Effect of Technological Change on Economic Growth in the Eastern Economic Corridor: The Case Study of Chachoengsao Province, Thailand

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(Received: December 23, 2023; Revised: March 31, 2024; Accepted: April 2, 2024)

Abstract

The purpose of this research aims to study changes in technology in Chachoengsao Province that affect the economic growth of Chachoengsao Province and analyze the factors that determine technological changes in Chachoengsao Province. It's using historical annual data from 1992-2022, which is quantitative analysis. It's using an econometric model in the form of a multiple regression equation. The research found that the study of technological change has a positive impact on the economic growth of Chachoengsao Province by the total economic sector is equal to 0.0043 percent and there is difference in each production sector. However, the production branch has the highest rate of technological change that is the mining of metal and non-metallic minerals are equal to 0.3998, followed by the commerce sector, service sector, construction, repair and demolition sector, transportation, warehousing and transportation sector and the handicraft industry sector with technological change rates are equal to 0.0791, 0.0507, 0.0372, 0.0142 and 0.0088, respectively. Moreover, the manufacturing sector in the field of public utilities and sanitation and the fields of agriculture, hunting, and fishing had a rate of change in the negative direction are equal to -0.0131 and -0.0080, respectively. As for the factors affecting the change in growth of the entire economic sector as a whole and every branch of production uses capital factors more than labor factors. As for the analysis of the influence of factors that determine technological change results in each production sector differently as well. It was found that the investment promotion factors of Chachoengsao Province and the factors of the number of unemployed workers in Chachoengsao Province it has the most relationship in the same direction and the factors of foreign direct investment at the country level, national technology and patent fee factors, national inflation factors and the factor of national research and development expenses has an opposite relationship with the value of output in both of economic sectors as a whole and each production sector is the most. So, this research provides recommendations to the government and related agencies by giving priority to workers with a high level of education and solving the problem of decreasing unemployment rates within Chachoengsao Province. Including providing benefits and support for foreign investment and domestic entrepreneurs in order to achieve growth in both of all economic sectors and each production sector at Chachoengsao provincial and national levels.

Keywords: 1) Chachoengsao Province 2) Economic Growth 3) Effect of Technological Change

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Introduction

Chachoengsao Province is located in the east of Thailand. The Bang Pakong River basin has an area of 5,351 square kilometers that accounting for 13.8 percent whole the total areas of the eastern region. It has a strategic location that connects Bangkok with many provinces in the eastern region. There are the potential for a trade and transportation center and has an outlet by the sea which has the Bang Pakong River. It is a prominent feature in geography that connecting the central and eastern regions including the northeastern region passes through Prachinburi Province to Nakhon Ratchasima Province. Chachoengsao Province is 1 of 3 provinces in the economic development group, namely Chonburi, Rayong, and Chachoengsao which recognizing the importance to development this area both of physical and social in order to raise the level competitiveness of the country to continue the development of the Eastern Seaboard area known for more than 30 years, also known as Eastern Seaboard. There were determined the target industries that will be promoted to create concrete investment by investments in infrastructure and public utilities to increase the potential for supporting investment and the development of economic activities and facilitate various activities in the areas, Including the development of human resources and the organization of technology accumulation, such as research and development, education and training etc. Under the integrated plan to develop industries and services of the future and a strategic plan to develop people's potential throughout their lives. There was budget of 768,651,800 baht according to the budget allocation plan of 2023 (Budget Bureau, 2023, pp. 27-96) or equivalent to 0.15 percent of the gross product of Chachoengsao Province in 2022 for a sustainable in the future of Thailand. The important industries of Chachoengsao Province are the automotive and automotive parts industries, electrical appliances and electronics industries from spatial advantage because of its located close to provinces that are production bases for the automotive industry, such as Samut Prakan, Prachinburi, Chonburi, Rayong, and also close to Laem Chabang Port. Therefore, it is an important factor that attracts large automotive manufacturers and SMEs to invest in order to expand production capacity including setting up factories in the area of Chachoengsao Province.

The economic situation in Chachoengsao Province in 2022 was expected to expand by 3.3 percent (with a forecast range of 3.1 - 3.8 percent, increased from the original forecast in September 2022 that was expected to expand by 1.7 percent) that expanded continuously from last year’s expansion of 2.8 percent. It was reflected by supply-side economic indicators from the industrial sector, the service and agricultural sectors are important and the demand side is expanding that mainly from private investment, private consumption, and government spending. The province was expected to expand by 3.9 percent (with a forecast range of 3.6 - 4.4 percent, an increase from the original forecast in September 2022 that was expected to expand by 2.3 percent) that expanded continuously from last year’s expansion of 3.5 percent from the industrial

sector expanded 5.1 percent. (Comptroller General's Department, 2022, pp. 1-2) By receive positive factors from the relaxation of government measures and the recovery of the economy together with the expanding manufacturing sector from increased demand for industrial products. It is a result of what the government has policy to develop the Eastern Economic Corridor (EEC) project to become a leading economic zone in ASEAN. It will promote 10 target industries as a mechanism driving the economy for the future (New Engine of Growth) private investment that expanded by 5.5 percent as economic activities began to return to normal that mostly businesses in the manufacturing sector invest to increase efficiency and reduce production costs. The researcher chose the period between 1992-2022 to study changes in technology and factors that determine changes in technology that affect to the economic growth of Chachoengsao Province.

Research Objective

To study changes in technology in Chachoengsao Province that affect to the economic growth of Chachoengsao Province and analyze the factors that determine changes in technology in Chachoengsao Province.

Theoretical Background

The word "technology" comes from the words Techno and Logy which Techno comes from the Greek word Techne which means applying science to industrial applications. Logy comes from the Greek word Logos which means systematic study and systematic steps. Therefore, the word "Technology" means the application of science to industrial work or operational work by systematic education and correctly procedures. In addition, technology also covers the application of science to work in other production sectors such as agriculture, transportation and service sectors to cover both of production and distribution of products. So, economists often define technology as knowledge used in production and making products commercially valuable and distributing goods and services. (Phattharasuk, 1993, pp. 1-2)

Vernon explained the use of different factors of production to develop new products instead of producing the old products. Therefore, it is necessary to have human capital with a high level of education and an experienced workforce. It will cause the level of technology to increase rapidly according to leading countries that create technology. Therefore, countries are able to catch up with technological leaders by increasing the level of education and the level of human capital. Include the level of investment that goes into developing and creating new technology (Vernon, 1996 as cited in Santipholwut, 2015, pp. 106-107)

Schumpeter is the master of innovative business strategy who created the theory of Creative Destruction (creative destruction) with the idea that Entrepreneurs must find ways to use innovative technology in the product production process, service or innovation that is a new product to create business benefits for the organization. Especially, if the innovation can make the organization profitable as a monopoly gain a competitive advantage but there are also investors who try to copy other people's technology or modifying and developing further creates new inno-

vations all the time as well becomes cycle continue until the point where the monopoly is gone. At a point, things go back in cycles to avoid imitating existing entrepreneurs or people looking for new innovations to create new forms of competition. So, Schumpeter called "creative destruction" when new ideas are invented and destroy what already exists in the entire goal is to create something new and create more profits for the organization. Schumpeter also tried to relate the importance of innovation to Entrepreneurship Including the idea that an entrepreneur is like an innovation (Innovator) which innovation will help make economic growth occurs only when entrepreneurs create innovations. Therefore, the concept of innovation from an entrepreneurial perspective assumes that entrepreneurs play a role and important to the innovation development process and innovation also plays a role in making an entrepreneur successful so both of these things will have a positive relationship with each other (Schumpeter, 1934 as cited in Santipholwut, 2015, pp. 40-42)

Ayres proposed the concept of economic development of developed countries and developing countries that the key of factor for development will depend on technology and social pattern system. By the technology comes from the collaboration between people and tools that people who use tools technological processes will arise from the skills of people and tools that people use technological progress occurs through invention and human discoveries. So, Ayres believes that technological progress and economic development are the one and the same if there is no technological progress economic development cannot occur. Technological change is the result of scientific discovery, research, experimentation, and innovation. The successful application of technology to domestic production processes requires the ability to apply technological knowledge from abroad to local conditions. Over time, the ability to conduct research on one's own and developing countries must build the capacity to independently learn about technology is the first step towards technological self-reliance (Ethics). (Ayres, 1883 as cited in Tohsa, 2005, p. 22)

Harrod-Domar has developed theories or models in economic growth, which aims to explain the relationship during level of growth. So, both of him had an idea that investment is the key to economic growth. In addition to increasing income there is also the ability to produce or increase efficiency production of the economic system. As well as maintaining full employment levels must it relies on economic growth which is high enough to absorb savings that desired for investment to generate income at full employment level. Harrod-Domar makes assumptions of the model whether it will be an industrial production unit or the overall economic system will depend on the amount of capital invested in such economic unit. That is the importance of savings and increased capital accumulation as important factors that increase the country's total output it will push the economic system to grow and expand (Harrod-Domar, 1997 as cited in Bramahitadata, 2015, pp. 18-22)

Robert Solow improved the Harrod-Domar model by adding labor factors and

technology considerations to the growth equation. Although, Solow's model describes developed countries better than developing countries but the model still paints a clear picture of economic growth and development. The model suggests that different economies can reach the same level of income by specifying that savings, depreciation, the labor growth rate and the growth in productivity are all the same. Therefore, the Solow model is the main basis for explaining the interaction of two different economies. (Solow, 1957 as cited in Santipholwut, 2015, pp. 47-65)

Literature Review

Technology and human capital shows that the population is a factor that causes to both of internal and external factors of technology. While, the human capital is both of causes and effects factor. In addition, the influence analysis of the factors affecting the economic growth of Thailand. It was found that technology resulting from the factors internal factors have a more positive influence on economic growth than technology caused by external factors. (Kasrisom, 2019, p. 45)

By the most production functions of the overall economic sector and classified by sector has production flexibility values. The use of capital factors is higher than the production elasticity of the use of labor, which is a return on the production scale in an increased manner. Except in the field of agriculture which has a high elasticity of factors, labor is higher than capital, the rate of technological progress was found to be rate of technological progress based on Solo's concept of residual measurement is highest in the industry and other fields have a positive rate of technological progress. Considering the form of technology that arises from external factors that come in the form of foreign direct investment. Research and development expenses have the rate of catching up in technology, Social Capability factors are policy determinants, educational factors help to promote skilled workers and expertise in learning the production process each factor has an effect on the increase in total output and development of technology. (Wangsukij, 1996, pp. 114-115)

Technological changes have a positive impact in Thailand's economic growth, both of the overall economic and in each production sector. Changes in technology cause of output to increase at different rates in different fields of production. Also, the analysis of the influence of factors that determine technological change. It was found that there are differences in each production branch, that is the number of workers with education from High school and above have a positive influence on technological change. As for, direct investment from abroad and research and development costs have a negative influence on technological change both of the overall economic sector and in most production sectors. (Tohsa, 2005, pp. 102-105)

In addition, it was found that technological change measured by the value of machinery and equipment used in research and development and the number of trained employees, it is positively related to comparative advantage measured by the proportion of exports, it was found that the number of

trained employees resulted to increase in the proportion of exports for both groups of establishments. While the value of machinery and equipment used research and development has a positive effect to the proportion of exports only for establishments that focus on the domestic market (Tohsa, 2005, pp. 31 as cited in Kasrisom, 2019, pp. 44-45).

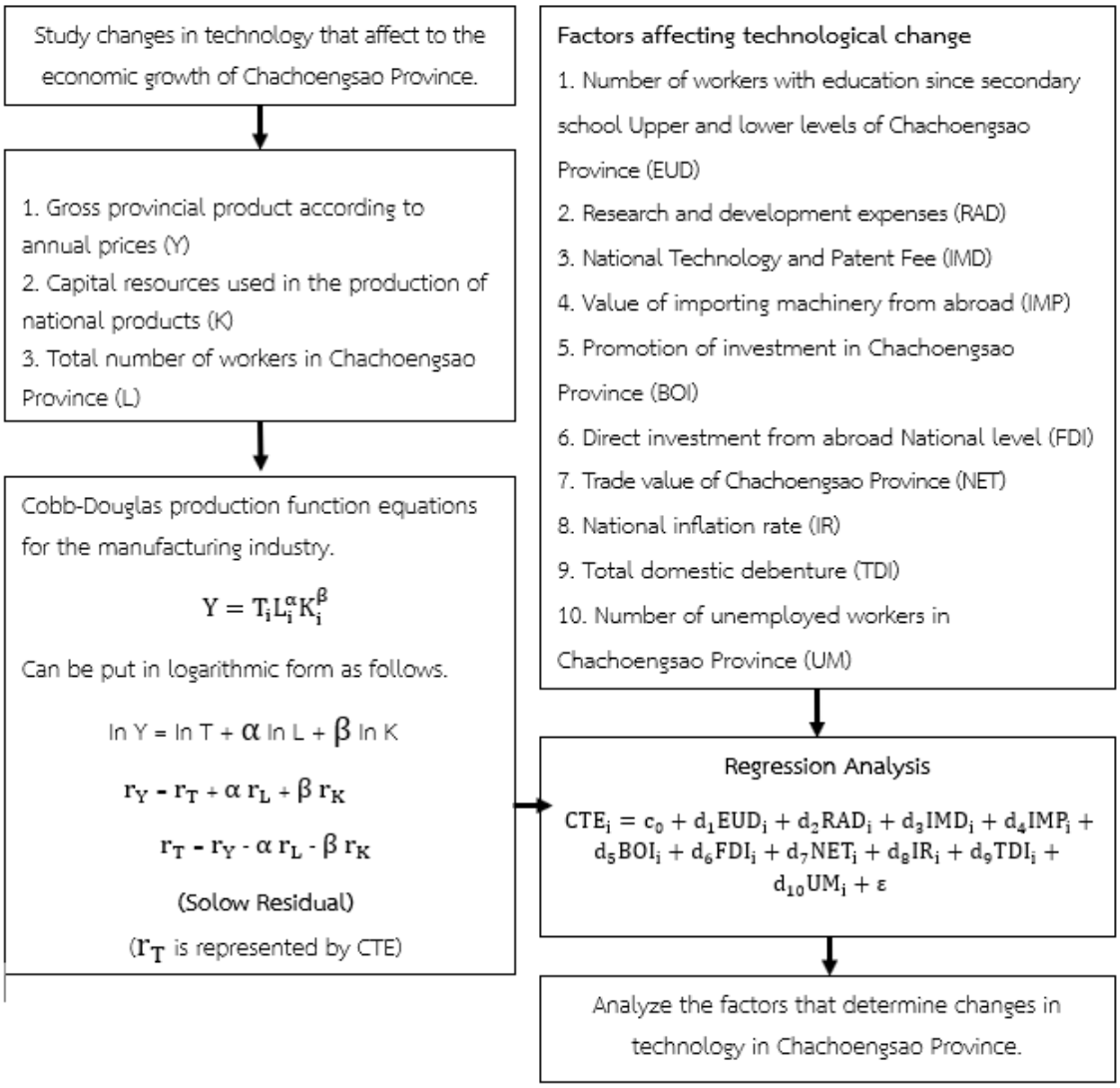

Figure 1 Research Conceptual Framework

Methods

Scope of study period Determine the scope of the study about changes in technology and analyze the factors that determine technology in Chachoengsao Province. The researcher use secondary data that is annual data from 1992-2022, a period of 31 years, including the value of gross provincial product according to annual prices (Y) (Office of the National Economic and Social Development Council, 2023b), Capital resources used in the production of national products (K) (Office of the National Economic and Social Development Council, 2023a) and Total number of workers in Chachoengsao Province (L) (Ministry of Labor, 2023) Both the economic system and

each sector of production. Factors affecting technological changes in Chachoengsao Province include the number of workers with education from high school or higher in Chachoengsao Province (EUD) (Ministry of Labor, 2023), Cost National Research and Development Payment (RAD) , National Technology and Patent Fee (IMD), National Foreign Machinery Import Value (IMP), National Foreign Direct Investment (FDI), National inflation rate (IR) and Total domestic debenture (TDI) (Bank of Thailand, 2023), Chachoengsao Province Investment Promotion (BOI) and trade value of Chachoengsao Province (NET) (Department of Internal Trade, 2023) and Number of unemployed workers in Chachoengsao Province (UM). (Chachoengsao Provincial Statistical Office, 2023)

Scope of study Analysis of changes in technology from Solow's production function which defines it's in the form of a Natural Logarithm equation by analyzing the results of the growth rate of various factors that affect to the production process, the number of workers, supplies, and technology. Also, the emphasizing the effects of changes in technology and the relationship between output and production factors used in the production process in Chachoengsao Province. As for the analysis of factors that determine technology in Chachoengsao Province, both of overall economic sector and each branch production sector have been determined in the form of multiple regression equations. Analyze the rate of technological change in Chachoengsao Province. The various factors are from concepts, theories, and literature reviews and problems affect to the economic system including the number of workers with education from high school or higher in Chachoengsao Province (EUD), Cost National Research and Development Payment (RAD), National Technology and Patent Fee (IMT), National Foreign Machinery Import Value (IMP), Chachoengsao Province Investment Promotion (BOI), National Foreign Direct Investment (FDI), trade value of Chachoengsao Province (NET), national inflation rate (IR), Total domestic debenture (TDI) and Number of unemployed workers in Chachoengsao Province (UM), to know the relationship of various factors that results in technological change in Chachoengsao Province.

The researcher has reviewed the concepts regarding economic growth and technology that is the factors affecting economic growth are capital factors and labor factors which may be substituted in the production process leading to the expansion of mass production also within the country according to the concepts of Harrod – Domar, (Bramahitadata, 2015, pp. 18-22) E.F. Schumacher and Lucas (Tohsa, 2005, pp. 9-11) In addition, technological progress it brings about the development of the use of tools, machines, modern innovations and the creation of human resources to have more knowledge, abilities and skilled workers. Furthermore, including investment in research and development that will affect the change of technology according to the concept of Joseph Schumpeter (Santipholwut, 2015, pp. 40-42), also the research, the development, and the spread of international technology in the form of trade and investment between Countries according to Paul M. Romer

(Wangsukij, 1996, p. 55), that affect to technological change. In addition, it will be affected to economic growth continuously with such ideas including reviewing various related research studies which the researcher has established a conceptual framework for the research according to the stated objectives. As shown in Figure 1

From the research concept the production function is set to be in the form of Natural Logarithm According to Solow method as follows.

The production function is set to be in the form of Cobb-Douglass

$$Y = TL^{\alpha}K^{\beta} \qquad (1)$$

Where Y is the gross provincial products of Chachoengsao Province (million baht)

T is the technology that is used in the production of products.

K is capital assets used in product production in Chachoengsao Province (million baht)

L is the total labor force used in producing products in Chachoengsao Province (people)

α is the elasticity of output per labor.

β is the elasticity of output per capital.

As for changes in technology that affect the economic growth of Chachoengsao Province in the manufacturing industry (i is each production sector), it is shown in this equation.

$$Y_i = T_i L_i^{\alpha} K_i^{\beta} \qquad (2)$$

From Equation (2), it can be in logarithmic form as follows.

$$\ln Y = \ln T + \alpha \ln L + \beta \ln K \qquad (3)$$

Find the derivative of equation (3) with respect to time.

$$\frac{1}{Y}\frac{dY}{dt} = \frac{1}{T}\frac{dT}{dt} + \alpha\frac{1}{L}\frac{dL}{dt} + \beta\frac{1}{K}\frac{dK}{dt} \qquad (4)$$

when giving $\frac{dY}{dt} = \dot{Y}$, $\frac{dT}{dt} = \dot{L}$, $\frac{dK}{dt} = \dot{K}$ will get

$$\frac{\dot{Y}}{Y} = \frac{\dot{T}}{T} + \alpha\frac{\dot{L}}{L} + \beta\frac{\dot{K}}{K} \qquad (5)$$

or $$\frac{\Delta Y}{Y} = \frac{\Delta T}{T} + \alpha\frac{\Delta L}{L} + \beta\frac{\Delta K}{K} \qquad (6)$$

or $$r_Y = r_T + \alpha r_L + \beta r_K \qquad (7)$$

$$r_T = r_Y - \alpha r_L - \beta r_K \qquad (8)$$

Where r_Y is Rate of change in output or total income of Chachoengsao Province ($\Delta Y/Y$)

r_T is the rate of change in technology and other factors besides L and K of Chachoengsao Province Also known as "Solow's Residual" ($\Delta T/T$)

r_L is the labor change rate ($\Delta L/L$) of Chachoengsao Province.

r_K is he capital change rate ($\Delta K/K$) of Chachoengsao Province.

From Equation (1), when α and β are known at the least squares analysis technique. Then, substitute the values obtained in Equation (8) to be able to measure the rate of technological change that affects to the change in output of the overall economic sector and output of the production sector. Due to the rate of change in total output is known or the output in each branch of production (r_Y), the rate of change in the number of workers (r_L), and the rate of change in capital (r_K) of the overall economic system and each production sector in Chachoengsao Province it will make able to calculate the rate of technological change (r_T) of Chachoengsao Province. In terms of analyzing the factors that determine chang-

es in technology in Chachoengsao Province able to use econometric models in the model of a complex multiple regressive equation, it is as follows.

In terms of analyzing the factors that determine changes in technology in Chachoengsao Province able to use econometric models in the model of a complex multiple regressive equation, it is as follows.

$$CTE = a_0+b_1EUD+b_2RAD+b_3IMD+b_4IMP+ b_5BOI+b_6FDI+b_7 NET+b_8IR+b_9TDI +b_{10}UM+\varepsilon \quad (9)$$

and in the model section for each production industry group in the model of complex multiple regressive equations

$$CTE_i = c_0+d_1EUD_i+d_2 RAD_i+ d_3IMD_i+d_4IMP_i+d_5BOI_i+ d_6FDI+d_7NET_i+d_8IR+d_9TDI_i+ d_{10}UM_i+\varepsilon \quad (10)$$

Where CTE is the rate of change in technology and other factors. In addition to the number of workers (L), capital resources (K) or It is called "Solow's Residual" ($\Delta T/T$) or r_T from the calculation in equation (8).

EUD is the number of workers with education from high school or higher in Chachoengsao Province (people)

RAD is national research and development expenditure (million baht).

IMD is the national technology and patent fee (million baht).

IMP is the national value of machinery imported from abroad (million baht)

BOI is investment promotion in Chachoengsao Province (million baht)

FDI is foreign direct investment at the national level (million baht).

NET is the trade value of Chachoengsao Province (million baht) (exports-imports)

IR is national inflation rate (IR) (million baht).

TDI is total domestic debenture (million baht).

UM is Number of unemployed workers in Chachoengsao Province (people).

a_0, c_0 are constant values.

$b_1, b_2, \ldots, b_{10}$ are coefficients.

$d_1, d_2, \ldots, d_{10}$ are coefficients.

i is each production sector

ε is the error that cannot be explained by the regression equation. Causes of changes in factors that can affect technology It is a factor that determines technology due to the influence of independent variables beyond consideration.

Data Collection

Relevant secondary data sources are from various agencies such as the National Economic and Social Development Board, Bank of Thailand, National Statistical Office, Research Policy and Planning Division, National Research Council of Thailand, Trade Economic Information Center, Department of International Trade Negotiations (Department of Commercial Economics), Chachoengsao Provincial Statistical Office, Chachoengsao Provincial Treasury Office, Laem Chabang Port Customs and Map Ta Phut Customs House.

Data Analysis

The researcher uses quantitative analysis methods divided into 2 objectives, consisting of Objective 1: Study changes in technology that affect to the economic growth of Chachoengsao Province with determine the production function using Natural Logarithm

and analysis by Ordinary Least Square (OLS). Objective 2: Analyze the factors that determine changing of technology in Chachoengsao Province, determine the function of technology due to various factors in the model, the econometrics, the form of the multiple regression equation (Multiple Regression), and analyze the data in this article by selecting the period in 1993-2022 as the cause of the Tom Yum Kung crisis in 1997. The researcher did more research with an explanation of the puppets. (dummy variable) in the equation 0 it means the Tom Yum Kung crisis did not occur and the equation 1 is the cause of the Tom Yum Kung crisis. It was found that the analysis of impact has no influence or any effect to the economy in Chachoengsao Province.

Results

Study changes in technology in Chachoengsao Province that affect to the economic growth of Chachoengsao Province

According to Table 1, when considering the multiple correlation values (R^2) for the overall economic sector, it was found that the capital stock used in the production of goods in Chachoengsao Province (K) and the total number of labor used in the production of goods in Chachoengsao Province (L) can explain the change of the gross domestic product in Chachoengsao Province at 97.602 percent, with statistical significance at the 99 percent confidence level. In the section of each production sector can explain the change in the gross domestic product in each production. The best production sector in Chachoengsao Province is the Service sector followed by, Warehouse transit and transportation sector, Commerce sector, Handicraft industry sector, Utilities and Sanitary sector, Agriculture of forestry, Hunting and Fishery sector, Construction-repair and Destroy sector and Metal and Non-metallic mining sector, respectively. All of them are a statistically significant relationship at the 99 percent confidence level for all variables, Durbin-Watson (DW.) values falling into the range where the tolerance value has no relationship with the ego. (Autocorrelation)

From the analysis of the production function, it was found that the change in output value can be explained by capital factors used in producing products in Chachoengsao Province and the factor of the number of workers used in producing products in Chachoengsao Province is more than 90 percent its showing that the production factors can appropriately explain changes in output. When considering the coefficient of production factors in apply capital factors for using production of goods and the number of workers used in producing products it was found that when using capital factors to produce products, a change of 1% would effect to the overall economic sector's gross output to change in the same direction by 2.38708%, and the highest production per sector was in the metal and non-metallic mining sector are equal to 2.85611%, followed by the Service sector, Handicraft industry sector, Warehouse transit and transportation sector, Construction-repair and Destroy sector, Utilities and Sanitary sector and Agriculture of forestry, Hunting and Fishery sector are equal to 0.21966, 1.76887, 1.75749, 1.50414, 1.32903, and 0.90189 percent, respectively. By using capital factors to produce goods changes by 1% will cause the gross output of the commerce sector. Changes in the opposite

direction by -0.12947 percent and when using labor factors to produce products changes by 1 percent, it will cause the gross output of the overall economic sector to change in the same direction by 0.43290 percent, and the most production in the warehouse transit and transportation sector are equal to 0.51323 percent, followed by Handicraft industry sector, Construction-repair and Destroy sector, Agriculture of forestry, Hunting and Fishery sector, Commerce sector and Utilities and Sanitary sector at 0.42519, 0.17360, 0.08667, 0.04816, and 0.03753 percent, respectively. Moreover, using labor factors to produce products changes by 1% will make the total gross output of service sector and metal and non-metallic mining sector are equal to -0.10803 percent and - 0.03270, respectively. The production of the overall economic sector and the factor of capital resources used in the production of goods in Chachoengsao Province are higher than the factor of the number of labor used in the production of goods in Chachoengsao Province. As for the production sector, it was found that every production branch has a coefficient of production factors in the use of capital factors. The capital products used in the production of products in Chachoengsao Province is higher than the factor of the number of labor used in the production of products in Chachoengsao Province. So, that is, the labor factors have none or little effect on the change in gross product of the economy as a whole and in each production sector. It follows the Lucas concept. (Tohsa, 2005, pp. 9-11) that capital factors and labor factors are causes long-term economic growth and the concept of Adam Smith (Wangsukij, 1996, p. 55) that capital factors and labor factors are very important factors that allow the economic system to expand. Changes in capital and labor factors will have an impact to gross domestic productions.

When considering the overall economic sector and mostly production sectors it was found that the factor has the highest influence on a level of output, it is the factor of capital resources used in the production of goods in Chachoengsao Province followed by the factor of the number of labor used in the production of goods in Chachoengsao Province. In other words, the capital factors used in the production of goods are contribute to increase the productivity of the overall economic sector and every sector of production is more than the number of workers used in producing the product. Moreover, it can be seen increasing of capital factors used in the production of goods in the production process, it will result to increase the productivity of Chachoengsao Province, according to the concept of Solow (Santipholwut, 2015, pp. 47-65) that the evaluation of the coefficient contributes to economic growth. (Charoenlert and Atiwanichayapong, 2003, p. 171) So, the valuable of all output depends on capital factors and labor factors.

From Table 2, analyzing the rate of technological change by analyzing equation (8) with the Solow's Residual value of the output of the overall economic sector and each production sector, it is found that the rate of technological change in the overall economic sector is equal to 0.0043 in the positive direction, the production branch has the

highest rate of technological change, metal and non-metallic mining sector are equal to 0.3998, followed by the commerce sector, service sector, construction-repair and destroy sector, warehouse transit and transportation sector and handicraft industry sector. There were technological change rates are equal to 0.0791, 0.0507, 0.0372, 0.0142 and 0.0088, respectively. It was indicating that the change in technology. This results in the rate of change in technology in a positive direction and the change in technology causes the output to increase in different ratios according to the production branch, (Petprasert, 2003, pp. 225-227; Aujirapongpan, et al., 2010, pp. 51-52) utilities and sanitary sector and agriculture of forestry, hunting and fishery sector had a rate of change in a negative direction is equal to -0.0131 and -0.0080, respectively. It shows that changes in technology or still using technology in the same way that effect to output of each production branch decreased.

The analysis results of factors that determine changes in technology in Chachoengsao province.

According to Table 3 the results of the analysis of factors that determine technological change in Chachoengsao Province as a whole, found that the factors that have a positive influence on technological change are statistically significant, including investment promotion in Chachoengsao Province are equal to 0.000022 percent. The factors that have a positive influence but do not have a statistically significant effect on technological change include the Value of machinery imported from abroad at the national level, Trade value of Chachoengsao Province and Number of unemployed workers in Chachoengsao Province are equal to 0.000000, 0.000046 and 0.000005 percent, respectively. The factors that have a negative influence on technological change with statistical significance include foreign direct investment at the national level, the national technology and patent fee and national inflation rate was -0.000001, -0.000002 and -0.069178 percent, respectively. Moreover, the factors that have a negative influence but have no statistically significant effect on technological change, including the number of workers with education from high school or higher in Chachoengsao Province, National research and development expenses and total domestic debenture were -0.000000, -0.000003 and -0.000000 percent. As for the factors have a positive and a negative influence to technological change in each production sector, it was found that

1. The number of workers with education since secondary school upper and lower levels of Chachoengsao province by positive with technological change direction includes: Metal and non-metallic mining sector, Handicraft industry sector and Service sector equal to 0.000004 0.000021 and 0.000003 percent, respectively. Negative with technological change direction includes: Agriculture of forestry hunting and fishery sector, Construction-repair and destroy sector, Utilities and sanitary sector, Warehouse transit and transportation sector and Commerce sector equal to -0.000003, -0.000021, -0.000004, -0.000008 and -0.000023 percent, respectively.

2. The promoting investment in Chachoengsao Province by positive with technological change direction includes: Agriculture of

forestry hunting and fishery sector, Handicraft industry sector, Construction-repair and destroy sector, Warehouse transit and transportation sector, Commerce sector and Service sector equal to 0.000011, 0.000017, 0.000016, 0.000013, 0.000006 and 0.000006 percent, respectively. Negative with technological change direction includes: Construction-repair and destroy sector and Utilities and sanitary sector equal to -0.000026 and -0.000006 percent, respectively.

3. The direct foreign investment at the national level by positive with technological change direction includes: Utilities and sanitary sector and Service sector equal to 0.000000 and 0.000000 percent, respectively. Negative with technological change direction includes: Agriculture of forestry, hunting and fishery sector, Metal and non-metallic mining sector, Handicraft industry sector, Construction-repair and destroy sector, Warehouse transit and transportation sector and Commerce sector equal to -0.000000, -0.000006, -0.000001, -0.000001, -0.000000 and -0.000000 percent, respectively.

4. The national technology and patent fees by positive with technological change direction includes: Agriculture of forestry, hunting and fishery sector and Construction-repair and destroy sector equal to 0.000000 and 0.000002 percent, respectively. Negative with technological change direction includes: Metal and non-metallic mining sector, Handicraft industry sector, Utilities and sanitary sector, Warehouse transit and transportation sector, Commerce sector and Service sector equal to -0.000012, -0.000002, -0.000001, -0.000003, -0.000001 and -0.000000 percent, respectively.

5. The value of machinery imported from abroad at the national level by positive with technological change direction includes: Agriculture of forestry hunting and fishery sector, Construction-repair and destroy sector, Utilities and sanitary sector, Warehouse transit and transportation sector and Commerce sector equal to 0.000000, 0.000002, 0.000000, 0.000000 and 0.000000 percent, respectively. Negative with technological change direction includes: Metal and non-metallic mining sector, Handicraft industry sector and Service sector equal to -0.000016, -0.000000 and -0.000000 percent, respectively.

6. The national inflation rates by positive with technological change direction includes: Construction-repair and destroy sector and Utilities and sanitary sector equal to 0.019842 and 0.019141 percent, respectively. Negative with technological change direction includes: Agriculture of forestry, hunting and fishery sector, Metal and non-metallic mining sector, Handicraft industry sector, Warehouse transit and transportation sector, Commerce sector and Service sector equal to -0.017043, -0.259800, -0.057658, -0.061773, -0.041342 and -0.002765 percent, respectively.

7. The trade value of Chachoengsao Province by positive with technological change direction includes: Agriculture of forestry, hunting and fishery sector, Metal and non-metallic mining sector, Handicraft industry sector, Construction-repair and destroy sector and Warehouse transit and transportation sector equal to 0.000040, 0.000235, 0.000025, 0.000070 and 0.000043 percent, respectively. Negative with technological change direction includes: Utilities and sanitary sector, Commerce sector and

Service sector equal to -0.000006, -0.000002 and -0.000006 percent, respectively.

8. The national research and development expenses by positive with technological change direction includes: Utilities and sanitary sector and Commerce sector equal to 0.000001 and 0.000001 percent, respectively. Negative with technological change direction includes: Agriculture of forestry, hunting and fishery sector, Metal and non-metallic mining sector, Handicraft industry sector, Construction-repair and destroy sector, Warehouse transit and transportation sector and Service sector equal to -0.000004, -0.000020, -0.000002, -0.000007, -0.000002 and -0.000000 percent, respectively.

9. The total domestic debenture by positive with technological change direction includes: Metal and non-metallic mining sector, Handicraft industry sector, Warehouse transit and transportation sector and Commerce sector equal to 0.000006, 0.000000, 0.000000 and 0.000000 percent, respectively. Negative with technological change direction includes: Agriculture of forestry hunting and fishery sector, Construction-repair and destroy sector, Utilities and sanitary sector and Service sector equal to -0.000000, -0.000001, -0.000000 and -0.000000 percent, respectively.

10. The Number of unemployed workers in Chachoengsao Province by positive with technological change direction includes: Agriculture of forestry hunting and fishery sector, Handicraft industry sector, Construction-repair and destroy sector, Warehouse transit and transportation sector, Commerce sector and Service sector equal to 0.000015, 0.000017, 0.000058, 0.000003, 0.000015 and 0.000000 percent, respectively. Negative with technological change direction includes: Metal and non-metallic mining sector and Utilities and sanitary sector equal to -0.000153 and -0.000016 percent, respectively.

Table 1 Results of analysis of factors affecting economic growth of the overall economic sector and each production sector in Chachoengsao Province.

Constant/ Independent variable	Regression coefficient			
	Overall economic sector	Agriculture of forestry, hunting and fishery sector	Metal and non-metallic mining sector	Handicraft industry sector
Constant	-34.69785	-4.76997	-32.31693	-20.77472
	(-4.97400)***	(-0.73833)	(-6.22487)***	(-3.14022)***
K	2.38708	0.90189	2.85611	1.76887
	(7.50705)***	(4.81958)***	(7.26855)***	(4.21549)***
L	0.43290	0.08667	-0.03270	0.42519
	(0.82473)	(0.21347)	(-0.56755)	(1.40957)
R^2	0.97602	0.93426	0.89395	0.97232
Adjust R^2	0.97233	0.92415	0.87763	0.96807
F	264.50570***	92.37294***	54.79138***	228.36250***

Constant/ Independent variable	Regression coefficient			
	Overall economic sector	Agriculture of forestry, hunting and fishery sector	Metal and non-metallic mining sector	Handicraft industry sector
D.W.	1.79231	1.57481	1.95393	2.11841
N	31	31	31	31

Source: From calculation

Note: Numbers in parentheses are t-statistics values.

***, **, * is statistical significance at the 99, 95, and 90 percent levels, respectively.

Table 1 Results of analysis of factors affecting economic growth of the overall economic sector and each production sector in Chachoengsao Province. (continued)

Constant/ Independent variable	Regression coefficient				
	construction-repair and destroy sector	Utilities and sanitary sector	Warehouse transit and transportation sector	Commerce sector	Service sector
Constant	-14.25994	-11.08475	-23.38923	10.19717	6.75098
	(-2.20891)**	(-2.71501)**	(-7.07437)***	(2.72727)***	(1.55752)*
K	1.50414	1.32903	1.75749	-0.12947	0.21966
	(3.29860)***	(4.34535)***	(9.59914)***	(-0.60819)	(0.78653)
L	0.17360	0.03753	0.51323	0.04816	-0.10803
	(0.34701)	(0.38320)	(2.01094)**	(0.57050)	(-1.20124)
R^2	0.87044	0.96605	0.97648	0.97515	0.98996
Adjust R^2	0.85051	0.96083	0.97286	0.97018	0.98795
F	43.67031***	184.97560***	269.87600***	196.22430***	492.79330***
D.W.	1.99128	2.23107	1.74030	2.46502	2.21819
N	31	31	31	31	31

Source: From calculation

Note: Numbers in parentheses are t-statistics values.

***, **, * is statistical significance at the 99, 95, and 90 percent levels, respectively.

Table 2 Results of the analysis of the rate of change in technology affecting the rate of change in the output of the overall economic sector. and by sector of production 1992-2022

Production sector	Rate of change in technology
Overall economic sector	0.0043
Agriculture of forestry, hunting and fishery sector	-0.0080
Metal and non-metallic mining sector	0.3998

Handicraft industry sector	0.0088
Construction-repair and destroy sector	0.0372
Utilities and sanitary sector	-0.0131
Warehouse transit and transportation sector	0.0142
Commerce sector	0.0791
Service sector	0.0507

Note: From the calculation, Equation (8) the rate of change in technology and other factors besides L and K of Chachoengsao Province Also known as "Solow's Residual" (ΔT/T)

Table 3 Results of analysis of factors that determine technological change in the overall economic sector. and each production sector in Chachoengsao Province

Constant/ Independent variable	Regression coefficient			
	Overall economic sector	Agriculture of forestry, hunting and fishery sector	Metal and non-metallic mining sector	Handicraft industry sector
Constant	-0.044935	-0.013392	6.640543	-0.191086
	(-0.271242)	(-0.046482)	(2.487520)**	(-0.997116)
EUD	-0.000000	-0.000003	0.000021	0.000004
	(-0.414240)	(-2.445530)**	(0.093873)	(1.733057)*
BOI	0.000022	0.000011	-0.000026	0.000017
	(1.694624)*	(1.304070)	(-0.083487)	(1.320480)
FDI	-0.000001	-0.000000	-0.000006	-0.000001
	(-2.605373)**	(-0.739502)	(-0.523912)	(-2.251613)**
IMD	-0.000002	0.000000	-0.000012	-0.000002
	(-3.353739)***	(0.110702)	(-0.568885)	(-2.880517)***
IMP	0.000000	0.000000	-0.000016	-0.000000
	(0.865274)	(0.783684)	(-1.631520)	(-0.398101)
IR	-0.069178	-0.017043	-0.259800	-0.057658
	(-3.055674)***	(-1.013654)	(-0.414221)	(-2.092997)**
NET	0.000046	0.000040	0.000235	0.000025
	(1.221104)	(1.027537)	(0.715537)	(0.771813)
RAD	-0.000003	-0.000004	-0.000020	-0.000002
	(-0.957128)	(-1.181368)	(-0.485891)	(-0.789079)
TDI	-0.000000	-0.000000	0.000006	0.000000
	(-0.842940)	(-0.852177)	(4.187856)***	(0.836778)***
UM	0.000005	0.000015	-0.000153	0.000017

Constant/ Independent variable	Regression coefficient			
	Overall economic sector	Agriculture of forestry, hunting and fishery sector	Metal and non-metallic mining sector	Handicraft industry sector
	(0.471576)	(0.894827)	(-0.741560)	(1.405233)
R^2	0.594902	0.509641	0.953149	0.514092
Adjust R^2	0.265760	0.111224	0.851638	0.119292
F	1.807431***	1.279165***	9.38962***	1.302159***
D.W.	2.246202	1.718019	2.241893	2.320202
N	31	31	31	31

Source: From calculation

Note: Numbers in parentheses are t-statistics values.

***, **, * is statistical significance at the 99, 95, and 90 percent levels, respectively.

Table 3 Results of analysis of factors that determine technological change in the overall economic sector. and each production sector in Chachoengsao Province (continued)

Constant/ Independent variable	Regression coefficient				
	Construction-repair and destroy sector	Utilities and sanitary sector	Warehouse transit and transportation sector	Commerce sector	Service sector
Constant	-0.860820	0.152833	0.279991	0.137663	-0.068491
	(-2.661729)**	(0.838336)	(1.587395)*	(1.832354)*	(-0.742848)
EUD	-0.000021	-0.000004	-0.000008	-0.000023	0.000003
	(-2.024385)*	(-0.124233)	(-1.744620)	(-3.455646)**	(2.613305)
BOI	0.000016	-0.000006	0.000013	0.000006	0.000006
	(0.805029)	(-0.596393)	(1.203276)	(1.504620)	(1.449690)*
FDI	-0.000001	0.000000	-0.000000	-0.000000	0.000000
	(-1.789746)*	(1.258342)	(-0.360038)	(-3.132248)	(0.649017)
IMD	0.000002	-0.000001	-0.000003	-0.000001	-0.000000
	(1.355870)	(-1.309814)	(-2.408427)**	(-4.712382)**	(-0.146953)
IMP	0.000002	0.000000	0.000000	0.000000	-0.000000
	(3.456265)***	(0.025534)	(0.571138)	(2.990605)*	(-1.209187)
IR	0.019842	0.019141	-0.061773	-0.041342	-0.002765
	(0.463204)	(1.195228)	(-2.232154)**	(-3.386380)***	(-0.162539)
NET	0.000070	-0.000006	0.000043	-0.000002	-0.000006

Constant/ Independent variable	Regression coefficient				
	Construc-tion-repair and destroy sector	Utilities and sanitary sector	Warehouse transit and transportation sector	Commerce sector	Service sector
	(1.655046)*	(-0.213187)	(0.979177)	(-0.226645)	(-0.305633)
RAD	-0.000007	0.000001	-0.000002	0.000001	-0.000000
	(-2.104963)**	(0.570490)	(-0.506077)	(1.767581)	(-0.065914)
TDI	-0.000001	-0.000000	0.000000	0.000000	-0.000000
	(-2.720634)**	(-0.583609)	(0.608633)	(1.006556)	(-0.359384)
UM	0.000058	-0.000016	0.000003	0.000015	0.000000
	(3.366939)***	(-1.493324)	(0.188524)	(3.135919)	(0.038088)
R^2	0.711209	0.485184	0.397324	0.771467	0.483818
Adjust R^2	0.476567	0.066896	-0.02809	0.585784	0.06442
F	3.031036***	1.159928***	0.933961***	4.154746***	1.153601***
D.W.	2.199255	2.004845	2.144653	2.308115	2.158095
N	31	31	31	31	31

Source: From calculation

Note: Numbers in parentheses are t-statistics values.

***, **, * is statistical significance at the 99, 95, and 90 percent levels, respectively

Conclusion and Discussion

As a result of changes in capital and labor factors, the rate of change in technology in Chachoengsao Province has an effect on the growth rate of the overall economic sector by 0.0043 percent, and the highest production sector is the mining sector. Metal and non-metallic mining sector with a technology change rate of 0.3998 percent, followed by the Commerce sector, Service sector, Construction-repair and destroy sector, Warehouse transit and transportation sector and Handicraft industry sector with technological change rates equal to 0.0791, 0.0507, 0.0372, 0.0142, and 0.0088, respectively. It shows that results of technological change mostly result in increased economic growth. The whole economics sector as a whole and increased differently in each production branch in a positive direction. Because of the expansion of investment which has led to the introduction of modern technology and innovation to help increase productivity. Also, in the rate of change in technology that affects the rate of change in economic growth, it was found that the utilities and sanitary sector and agriculture of forestry, hunting and fishery sector have rates of technological change are equal to -0.0131 and -0.0080, respectively, indicating that the results of technological change do not have an effect on increasing economic growth. Because of the investment expansion is not hidden by technology and modern innovation still mainly uses traditional technology or labor factors to increase productivity.

As for the analysis of factors that determine technological change, it is found that the influence of factors that determine technological change is different for each production branch. However, it will be found that the overall economic sector and most production sectors include promoting investment in Chachoengsao Province and the number of unemployed workers in Chachoengsao Province has the most relationship in the same direction. Because of Chachoengsao Province have a large number of establishments and industrial estates and a large product production base of the country that produced for export and sale within the country, such as the automotive industry and automotive parts, electrical appliances and electronics industry. So, the promotion of investment in Chachoengsao province has increased that resulted to Chachoengsao province receiving modern technology, improve and develop production techniques, and the ability of producing. The results of these things are the level of technology increasing and the number of unemployed workers in Chachoengsao Province decreased that the ability of workers is also a determining factor in inventing, creating, manufacturing the innovations and modern technology to help the production of the production sectors that reflecting the increasing level of technology and the relationship in a negative direction in the overall economic sector and mostly sector. For example, national direct investment from abroad, national technology and patent fees, national inflation rate and national research and development expenses, it will reduces the rate of technological change and shows that the aforementioned factors are not hidden in the form of technology. Chachoengsao Province is 1 of 3 provinces that have been developed in the Eastern Special Development Zone. As for Chachoengsao Province, it has been designated automotive industry and automotive parts electrical appliances and electronics industry from special advantage because of it is located near the province that is a production base for the automotive industry. Chachoengsao Province has the Well grow Industrial Estate area, TFD Industrial Estate Chachoengsao Industrial Estate, Blue Tech City and Industrial Park 304 (Chachoengsao) it has the highest growth potential. In order to raise the level of competitiveness of the country and continue the development of the Eastern Seaboard area known for more than 30 years, also known as Eastern Seaboard.

Suggestions for Using Research Results

From the analysis of changes in technology in Chachoengsao Province both the overall economic sector and each production sector give importance to changes in technology and pushing to increased capital factors to solve the problem of decreasing efficiency of capital assets. The public and private sectors should support technology development. It brings more technology and innovation into the production process but must be careful. It is worth the investment spent on technology development in production. As for the production sector, changes in technology have resulted in decreased economic growth. The public and private sectors should support the use of capital factors rather than labor factors and push for more investment.

Analysis of technological changes shows that attention should be paid to domes-

tic inflation. This is a low level of inflation can attract more investment both domestically and abroad. Also, the technology is often hidden from increased investment including workers with a high level of education and solving the problem of decreasing unemployment rates in Chachoengsao Province which is important in improving and developing production techniques, production process and inventing modern technology due to human resources are an important force in every development in driving the country's economic system. This is to increase the value of products in the overall economic sector and each branch of production to be strengthened. In addition, the analysis of the factors that determine the change in technology of each production branch found that the fields of agriculture, forestry, hunting and fishing have also improved and developed production techniques are tiny modern production technology. Also, it should be more attention to developments in this sector because of it has been the original production branch of Chachoengsao Province and Thailand for a long time. In addition, Chachoengsao Province is a coastal city where has the natural resources and environment are abundant and a land of many important plants and fruits such as rice, cassava, rubber, mangoes, and coconuts. Moreover, the Bang Papong River is an important river flow through it formed from the combination of the Nakhon Nayok River and the Prachinburi River where flows together in the area of Bang Taen Subdistrict, Ban Sang District, Chachoengsao Province. It flows from the north through the low plains and the middle part flows through the lower part to the south and out into the Gulf of Thailand at Pak Ma Subdistrict, Bang Khla District, Chachoengsao Province. Therefore, it is a strategy for development that connects the central and northeastern regions of Thailand suitable for promotion in all sectors of production in domestic and abroad. It also causes of the number of workers in agriculture, forestry, hunting, and fishing are still amount more than every sector of production. It should promote both of training and skill training in the sector or vocational sector. In addition, the industrial and handicraft sector are the most important to the production value of Chachoengsao Province. It should provide exceptionally high investment benefits also supports foreign investment, direct investment from abroad, investment promotion continuous development of technology and research. Along with entrepreneurs in the country complete with facilities for doing business and push for stable investment, provides an area for strength and spread to the area that was the original production base in every production sector that affects to the mechanism for driving the economy in the future of Chachoengsao Province and Thailand.

Suggestions for Next Research

From the analysis of changes in technology in Chachoengsao Province or other provinces if you want to study the impact of technological change to the overall economic growth and information of the factors that determine technological change. The important information should be actual information from Chachoengsao Province, such as research and development cost factors, technology and

patent fee factors, factors in the value of importing machinery from abroad, foreign direct investment factors and other factors that affect to changes in technology stored at the provincial level. Some types of information were still stored at the national level. If data is stored at the provincial level it will make the analysis results very clear and affect to development and promotion at the provincial level.

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