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Analytical Quantitative Study for Forecasting Methods of the Numbers of Students in Palestinian Schools

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Abstract: The forecasting process of the total number of students in Palestine contributes in studying the future educational needs by government and policy makers. The more accurate the forecasting, the more it contributes in saving time, effort, and money when providing educational services. It also contributes in providing other valuable information such as buildings, human and financial resources, and educational plans required. Since these services rely heavily on the accuracy of the forecasting, choosing an inappropriate method will result in unrealistic predictions that may lead to an increase or decrease in budgeted costs, and ultimately to a failed planning process. In this paper, six mathematical forecasting methods were discussed, and then utilized to forecast the number of students for a specific number of years. In order to compare and evaluate the performance and accuracy of the methods, the Mean Absolute Deviation (MAD), Mean Absolute Percent Error (MAPE), and Root Mean Square Error (RSME) common measurements were used to find the most accurate and suitable method to the Palestinian reality. The study find that the exponential method is the most accurate and suitable to the Palestinian reality, and it recommends that not to use the same method to forecast the student numbers for periods longer than a decade.

Keywords: Forecasting population, Total student numbers, Forecasting accuracy

Introduction

The State of Palestine is a small country with limited resources and it relies on donors from different countries and some international organizations. Therefore, in order to develop its economic, educational and health plans, while efficiently using the financial and human resources, the forecasting of populations is very important because these numbers will contribute to the perception of the nature of the community at a certain time in the past or the future, helping to anticipate the characteristics of the economy, socially and educationally, and in developing and improving economic, social and educational plans and programs in all fields.

Population forecasting is an important source for educational, economic and social plans and programs for all sectors. It is used to estimate the future needs of the population from educational opportunities for all stages and the size of the labor force that will enter the labor market in the future. (Qassim, 2013) believes that the lack of a clear vision of the future number of students will lead to either a shortage or a waste of financial and human resources, and to hindered future educational plans. Educational planning is the mainstay of the educational administration. One of the biggest difficulties facing educational planning is its lack of accuracy in identifying future needs.

Planners can follow up the numbers of students in the future from the elementary level to all levels of education, both in public and private education, and then can predict the number of students who will join universities in the future. Therefore, if the plans are prepared based on data and figures close to reality there will be a better investment of financial resources, and the proportion of financial and human waste will decrease. (Sawah, 2013) indicated that one of the main reasons for the severe shortage of faculty members in some universities is the lack of well thought out plans, lack of follow-up of students in different educational stages, and the unpredictability of the number of graduate students year after year.

Educational planning in Palestine is facing many problems like any other country. The most important of which is the lack of accurate data and statistics related to population information, which are considered the starting point in any economic, social or educational planning. Educational planners can only plan properly if they have a clear vision of the population of their countries, especially the number of students expected to attend school in the coming years. Therefore, it is urgent to find an effective method to forecast the number of students in the future. One of the best ways to forecast population numbers according to (Nichaphat & Klot, 2013) is the mathematical methods.

There are different mathematical methods that are used to forecast the numbers of the population, each with different assumptions and factors and each giving a different forecasting result. In this study, six common mathematical methods were discussed to forecast the total number of students in Palestine for the years 2010-2016 based on historical data from 1994 to 2009, and then its performance was compared and evaluated by studying the accuracy of its forecasting in order to find out the closest of these methods to the Palestinian reality.

The Study Problem

Due to the importance of educational planning in Palestine, which is facing the problem of lacking accurate population statistics and data, and the fact that educational planners cannot properly plan unless they have a clear perception of the numbers of students in their country, there is an urgent need to predict the numbers of students in the future, which is considered the starting point for any economic, social or educational planning. The current forecasting method that is used in Palestine is the students flow "UNESCO method", which is a complicated method because it requires a lot of time, effort and information that must be dealt with in order to forecast the number of students in the future. Therefore, there is an urgent need to forecast the numbers of students so that the planning authorities can make their future plans using more clear information, which may reduce wasted time, money and efforts. This study discussed several mathematical methods that enable forecasting future numbers of students. In view of the number of students predicted, it is possible to know the needs that the educational institutions must provide in order to ensure a sound and appropriate educational environment for students, with the aim of focusing on raising their level of achievement.

The aim

The aim of this study was to discuss several mathematical forecasting methods in order to find the most capable method to predict the student numbers for the years 2010-2016 that will enroll in Palestinian schools in different stages using historical data from the period 1994-2009.

The Importance of the Study

It is hoped that the educational planners will benefit from its results so that they can plan for the future with more precise information about future students numbers for years to come. It is assumed that one of the discussed methods will help to forecast the students numbers in Palestine to be more accurate and clear, through the analysis of a set of methods used globally.

Study Terms

Mathematical method

Mathematical Approach is defined in (Ibrahim, 2011) as the use of the mathematics language to describe the manifestations of a system to identify and predict what will happen in the future.

Forecasting

In (Bogazi, Boglita and Salam, 2015), prediction was defined as planning and making assumptions about future events, using special techniques over different time periods, and that the process upon which managers and

decision-makers depend on developing assumptions about future situations. The researcher defines a procedural prediction as the expected numerical value of something in the future that can be calculated based on a mathematical method.

The Research Questions

1. What is the reality of the mathematical forecasting methods that are used in this research to forecast the number of students in Palestinian schools?
2. What is the accuracy of the forecasting methods that are used in this research to forecast the number of students in Palestinian schools?
3. Which is the most accurate and suitable method to the Palestinian reality among all the mathematical forecasting methods that were discussed in this research, and why?

Methodology

This study used the research developmental approach in terms of: identifying the problem, collecting the necessary data, selecting the mathematical methods to be discussed, forecasting the student numbers using all the selected methods by applying them to previous data, comparing the methods and examining their accuracy using three parameter errors, and determining the most appropriate method for Palestinian reality.

The idea of the forecasting methods is based on the processing of population known data in order to calculate the continuation of their trend. These methods according to (Chapin & Diaz-Venegas, 2007) require a series of historical data for a decade or more so that a particular pattern or trend can be drawn. In this study, each of these methods, which were obtained by reference to educational literature, will be used. Historical data on the number of students in Palestine for the years 1994-2016 drawn from tables of the Palestinian Central Bureau of Statistics will be used to forecast for all methods that will be discussed in this research. See Table (1)

Table 1. Represents the historical data for the total number of students in Palestine for the years 1994-2016

year	Number of students
1995/1994	617,868
1996/1995	662,627
1997/1996	712,820
1998/1997	763,467
1999/1998	812,722
2000/1999	865,540
2001/2000	907,128
2002/2001	947,299
2003/2002	984,108
2004/2003	1,017,443
2005/2004	1,043,935
2006/2005	1,067,489
2007/2006	1,085,274
2008/2007	1,097,957
2009/2008	1,109,126
2010/2009	1,113,802
2011/2010	1,116,991
2012/2011	1,129,538
2013/2012	1,136,739
2014/2013	1,151,702
2015/2014	1,171,596
2016/2015	1,192,808

(Palestinian central bureau of statistics, 2016)

The Most Common Mathematical Forecasting Population Methods

Numerous methods are used to forecast population, but the most commonly used mathematical methods are:

1. **Arithmetical Increase Method**

This method is one of the simplest methods to be discussed and used to forecast the population numbers when no statistical life data such as birth and mortality are available. The annual variation in population growth is assumed to be one decade to another between two censuses according to a numerical sequence as follows:

Δ= (P0 –Pb) / (y)

This method requires obtaining historical data for the population at least for one period of time between two censuses. The future population is calculated using the following formula:

Pt = P0 + [(z)(Δ)]

Where:
    Δ: the Annual natural increase (average annual absolute change of population between launch year and base year)
    P0: Population in the launch year
    Pb: Population in the base year
    Y: Number of years for base period (number of years between the base year and the launch year)
    Pt: Population for the year to be forecasted
    Z: The difference in the number of years (number of years between the target year and the launch year) (George, Smith, Swanson & Tayman, 2004)

In order to forecast the number of students in Palestine for the years (2010-2016) in the Arithmetical Increase Method, we first calculate the absolute average change Δ for the period (1994-2009)
    Δ= (P0–Pb) / (y)
    Δ = (P2009- P1994)/ (2009-1994)
    Δ = (1109126-617868)/ (15) = 32750.533

The forecasted number of students for 2010 is:
    Pt = P0 + [(z) (Δ)]
    P 2010 = P 2009 + 1* 32750.533=1109126+32750.533=1141877

the forecasts for the number of students in Palestine for the years 2016-2010 in the Arithmetical Increase Method**:** are presented in Table (4)

2- Geometric Change Method

This method assumes that the population will increase (or decrease) by the same annual percentage rate during projections as in the base year. The estimated growth rates to be used should be multiplied in separate time periods. In order to calculate the annual growth rate (r) by this technique the following formula will be used:

$$r = \sqrt[z]{\frac{Pi}{Pb}}$$ -1

According to this value, the forecasting of the population using the Geometric Change Method is calculated by this formula:

$$Pt = P0 * (1 + r)^z$$

Where:
    r = annual geometric growth rate between launch year and base year.
    P0 = population in launch year
    Pb= population in base year
    Pt = expected population depending on launch year
    Z = the number of years between the launch year and the target year

(Adelamar,2002,Georgeetal2004).

In order to forecast the number of students in Palestine for the years (2010-2016) in the Geometric Change Method, we first calculate the annual growth rate "r" for the period (1994-2009) as the base year is 1994 and the launch year is 2009:

Pb= P1994 =617868

P0=P2009= 1109126

z =2009-1994=15

$$r=\sqrt[z]{\frac{P0}{Pb}} -1= [(1109126/ 617868) (1/15)] -1= 1.03977414 -1 =.03977414$$

Based on this value, the number of students forecasted for 2010 using the Geometric Change Method is calculated from the relationship:

$$Pt = P0 * (1+ r)^z$$

P2010=1109126*(1+.03977414)^1=1153241

The forecasts for the number of students in Palestine for the years 2010-2016 using the Geometric Change Method are shown in Table (4)

3- Incremental Increase Method

This method combines Arithmetical Increase Method and the Geometric Change Method to obtain a better population forecasting results. The first step is the same as in the arithmetic increase method where the annual rate of increase is calculated, while the next step is to find an increase in the increase for each year, and then we find the increase in the increase in the population per decade. From these values we find the average increase in the increases (called the gradual increase).

The population is forecasted by the following equation:

$$Pt=Pb + nr + \frac{n(n+1))}{2} *I$$

Where:

Pt = expected population depending on launch year

Pb=population of launch year

n = number of years in decades

r = annual rate of increase

I = rate of incremental increase (Gawatre , Kandgule &, Kharat , 2016)

In order to forecast the number of students in Palestine for the years 2010-2016, we first calculate the annual growth rate for the period 1994-2009 and the rate of incremental increment I, considering that the base year is 1994 and the launch year is 2009, and the values as in Table (2) below:

Table 2. To calculate the rate of annual and gradual increase

number of students	r	I
617868	--	--
662627	44759	--
712820	50193	5434
763467	50647	454
812722	49255	-1392
865540	52818	3563
907128	41588	-11230
947299	40171	-1417
984108	36809	-3362
1017443	33335	-3474
1043935	26492	-6843
1067489	23554	-2938
1085274	17785	-5769
1097957	12683	-5102
1109126	11169	-1514

sum	491258	-33590
Average	=491258/14	=-33590/13
	r =35089.86	I =-2583.85

Based on this value, the number of students forecasted for 2010 using the incremental increase method is calculated from the equation below:

$$Pt = Pb + nr + \frac{n(n+1))}{2} * I$$

P2010=1109126 +.1*35089.86 - .055*2583.85=1112493

The forecast for the number of students in Palestine for the years 2010-2016 using the incremental increase method are shown in Table (4)

4- Exponential Change method

The exponential method is one of the most accurate methods of estimating the size of the population when life statistics are not available. It assumes that the population growth is continuous. This method is realistic because of the nature of the population growth in which the change occurs every day of the year. (Matar,, 2012). The exponential model (accelerated change) is closely related to the geometrical method, but considers that change occurs continuously rather than sporadically. The rate of exponential population change during the base period can be calculated as follows:

$r = [ln (P0 / Pb)] / (y)$

Depending on this value, the number of students using the exponential method is calculated from the next equation:

$$Pt = (P0) e^{rz}$$

The equation can be modified to make it easier to apply as follows:

Ln Pt =*Ln* P0 + rz

Where:
 r = the rate of change for the annual exponential growth.
 P0 = population for the base year
 Pb = population for launch year
 y = number of years for base period (years between base year b and launch year 0)
 Pt = forecasted population depending on the launch year
 Z = the number of years between the launch year and the future year
 e = 2.71828 the base of the natural logarithm
 ln = the natural logarithm (George, Smith, Swanson & Tayman, 2004)

In order to forecast the number of students in Palestine for the years 2010-2016, we first calculate the annual exponential growth rate for the period 1994-2009 as the base year is 1994 and the year of launch 2009:
 r = [ln (Pb/ P0)] / (y)
 Pb=P2009= 1109126,   P0= P1994 =617868
 r = [ln (1109126 / 617868)] / (15) =0.016939

According to this value, the number of students forecasted for 2010 in the exponential change method is calculated from the below equation:

$$Pt = (Pb) e^{rz}$$

$$P2010 = (P2009) e^{0.016939 *1}$$

$$P2010 = (1109126) e^{0.016939 *1} = 1128074$$

The forecasts for the number of students in Palestine for the years 2010-2016 using the exponential method are presented in Table (4)

5- Least Squares Method

Linear models are the simplest methods of complex induction, and assume that the population will change in the same numerical amount in the future as in the past. This assumption is identical to the method of numerical sequence (linear variation) discussed previously, but the method of calculating the population of this method is completely different and is calculated from the equation:

Yi = a + [(b)(Xi)]

$$a = \bar{Y} - b * \bar{X} \qquad b = \frac{\sum X_i Y_i - \sum X \sum Y / n}{\sum X_i^2 - \left(\sum X_i\right)^2 / n}$$

Where:

Yi: i is the set of views for the "dependent variable" values

Xi: is an i set of notes for the Independent Variant values

a: is a constant number

b: is the slope of the straight line "for the best linear relationship between the values of X and Y"

This method is called a least squares method, and in order to use this method to predict population numbers, it is better to let X be the time and Y the population predicted.

(Miller, & Miller, 2004)

To calculate the constants a, b, historical data was used for fifteen years and some calculations were shown in Table (3)

Table (3) represents information on the number of students for the previous fifteen years

x	#x	y	x y	x^2
1995	0	617868	0	0
1996	1	662627	662627	1
1997	2	712820	1425640	4
1998	3	763467	2290401	9
1999	4	812722	3250888	16
2000	5	865540	4327700	25
2001	6	907128	5442768	36
2002	7	947299	6631093	49
2003	8	984108	7872864	64
2004	9	1017443	9156987	81
2005	10	1043935	10439350	100
2006	11	1067489	11742379	121
2007	12	1085274	13023288	144
2008	13	1097957	14273441	169
2009	14	1109126	15527764	196
$\sum$	105	13694803	106067190	1015
	$\dot{X}=7$	$\bar{Y}= 912986.9$		

$$b = \frac{\sum X_i Y_i - \sum X \sum Y / n}{\sum X_i^2 - \left(\sum X_i\right)^2 / n} \qquad a = \bar{Y} - b * \bar{X}$$

$$b = \frac{106067190 - (105 * 13694803) / 15}{1015 - (105 * 105) / 15} = 36441.32$$

$\bar{X} = \sum x/15 = 105/15 = 7 \quad \bar{Y} = \sum y /15 = 13694803/15 = 912986.9$

a =912986.9 -36441.32* 7 = 657897.7

According to these values, the forecasted number of students for 2010 using the least square method is computed using the next equation:

Yi= a+ b Xi =657897.7+ 36441.32 Xi

Y2010   =   657897.7+   36441.32   *16   =1240959

The forecasts for the number of students in Palestine for the years 2010-2016 using Least Squares Method are shown in table (4)

6- Decreased Rate of Growth Method "Logistics Method"

This method assumes that population growth is coupling for time, followed by logical mathematical relations with population leaning according to a logistic curve, starting with a decrease followed by a rise and a decrease until the saturation limit (Gawatre, Kandgule & Kharat, 2016)

This method is called a logistics method. This method assumes that the population of the state will increase to a certain point (called saturation point) and then the population reaches the so-called population. This happens because the resources available anywhere are not permanent or continuous and will decrease by time; this curve takes the form of S (Friendly Neighborhood Engineers, 2014).

The logistics method can be represented by the formula:

$$Pt = \frac{Psat}{1 + e^{a + b\Delta t}}$$

were

$$|Psat| = \frac{2PoP1P2 - P1^2(Po + P2)}{POP2 - P1^2}$$

$$a = Ln\frac{Psat - P2}{P2}$$

$$b = \frac{1}{n} Ln\frac{Po(Psat - P1)}{P1(Psat - Po)}$$

Where:

Psat= Saturated Population

Po=Initial Population

P1 = Population at the midpoint of historical data

P2= population at the end of the historical time period

Pt= Population after time 't'

Δt= Difference in time between year of prediction and base year

a, b= constants (Gawatre, Kandgule & Kharat, 2016)

To predict the numbers of students in Palestine for the years 2010-2016, we first calculate the values of Psat a, b, by reference to the values in Table (1)

Po= 617868, P1=947299 , P2=1109126

$$|Psat| = \frac{2PoP1P2 - P1^2(Po + P2)}{POP2 - P1^2}$$

$$|Psat| = \frac{2 * 617868 * 947299 * 1109126 - 947299^2(617868 + 1109126)}{617868 * 1109126 - 947299^2}$$

$$Psat = 1185420.635$$

$$a = Ln\frac{Psat - P2}{P2} = Ln\frac{1185420.635 - 1109126}{1109126} = -2.676724978$$

$$b = \frac{1}{n} Ln\frac{Po(Psat - P1)}{P1(Psat - Po)} = \frac{1}{15} Ln\frac{617868(1185420.635 - 947299)}{947299(1185420.635 - 617868)} = -0.102518768$$

Based on these values, the forecasted number of students for 2010 using the logistic method is calculated from the equation:

$$Pt = \frac{Psat}{1 + e^{a + b\Delta t}} = \frac{1185420.635}{1 + e^{-2.676724978 + -0.102518768\Delta t}}$$

P2010 $$= \frac{1185420.635}{1 + e^{-2.676724978 + -0.102518768 * 16}} = 1169816$$

the forecasts for the number of students in Palestine for the years 2010-2016 using the logistics method are presented in Table (4).

Table 4. The forecasting values for all the discussed methods

year	real numbers	logistic curve method	least squares method	incremental increase	exponential	Geometric increase	Arithmetical Increase Method
2010/2009	1,113,802	1,169,816	1,240,959	1,112,493	1,128,074	1,153,241	1,141,877
2011/2010	1,116,991	1,171,318	1,277,400	1,115,834	1,147,345	1,199,110	1,174,627
2012/2011	1,129,538	1,172,678	1,313,841	1,119,149	1,166,945	1,246,803	1,207,378
2013/2012	1,136,739	1,173,907	1,350,283	1,122,438	1,186,880	1,296,394	1,240,128
2014/2013	1,151,702	1,175,019	1,386,724	1,125,702	1,207,156	1,347,957	1,272,879
2015/2014	1,171,596	1,176,025	1,423,165	1,128,940	1,227,778	1,401,571	1,305,629
2016/2015	1,192,808	1,176,934	1,459,607	1,132,152	1,248,753	1,457,317	1,338,380

Accuracy of the Methods

In order to decide on the most accuracy and appropriateness forecast curves of existing historical data, according to (George, Smith, Swanson & Tayman, 2004) one of the following methods is often follows:

1. Direct observation of the curve data and comparing it with the observed data.
2. Statically Curve evaluation, quantitative techniques are used to evaluate the fit of curves with actual data (Chapin & Diaz-Venegas, 2007)

The forecasting process is not entirely accurate; it always deviates from actual values. The difference between expectations and actual values is called forecast error. Although the forecast error is unavoidable, the objective of the forecasting is to get as simple as possible size error; large error may indicate that the forecast method used needs to be modified (Chockalingam, 2009).

In order to compare and evaluate the performance and accuracy of the methods, three common measurements were used to find the most accurate and suitable method to the Palestinian reality.

1. Mean Absolute Deviation (MAD) : $\text{MAD} = \frac{\sum_{i=1}^{n} |fi - \hat{fi}|}{n}$

2. Mean Absolute Percent Error (MAPE): $\text{MAPE} = \frac{1}{n} \left(\frac{\sum_{i=1}^{n} |fi - \hat{fi}|}{\hat{fi}} \right)$

3. Root Mean Square Error (RMSE) : $\text{RMSE} = \sqrt{\frac{\sum_{i=1}^{n} (fi - \hat{fi})^2}{n}}$

These transactions are based on differences between real and forecasted data. If the transaction values are small, the performance is valid and the expectation is acceptable, the lower the values for a method, the better the performance is (Chockalingam, 2009; Chapin & Diaz-Venegas, 2007; Trappey &Wu, 2007) The statistical coefficients of the six methods were calculated and the results are shown in Table (5).

Table (5) represents the values of the statistical coefficients used to evaluate the curves

coefficient	logistic curve	least squares	incremental increase	exponential	Geometric increase	Arithmetical Increase
MAD	33467	205543	22353	42822	155602	95389
MAPE	0.030	0.179	.019	0.037	0.135	0.083
RMSE	38073	210839	30450	45356	172755	103302

Study Questions and Results

Question 1: What is the reality of the mathematical forecasting methods that are used in this research to forecast the student numbers in Palestinian schools?

To answer this question, the number of students in Palestine for the years 2016-2009 was calculated using six globally mathematical methods based on historical data for the years 1994-2009. The results obtained in Table (4) and the values in the table are The forecasted number of students in the Palestinian schools for the years 2016-2009 is estimated by the six methods mentioned previously in the study. For example, the number of students predicted by the 2011-2012 method is 1,166,945 students and the logistic method for the same year is 1,172,678. Forecasted numbers were also represented in Table (4) graphically represented using the EXCEL results and are shown in Figure (1)
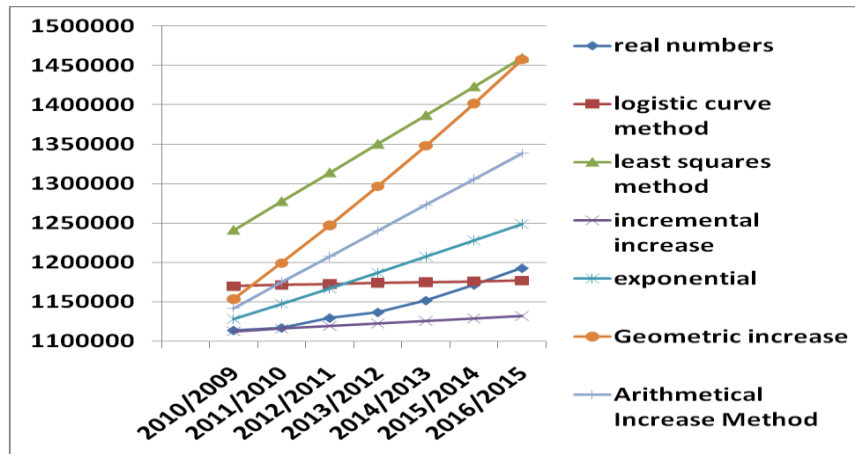

Figure (1) represents a linear curve of values predicted by all methods

The results from Table (4) and Figure (1) show that some methods are not suitable for the Palestinian reality because they give much more estimates of reality and the behavior of its graph is far from the behavior of real data, The rest of the methods provide more realistic estimates, but the method of continuous increase gives less estimates of reality with the increase in time. The logistic method gives less estimates of reality for the first years. The exponential mode predictions resemble the behavior of the real data.

In the light of the results of the first question, which are based on the values listed in Table 4 and figure 1, we can see that the least squares method, the arithmetical increase method and the geometric increase method tend to give estimates very far from reality, and the behavior of the curves are far from real data, which means that population growth does not apply with either of those assumptions, and that they do not fit to forecast the number of students in Palestine. That implies a very big risk of using any of them to forecast the number of students in Palestine. The results also show that the logistic method forecast is far from the Palestinian reality as it shows from the curve, since in the first years it gives a close estimate to reality, but as the years go by, it becomes more inaccurate. The incremental increase method seems to be suitable for forecasting for the first years and then appears to give lower values than reality with increasing forecasting time. Finally, the behavior of the exponential forecasted method is almost similar to the behavior of real data. In fact, the behavior of real data is exponential, and the values of the forecasts are slightly higher than the reality. This means that this method may be useful for forecasting the numbers of students in Palestine.

These results mostly apply to the results of (Abbasov & Mamedova,2003) which found that research conducted over recent years has shown that the application of traditional modeling and analysis methods to forecast population growth based on digital data processing has involved significant risks and errors. One of the main reasons is the fact that a large number of prediction models are not sufficiently effective, given the mismatch between the accuracy of quantitative methods and the considerable complexity of the population growth process.

Results of the Second Question

Question 2: What is the accuracy of the forecasting methods that are used in this research to forecast the number of students in Palestinian schools?

To answer this question, the forecasting error of three statistically international common methods for the forecasting results of the six methods referred to above was calculated by reference to the values in Table 4. The calculated values of the accuracy of the forecasting Methods studied were given in Table (5).

The values in table (5) means that the smaller the value, the better and closer to the Palestinian reality. For example, the percentage of absolute error rate "MAPE" of the exponential method was 0.037, which is acceptable, while the geometric method reached 0.135, which is far from reality. The absolute deviation of MAD for the geometric method was 155602 and for the exponential method reached 42822. Since lower values indicate a better forecasting method, the exponential method is better than the linear method for forecasting the number of students in Palestine. It is clear from the values in the table that the linear and geometric equation and the linear method are not suitable for predicting the numbers of students in Palestine because of the high values of accuracy coefficients of forecasting and that incremental, exponential and logistic increase methods are closer to Palestinian reality. However, these values alone are not enough to make a decision.

In the light of the calculated coefficient errors values, the results of both the linear squares and the geometric increase methods shown in Table (5) appear to be larger than the rest of the methods. The absolute error ratio of the linear equation method is 17.9% according to (Gawatre, Kandgule & Kharat, 2016) it shouldn't exceed ± 10%. Therefore, it is not recommended to use these two methods to forecast the number of students in Palestine because they are not accurate. The lowest values for the forecasted error factors was for the incremental increase method, the absolute error rate of this method didn't exceed 2%, it was within the standard error rate of ± 10%, followed by the logistics method value of 3%. These three methods can be considered relatively accurate and can be used to forecast the numbers of students. However, it is also necessary to study the behavior of the data curve of these methods before deciding which method is more accurate for the Palestinian reality.

Results of the Third Question

Question 3: Which is the most accurate and suitable method to the Palestinian reality among all the mathematical forecasting methods that were discussed in this research, and why?

In order to answer this question, the values in Table (5) were used, which means using the calculated accuracy of forecasting by calculating the error of forecasting of three statistical methods used to calculate the accuracy of the forecasting. But these values alone are not sufficient to decide which methods are more accurate. Therefore, the behavior of the data curve of the forecasting results of these methods will be studied, with the exception of the curve of the arithmetic increase, the geometric and the least squares methods. Because these methods are far from accurate, and do not fit the Palestinian reality. After the exception of some methods curve, now the curve becomes more visible and easier to compare the results that are shown in Figure (2):
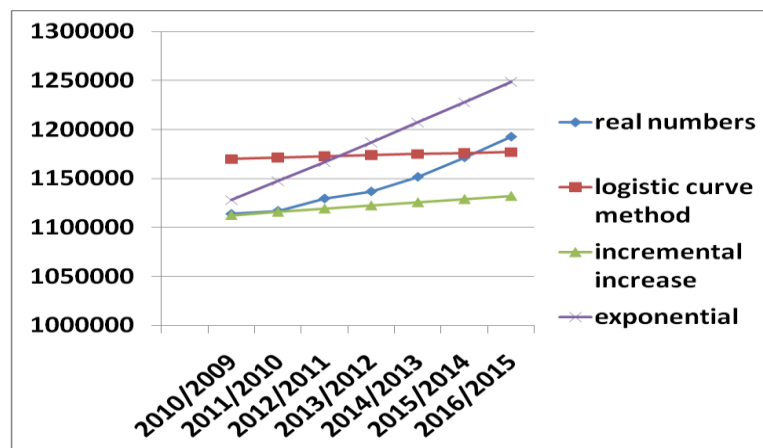

Figure 2. Represents the curve of forecasted values by logistic, exponential and incremental increase methods

From Figure 2, it is clear to us that the closest approach to Palestinian reality is the exponential method, where the behavior of forecasting in this mode seems to be similar to the behavior of the real numbers. The answer to the third question is that the exponential method is the most appropriate method for forecasting the total number of students in Palestine according to the historical data used.

The results showed that forecasting by the exponential mode was more accurate than the rest of the methods, and that the values of the coefficients forecasted errors were low. The absolute error rate was only 4%, which is reasonably acceptable. Figure (2) shows that the exponential method is closer to the Palestinian reality, although it is simple and uncomplicated method, it seems clear that the behavior of the Palestinian historical data is exponential. This is consistent with the findings of (Stanley & Jeff, 2003) which found that the systematic complexity of the approach has no consistent effect on accuracy and bias. All results indicate that the exponential method is the most appropriate method for forecasting the number of students in Palestinian schools.

The prediction values shown in Table 4 and Figure 1 show that it is not good to use one forecasting method for long periods of time over a decade for the possibility of change of the society characteristics and the complexity of its growth factors. The assumption that said earlier trends of a given society will not change in the future as it appears from the historical data series is often incorrect as (Chapin & Diaz-Venegas, 2007) stated in their study. Forecasts derived from mathematical forecasted methods should be used only in parallel with the scenario-building process that helps planning staff to understand local, regional and national trends that can contribute to change in the region's population.

Findings

The study found that the Exponential Method is the most accurate and suitable method to the Palestinian reality.

Recommendations

This study recommends to:
- Conduct similar research over a period of two decades historical data.
- Conduct more studies in order to develop a new method more representative of the Palestinian reality.
- Do not use the same method to predict the numbers of students for periods of time longer than a decade except after a comparative study between several methods for each contract, because it cannot ensure that the growth trends in the community cannot be changed.
- Conduct a similar study to find the most appropriate methods for predicting the number of students per regiment separately, since a method that fits the total number prediction may not be appropriate for group prediction.

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