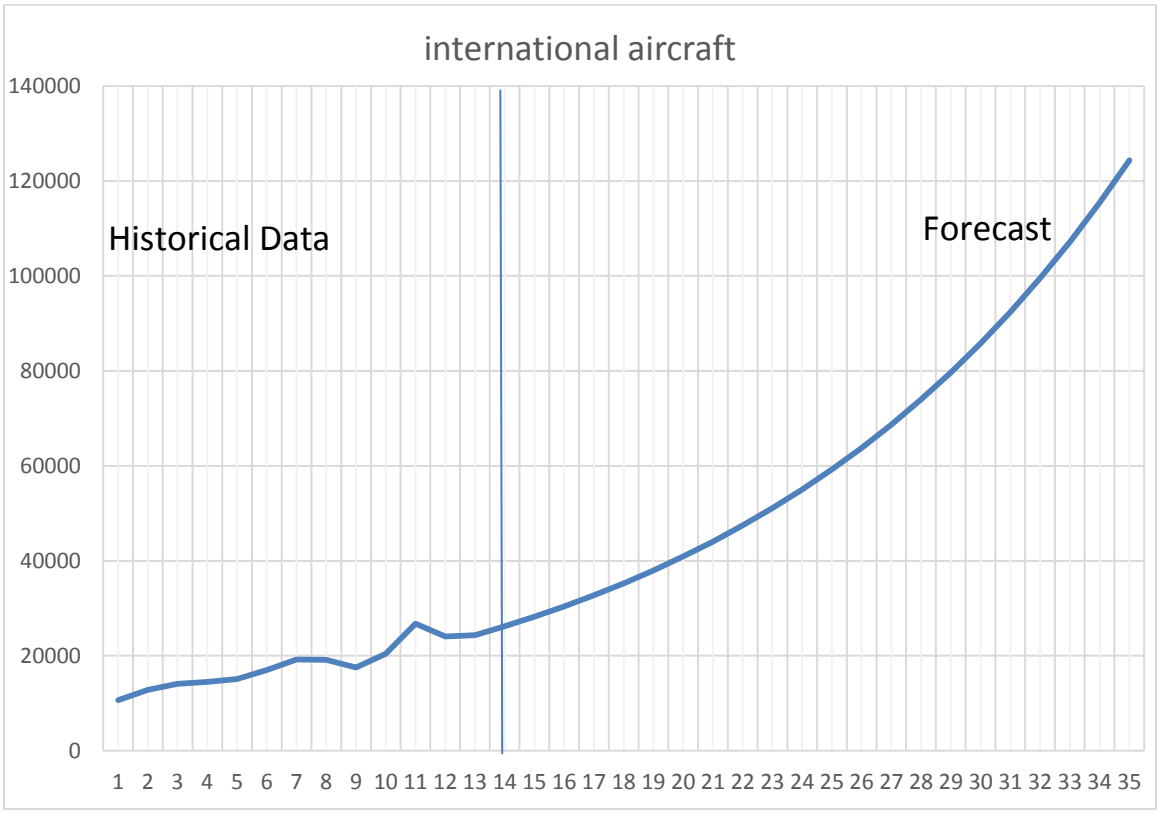

Figure 4.7: forecasting for international aircraft movement

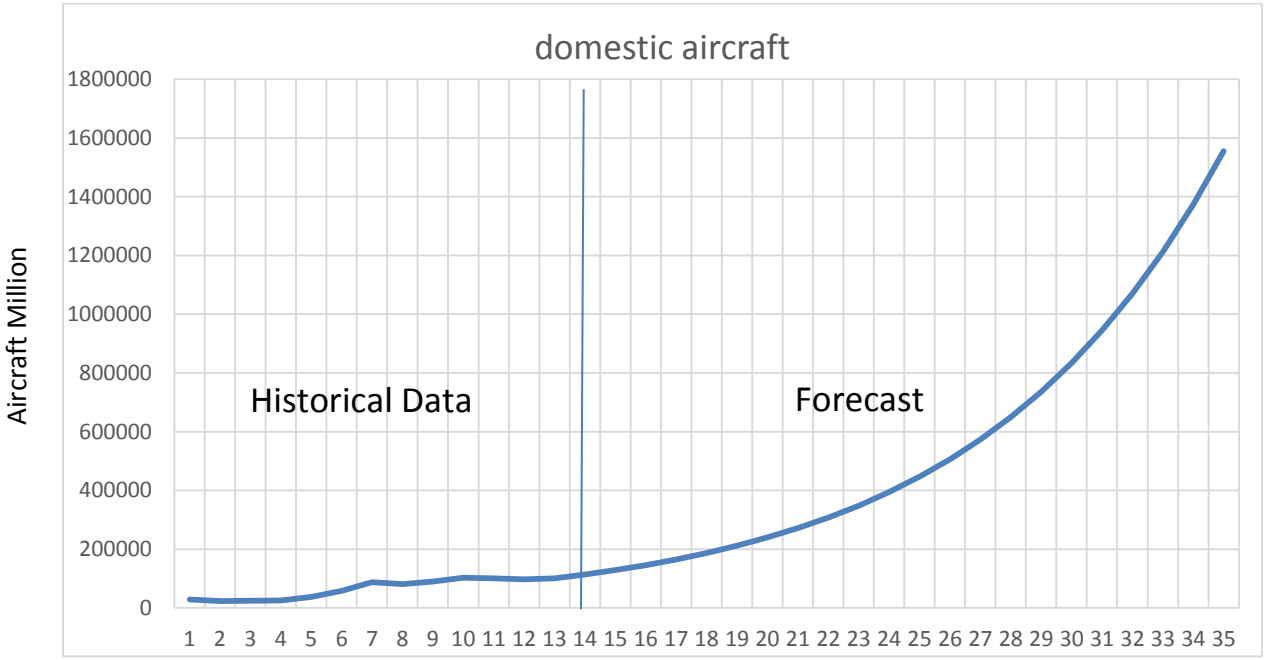

Figure 4.8: forecasting for domestic aircraft

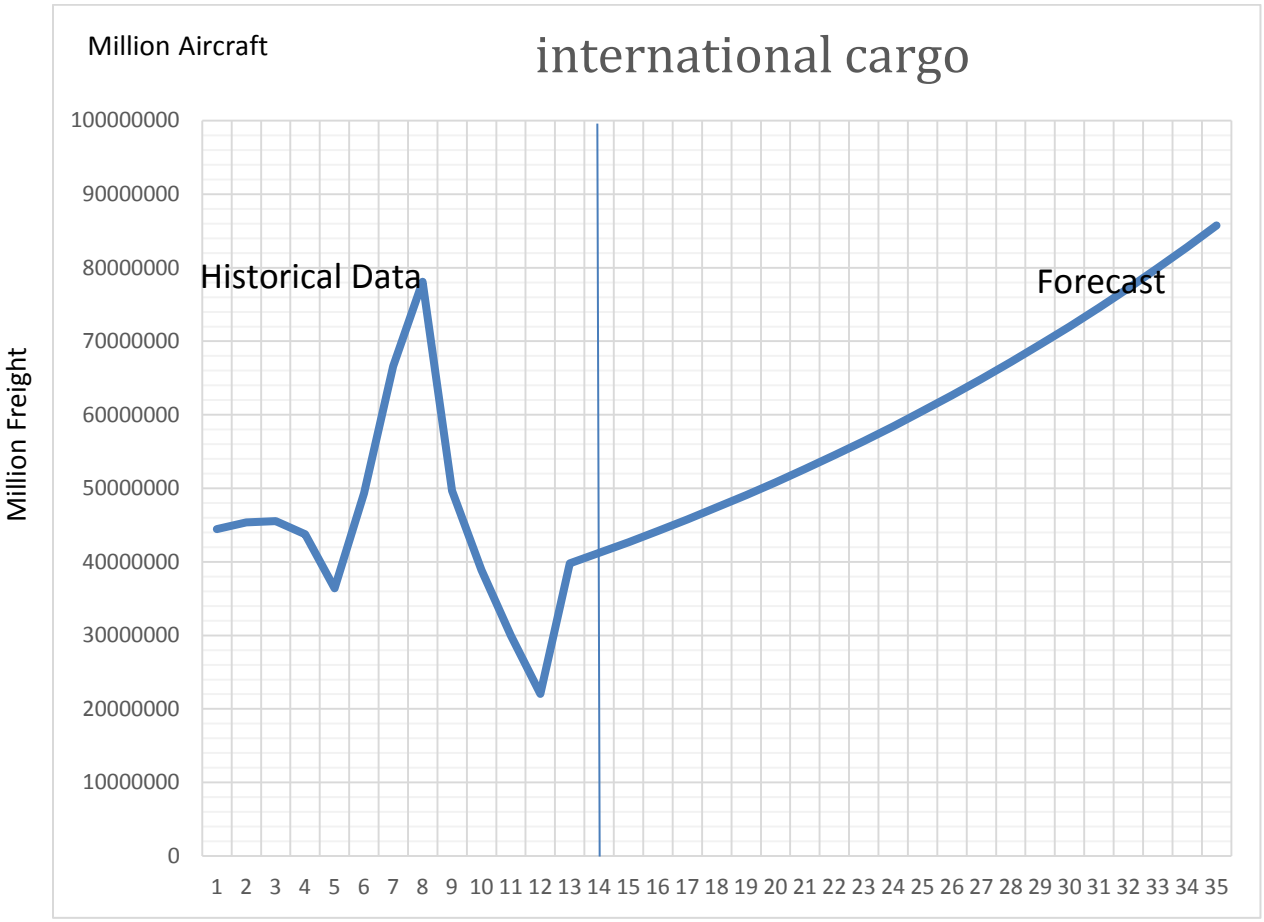

Figure 4.9: forecasting for international freight movement

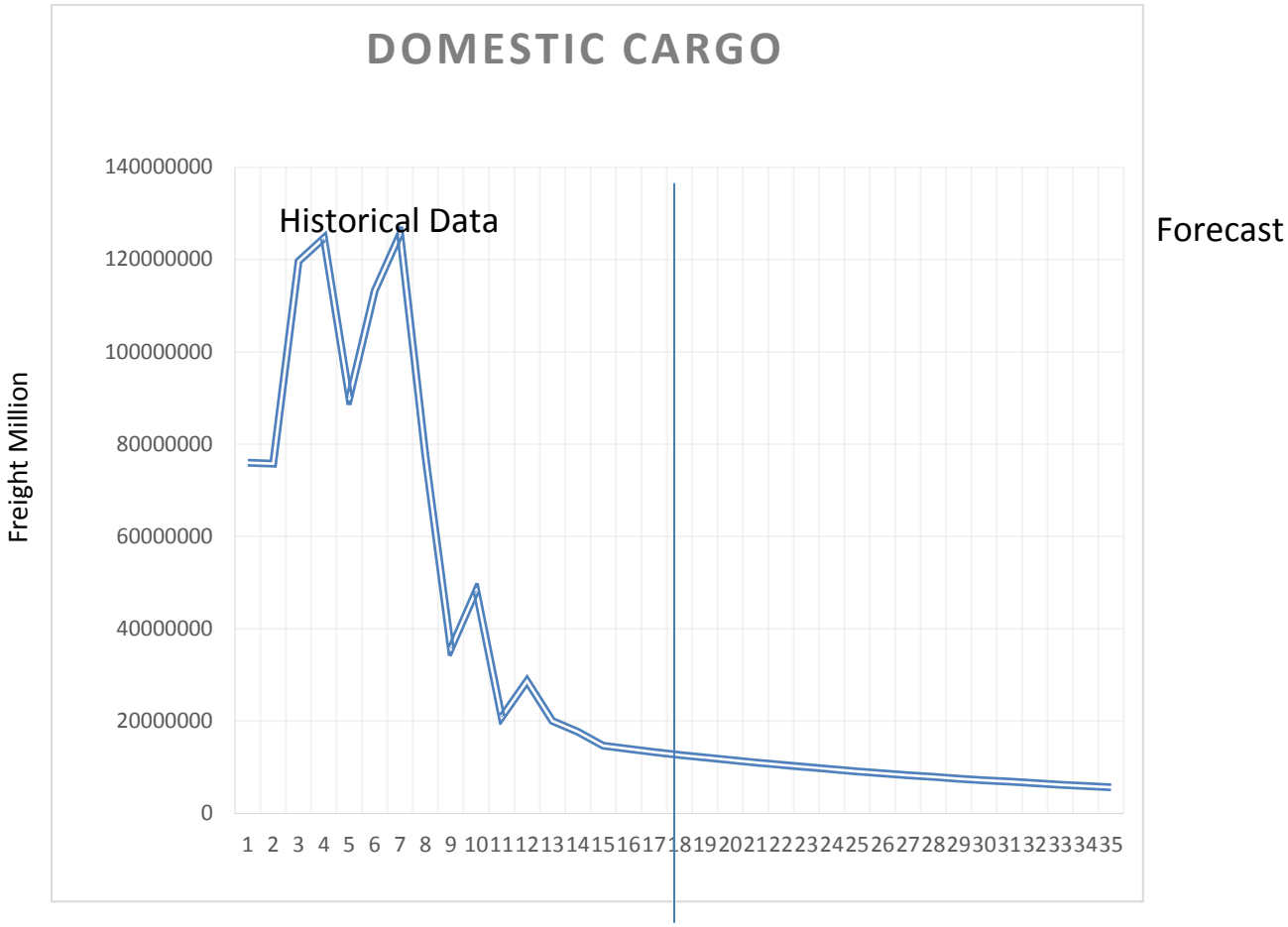

Figure 4.10: forecasting for domestic freight movement

The above charts show the expected air traffic for 20 years by using time series method the following table shows the 2034 movement.

Table 4.5: KNIA 2034 forecast data

Year = 2034	Aircraft movement	Passenger movement	Cargo movement
Domestic	1555327	8832383	5703955
international	124328	14997012	85738514
total	1679655	23829395	91442469

4.7.1 Traffic forecast analysis:

The forecasting results shows annual increase for the aircraft movement that shear of year 2034 alone to reach 1555327 for domestic movements and 124328 for international movements, Freight Movement increase to reach 5703955 (KG) for domestic movements and 85738514 (KG) for international movements and Passengers Movement increase to reach 8832383, 14997012 for international and domestic respectively. To reach the movement of aircraft to the limit we need the

proportion of annual increase for the movement of internal and external proportion of the increase expected it to serve that proportion is 13.3% for the domestic Movement and 7.7% for the international movement in 2014.

4.8 Merowi Forecast:

By time series:

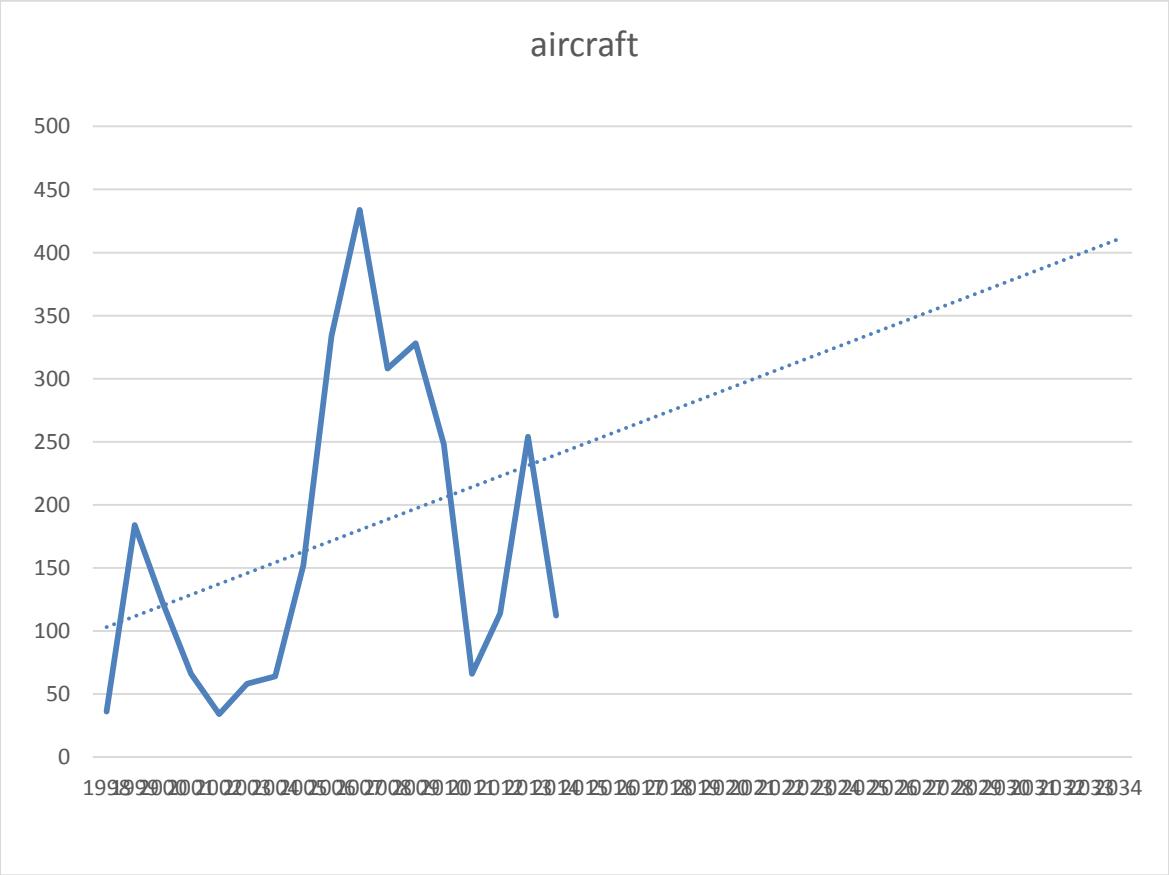

Figure 4.11: forecasting for aircraft movement

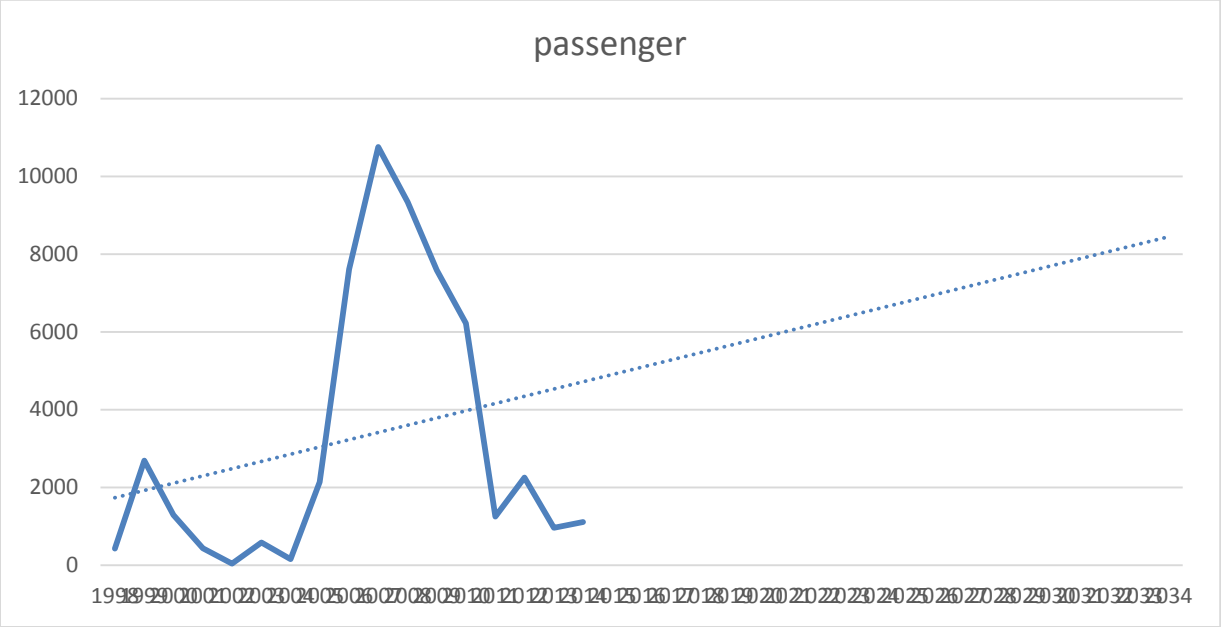

Figure 4.12: forecasting for passenger movement

Table 4.6: Merowi 2034 forecast data

Year =2034	Aircraft	Passenger
domestic	412	8755

Forecasting analysis:

The forecasting results shows annual increase for the aircraft movement that shear of year 2034 alone to reach 412 for domestic movements , and Passengers Movement increase to reach 8577 for domestic respectively. To reach the movement of aircraft to the limit we need the proportion of annual increase for the movement of internal and external proportion of the increase expected it to serve that proportion is 6.5% for the domestic Movement in 2014