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FORECASTING THE MANPOWER REQUIREMENT IN VIETNAMESE TERTIARY INSTITUTIONS

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ABSTRACT

In Vietnam, the number of students has risen so fast since reform and opening-up; whereas, the faculties are not enough to be sufficient to that raising. In fact, the Bachelors are outnumbered in many Vietnamese universities. Thus, the problem is how to prepare and to reach the high qualified teaching/learning and faculty to adapt with the rising numbers of students in recent years and next years on. In addition, this research is to do analyses and get prediction values of students and faculties in all Vietnamese universities for the future by taking the statistics provided by the Ministry of Vietnamese Education and Training from 1999 to 2011 and adapting Grey Model to forecast. This study also analyses on the trending of the faculty and students to get valuable results which are accurate by applying the Mean Absolute Percentage Error (MAPE) showing low range errors. After that, this study can provide the Ministry of Vietnamese Education and Training (MOET) a good method and results to plan the education policies and resources allocation in the future.

Keywords: Vietnam education, Numbers of students and faculties, Grey forecasting, Grey model

INTRODUCTION

Education now develops all around the world toward the life-long and international trend. The numbers of students and lecturers in which are the important and irreplaceable elements for any professional education to make this trend become effective and global. With the rapid development of society and economy in Vietnam since reform and opening-up, Vietnamese education has made great progress in which tertiary education also has made remarkable development and great contribution to the popularization and development of the whole society and economy, and the

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national quality improvement.Recently, many researches in the globe have been taken place with a cognitive activity to reveal the essence and law of higher education. As a result, these researches have contributed to the society, economy and education development. For example, Trends in Global Higher Education: Tracking an Academic Revolution - A report prepared for the UNESCO World Conference on Higher Education by Altbach, (2009). Another example is the contribution to the Chinese Education system Grey System Research on Influencing Factor and Forecast of Scale of Chinese Ordinary Higher Education from Li, (2009). Li has analyzed influencing factors and prediction of the future of scale of Chinese ordinary higher education. Nevertheless, tertiary researches are still at the early stage in Vietnam with single and simple research approaches, and so the research results are obviously limited and lack of positive analyses. That is the reason why there are not a lot of provided materials about education in Vietnam; especially in detail research even yearbooks and sources have been searched. In fact, just the rough statistics in the Vietnam Ministry of Education and Training website is available about the numbers of students and lecturers in recent academic years. Therefore, it is time to try the exact research method to extend the research thoughts of higher education.

Among the total numbers of faculties, according to Altbach *et al.* (2009), there are only 9% of Chinese academic professionals holding doctorates, 35% having doctoral qualifications in India. Altbach *et al.* (2009) also stated that up to half of the world's university faculties have only earned Bachelor's degrees. In 2011, Vietnam had 74,573 lecturers totally, just 1,924 PhDs and 30,374 Masters – shown in Figure-1.From the above figure, it states out that the Bachelors are outnumbered to the others, which makes education activities underdeveloped, according to Associate Professor Vo Van Sen - President of Social and Human Sciences University. He also declared that one of the weaknesses of Vietnamese education system is that there is a crisis towards lacking of teaching staff and the qualified ones.Another aspect is that the steady flow of students coming to universities to study annually in Vietnam is huge (Figure-3). The official data in Figure-2 show that there were around 2,162,106 tertiary students while totally calculated to be only 74,573 faculties in Vietnam in 2011.As the result, the research would see the numbers in future. This is the very important objective; since if it's predicted well or even likely exactly, the Ministry can have their calculation applied to this change in numbers of students and lecturers in universities. Whenever the good forecast is applied, it is easier to build the strategy. The strategy here includes how to adapt with the number of students which is rising so fast, how to provide faculty, facilities. Moreover, lecturers play the central part, so to standardize the numbers between students and lecturer is the contribution for the Ministry to consider and solve out some problems in order to minimize the ratio between students per a teaching staff into the ideal digit.

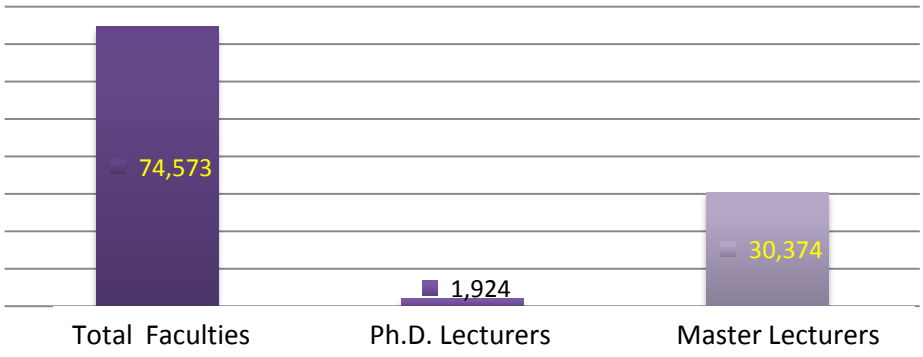


Figure 1: The total faculty; PhDs and master lecturers in 2011, Vietnam

Source: The Statistics of Ministry of Vietnamese Education and Training (2011)

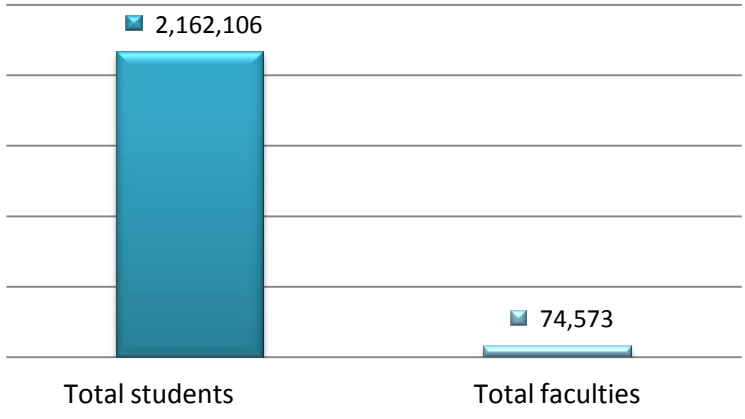


Figure 2: The total number of students compared with the total faculty in 2011, Vietnam

Source: The Statistics of Ministry of Vietnamese Education and Training (2011)

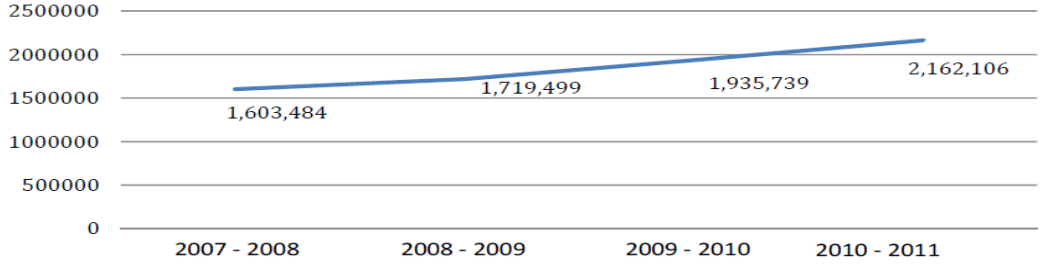


Figure 3: The total numbers of students (colleges and universities) in recent years, Vietnam

Source: The statistics of Ministry of Vietnamese Education and Training (2011)

Moreover, with all above-stated facts and reasons, this research will apply Grey Model formulated by Professor Deng Julong in 1982 to study the problems of less data, poor information and uncertainty (Liu *et al.*, 2004) to make positive analysis about trending of students and lecturers in Vietnam from 2007 to 2011, and prediction for 06 coming years 2012 - 2017. There are three problems raised and solved in this paper: first, it will apply Grey Forecasting to make grey prediction analysis about the total enrollment, then to estimate and to balance the ratio of university students and lecturers; second, it will find out the very urgent and significant concern that Bachelors are outnumbered to others; and finally, the solutions to reach high-qualified teaching staff.

LITERATURE REVIEW

Fundamental concepts of grey forecasting

To see and have an overview about the future values through the past and current data is what it means by prediction (Liu *et al.*, 2004). Grey Model is to forecast the system using both clear data and changeable information. It means that Grey is used to make forecasting the time-related grey process of change in particular field or range (Cheng, 2003). It is also known as GM as to predict quantity on Grey Prediction Model. Step 1 is to input the data sequence of strong regularity by methods of grey generating to make less randomness of the original data flow. The second step it gets various equation model established to discover and gain the rule of sequence, also forecast the trend for the future of the current system. Thus, a great leap can be easily achieved to set up the familiar and dynamic differential equation through fixed data source (Liu *et al.*, 2004 and Cheng, 2003). In short, Grey Forecasting is the most widely used and chosen to forecast the magnitude of numerical data leaned on the single time series data (Tang, 2007).

Grey model

This is a time series forecasting model, which is refreshed as the latest data coming available to the prediction model, and the differential equations of the Grey Model have time-varying coefficients. The Grey Model can only be used in positive data sequences (Deng, 1989). This paper uses grey models to make prediction for the future values of the primitive data points since all the primitive data points are positive. To obtain the n-step ahead predicted value of the system, this research solves the differential equation, Grey Model Lastly, the Inverse Accumulating Generation Operator (IAGO) is applied to search for the predicted values of original data by the predicted value (Deng, 1982).$X^{(0)} = \left(x^{(0)}(1), x^{(0)}(2), \dots, x^{(0)}(n)\right),\ \ n \geq 4$Where $X^{(0)}$is a non-negative sequence and **n** is the sample size of the data. When this sequence is subjected to the Accumulating Generation Operation (AGO), the following sequence $X^{(1)}$ is obtained. It is obvious that $X^{(1)}$ is monotonically increasing.

$$X^{(1)} = \left(x^{(1)}(1), x^{(1)}(2), \dots, x^{(1)}(n)\right), \ n \geq 4, x^{(1)}(k) = \sum_{i=1}^{k} x^{(0)}(i), \quad k = 1,2,3 \dots, n$$

The generated mean sequence of $Z^{(1)}$of $X^{(1)}$is defined as: $Z^{(1)} = \left(z^{(1)}(1), z^{(1)}(2), \dots, z^{(1)}(n)\right)$, where $z^{(1)}(k)$ is the mean of adjacent, i.e.$z^{(1)}(k) = 0.5\, x^{(1)}(k) + 0.5x^{(1)}(k-1), k = 2,3, \dots, n$.The least square estimate sequence of the grey difference equation of Grey Model is defined as follows (Deng, 1982): $x^{(0)}(k) + az^{(1)}(k) = b$.The whitening equation is therefore, as follows $\frac{dx^1(t)}{dt} + ax^1(t) = b$. In above,$[a, b]^T$ is a sequence of parameters that can be seen as follows:$[a, b]^T = (B^T B)^{-1} B^T Y$

$$Y = [x^{(0)}(2), x^{(0)}(3), \dots, x^{(0)}(n)]^T$$

$$B = \begin{bmatrix} -z^{(1)}(2) & 1 \\ -z^{(1)}(3) & 1 \\ . & . \\ . & . \\ . & . \\ -z^{(1)}(n) & 1 \end{bmatrix}$$

The solution of $x^{(1)}(t)$ at time **k**: $x_p^{(1)}(k+1) = \left[x^{(0)}(1) - \frac{b}{a}\right] e^{-ak} + \frac{b}{a}$. The IAGO is calculated to show out the following grey model to obtain the predicted value of the primitive data at time (k + 1): $x_p^{(0)}(k+1) = \left[x^{(0)}(1) - \frac{b}{a}\right] e^{-ak}(1 - e^{a})$ and the predicted value of the primitive data at time (k + H): $x_p^{(0)}(k+H) = \left[x^{(0)}(1) - \frac{b}{a}\right] e^{-a(k+H-1)}(1 - e^{a})$.

Important reasons to apply grey model

In education, many complicated issues, or even unsolvable, could be clearly solved, and deeper understandings towards difficult problems in the term related to the calculation of numbers can be solved out with the help of newly emerging fields of study (Gu and Xu, 1999). Moreover, applying to the predicting numbers of Vietnamese lecturers and students in the future is a critical problem that has not been solved yet. This method is suitable for the trends of the digits, and also opens a new view for forecasting the problems of human resources related to the numbers mentioned above in Vietnam education system.In fact, the numbers of lecturers and students in Vietnam fluctuate uncertainly due to many complicated reasons, such as education policies, facilities for researching, salary issue, and brain draining in high tech, fluctuated recruiting student numbers, and university

locations i.e. many are big cities and vice versa to suburb areas. So that applying this method is reasonable for the research and finding out solutions for the future work of the general management to the education system based on the predicted numbers in the next two years and future.

CASE ANALYSIS

Data source

This paper uses the statistics provided by the Vietnam Ministry of Education and Training. These data were posted in the official website based on the real numbers of total students and lecturers in all Vietnamese universities. Then to adapt with the purposes of research, this study divides the statistics into two main parts: students in universities and teaching staff in universities.

Table 1: Total university students in recent years

Academic Years	Full time	In-service	Total
1999-2000	376,401	343,441	719,842
2000-2001	403,568	327,937	731,505
2001-2002	411,721	351,535	763,256
2002-2003	437,903	367,220	805,123
2003-2004	470,167	428,600	898,767
2004-2005	501,358	544,933	1,046,291
2005-2006	546,927	469,349	1,087,813
2006-2007	677,409	495,738	1,173,147
2007-2008	688,288	492,259	1,180,547
2008-2009	468,855	468,855	1,242,778
2009-2010	496,292	496,292	1,358,861
2010-2011	465,243	465,243	1,435,887

Source: The statistics of ministry of Vietnamese education and training (Sept., 2011)

Table 2: Total university faculties

Academic Years	Doctors	Masters	Bachelors	Other Degrees	Total
2007-2008	5,643	15,421	16,654	499	38,217
2008-2009	5,879	17,046	17,610	472	41,007
2009-2010	6,448	19,856	19,090	567	45,961
2010-2011	7,338	22,865	20,059	689	50,951

Source: The Statistics of Ministry of Vietnamese Education and Training (Sept., 2011)

In the two tables, the total numbers of students have been arranged separately on the academic years including three kinds including full time: day time program (4-5 years); in-service: night time education – students can work and study at the same time; and the total of these numbers. Lecturers in universities are divided into levels PhDs, Masters, Bachelors and other degrees. After the data

are collected (Tables 1 & 2), this study uses them to have some calculating samples applying grey forecasting developed by Deng, (1982).

Sample forecasting of grey model

In this part, a practical forecasting is conducted on the number of students in the Academic years 1999~2007 by adopting the above Grey Model by Deng, (1982); and the predicted results are by means of relative error test. This model is based on Matlab software to do calculation. The number of students (as sample) in Vietnam from academic years 1999 to 2007 is listed as in Table 3. From the Table 3, it is apparent that the number of students during the eight school years from 1999 to 2007 increased from 893,754 to 1,540,201, which proves that this number is at a stage of rapid growth.

Table 3: The original, prediction values, and AGO of the total students

Values / School Years		Original	Prediction	AGO*
1	1999-2000	893,754	893,754	893,754
2	2000-2001	918,228	892,763	1,811,982
3	2001-2002	974,119	973,255	2,786,101
4	2002-2003	1,020,667	1,061,005	3,806,768
5	2003-2004	1,131,030	1,156,666	4,937,798
6	2004-2005	1,319,754	1,260,951	6,257,552
7	2005-2006	1,387,107	1,374,639	7,644,659
8	2006-2007	1,540,201	1,498,577	9,184,860

***AGO** (Accumulated Generating Operation*)*

Accuracy inspection analysis of forecasting ability

Numerous methods exist for judging forecasting model accuracy, and no single recognized inspection method exists for forecasting ability. Mean Absolute Percentage Error(MAPE) is often used to measure forecasting accuracy (Teng and Huang, 2009).MAPE is the average absolute percent error which measures of accuracy in a fitted time series value in statistics, specifically trending (Stevenson, 2009). Smaller MAPE value indicates better forecasting ability. $MAPE = \frac{1}{n}\sum \frac{|Actual - Forecast|}{Actual} \times 100$; **n**Forecasting number of step.Evaluation of MAPE forecasting ability is divided forecasting ability is evaluated as follows:

- <10% Excellent forecasting ability
- 10%~20% Good forecasting ability
- 20%~50% Reasonable forecasting ability
- >50% Poor forecasting

In order to ensure that the Grey Forecasting based on MATLAB has high accuracy for application in predicting the number in reality, this part of the research calculates the errors of the process. Table 4 shows the range of these errors from 0.09% to 4.46%, forecasting ability.

Table 4: Calculating process of MAPE

Period	Actual	Forecast	Error (A-F)	|Error|	[|Error| ÷ Actual] × 100
1	893,754	893,754	0	0	0.00
2	918,228	892,763	25,465	25,465	2.77
3	974,119	973,255	864	864	0.09
4	1,020,667	1,061,005	-40,338	40,338	3.95
5	1,131,030	1,156,666	-25,636	25,636	2.27
6	1,319,754	1,260,951	58,803	58,803	4.46
7	1,387,107	1,374,639	12,468	12,468	0.90
8	1,540,201	1,498,577	41,624	41,624	2.70

$$MAPE = \frac{1}{n}\sum \frac{|Actual - Forecast|}{Actual} \times 100 = \frac{17.14}{8} = 2.14\%$$

Moreover, in this sample, MAPE is used to know the average absolute percent error of the whole. Obviously, as the result of MAPE (2.14%) for the whole process equally to 8 periods, it is stated that grey prediction is a good method for forecasting.

FINDINGS AND DISCUSSIONS

Results

The calculations on the numbers of students and teach staff in recent academic years from 2007 to 2011 are analyzed in this section. Furthermore, the prediction values for the six next school years 2011-2012 to 2016-2017 are mentioned in table 5 with the updated data from the MOET.It's obviously that the real numbers of students and faculties are rising, and also the forecast's ones. The errors between the real and forecasted data in 2011-2012 are so small as calculated 6.97% for total students; and 4.25%, 4.21% and 4.72% for universities lecturers including PhDs, Masters and Bachelors, respectively.

Trending for development

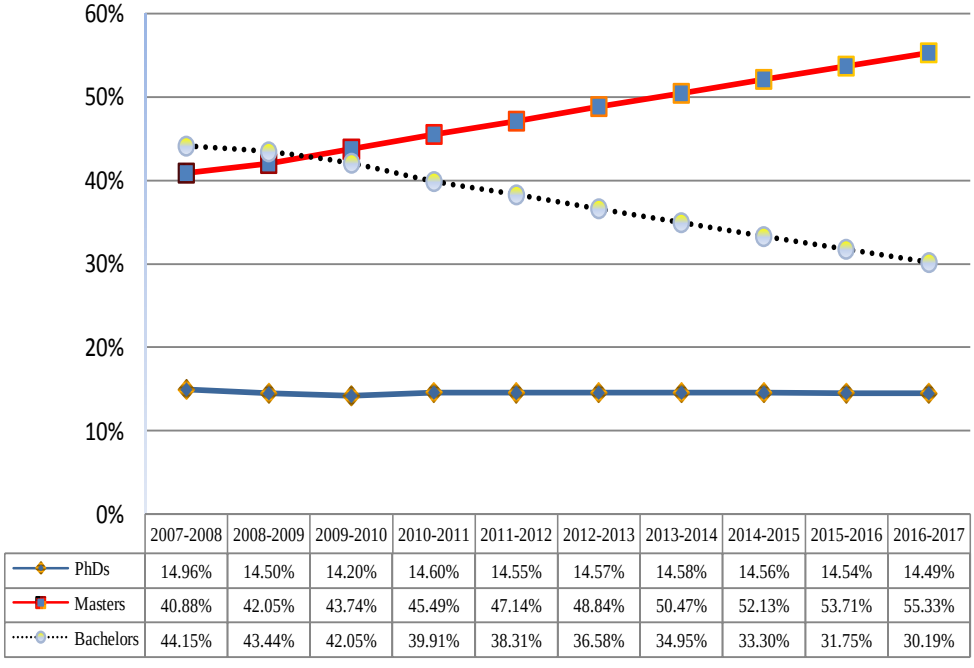
The line graph below demonstrates the general trend in recent school years and next six years as predicted. Firstly, Ph.D. lecturers are on progress with the percentage of Vietnamese university faculties around 14.20% and 14.96%. Masters, meanwhile, steadily rises in recent years and predicted values, at only 40.88% in (2007-2008) to 55.33% in (2016-2017) as forecasted. However, Bachelor lecturers, in general have dropped sharply in recent years and next 06 years. The gap

between Masters and Bachelors used to be **-3.27** (40.88% for Masters and 44.15% for Bachelors) in 2007-2008; and after 10 years it will be **+25.14** (55.33% Masters and 30.19% Bachelors). This is as a result showing good trend for the future; the other for PhDs is also important to raise the percentage of this group.

Table 5: The results of forecasting with updated data

Academic years	Forecasted by Grey Model				Updated Data (Sept. 11, 2012)*			
	Total students	Faculties			Total Students	Faculties		
		PhDs	Masters	Bachelors		PhDs	Masters	Bachelors
2011-2012	1,548,994	8,157	26,433	21,483	*1,448,021*	*8,519*	*27,594*	*22,547*
2012-2013	1,663,581	9,125	30,590	22,912	--	--	--	--
2013-2014	1,785,345	10,186	35,262	24,422	--	--	--	--
2014-2015	1,917,087	11,388	40,768	26,043	--	--	--	--
2015-2016	2,057,203	12,707	46,956	27,757	--	--	--	--
2016-2017	2,208,734	14,202	54,246	29,597	--	--	--	--

Updated Data Source: The Statistics of Ministry of Vietnamese Education and Training (Sept., 2012). *These are not mentioned in the time of doing this paper (Oct., 2011 – June, 2012)



	2007-2008	2008-2009	2009-2010	2010-2011	2011-2012	2012-2013	2013-2014	2014-2015	2015-2016	2016-2017
PhDs	14.96%	14.50%	14.20%	14.60%	14.55%	14.57%	14.58%	14.56%	14.54%	14.49%
Masters	40.88%	42.05%	43.74%	45.49%	47.14%	48.84%	50.47%	52.13%	53.71%	55.33%
Bachelors	44.15%	43.44%	42.05%	39.91%	38.31%	36.58%	34.95%	33.30%	31.75%	30.19%

Figure 3: The general trend in recent school years and next six years as predicted

Students-per-Faculty Ratio

In this thesis, the ratios are mentioned as an important part in the findings because it shows the Vietnamese education foundation to have the good ratios in the near future. Ratios here are calculated as the number of students per a lecturer."*The trend to have 450 students among 10,000 citizens, but this trend has to be adjusted to acquire the quality in education, due to the fact. The number of lecturers is not enough; socialized speed is not reached, and the potential of investment on education and training is limited so that we cannot make into the quantity only"* saidMr. Bui Van Ga – Vice Ministry of Vietnam Ministry of Education and Training.Vietnam is now trying to decrease the rate between students and lecturers, so that number of students is focused not to overestimate.

Total in (2007-2008): Ratio: $\frac{Students}{Teachers} = \frac{1180547}{38217} = 30.891$

Table 6: The ratio of student per a lecturer by the academic years

School Years	Total Students	Total Lecturers*	The Ratio $= \frac{Students}{Lecturers}$
2007-2008	1,180,547	38,217	30.891
2008-2009	1,242,778	41,007	30.306
2009-2010	1,358,861	45,961	29.566
2010-2011	1,435,887	50,951	28.182
*2011-2012***	*1,548,994*	*56,073*	*27.625*
2012-2013	*1,663,581*	*62,627*	*26.563*
2013-2014	*1,785,345*	*69,870*	*25.552*
2014-2015	*1,917,087*	*78,199*	*24.515*
2015-2016	*2,057,203*	*87,420*	*23.532*
2016-2017	*2,208,734*	*98,045*	*22.528*

*Lecturers with other degrees are in small in numbers so it does not effect to the results (around 1%). ** Numbers in italics are forecasted.

Table 6 figures that with the same process as above the rates in (2008-2009) was 30.306, and 29.565 and 28.182 for (2009-2010) and (2010-2011), respectively. The predicted values produce the ratio which is on downturn from 27.625 in next year (2011-2012) to 22.528 (2016-2017). It is apparently that the number of students for 01 lecturer's capacity is controllable with range from 22 to 30 students in one classroom.

The discussions of the results

To the listed calculation results, it is shown that there would be the stable trend to the predicted numbers. Relied on the meaning of each digit, it's concerned that the Vietnamese people's affordability for the tertiary and the society's educational structure are the main factors towards the

impact of the development scale around the adult higher education in Vietnam, whereas the demographic structure of society, the employment structure of society and the level of economic development are comparatively the minor ones.

After the further analysis of these indexes, we can find out some important information.

1. It is shown that the demand of Vietnamese society towards the well-educated or the high-level-educated people is rising up based on the education structure of society, so that day by day more non-school-age faculty with not-high-levels of education will make decision on accepting tertiary education to get the improvement in their educational level and meet the social requirements.
2. The growing income of most of residents is one more reason for top priority of the investment in higher education.
3. The demographic structure, the working environment structure of society and the developing economy review the quick growth of Vietnamese society and economy from the macroscopic view. Such development takes no doubt a good part in the development of tertiary education in Vietnam.

To solve the problem of quantity and quality in the tertiary education should be based on the new ways of thinking and application of the new training technology. In the recent 12 years, the total number of students has increased 2.5 times – from 893,754 in 1999 to 2,162,106 in 2011, especially the pace has become faster. However, the teaching staff in 2011 was only 74,573 (1) so the ratio of students per faculty in the country has been at around 28. Moreover, some universities have the bigger digit, up over 100 (2). The above figures make some education managers worried. The issue of managing quantity is in place a harsh and it is reflected more on the public opinion.

CONCLUSIONS AND SUGESTIONS

Itis a great opportunityforstudents, teachers, and staff to access to advanced knowledge, learning methodsandmodern research, and contact withthe cultures ofcountries around theworld. However,the questionis that not everyonegets theopportunity. The number ofstudents studying aboard isaccounted for onlyavery small percentageof the totalnumber ofpupils andstudentsall over Vietnam.Besides, ifviewedineconomicrelations, the foreignstudying abroadis aform ofpurchasedservicesinanother country,and then itwouldlosean amount offoreign currency. That's not to mention numerous menhavenotreturned afterstudying, but continuedliving andworkingabroad. This can lead to thebrain drainfordeveloping countries. Meanwhile, foreign directinvestmentineducation servicescansolvetheabove disadvantages, whenforeigninvestorsbuildscientificresearch institutions, schools andfacilities forhigherlearning andresearch. Thus, researchers, lecturers, pupils, students canstudyand learnattheir own country, it can lead to the result that foreign investment in local educationcansavecostsandavoid thebrain drainphenomenon.In conclusion, according to the research of this paper, the scale of tertiary

education is growing wider and larger with some influential factors, for instance the social educational structure, the eager and affordability to get higher education of the Vietnamese, the recent growth of social economy and infrastructure, and so on. However, due to the weak regularity of related data about adult higher education of our country, the results of this study probably contain some errors compared with the facts. Therefore, how to improve the reliability of application Grey Forecasting in the field of research on adult higher education will become a focus of further research. Moreover, with the attained results from this research, this method can be applied for further education resources planning, for example, high school or maybe the whole educational system so that, it is so important to have good strategies to make good development for Vietnamese education system.

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