MENDEL UNIVERSITY IN BRNO

Faculty of Regional Development and International Studies

Assessment of Socio-economic Development of Provinces in Indonesia in the Context of Palm Oil Production and Deforestation

Diploma Thesis

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Abstract

The thesis deals with the creation of composite indicators in order to compare the social and economic development of Indonesian provinces selected on the basis of the extent of palm oil production. The theoretical part provides the basic overview of the concept of regional development and description of the process of composite indicators creation. The analytical part is focused to creation of composite indicators and also contains correlation and cluster analysis. In the final part are proposed recommendations on how to improve the situation regarding the palm oil production in Indonesia.

Keywords: *palm oil, Indonesia, composite indicator, socio-economic development*

Abstrakt

Diplomová práca je zameraná na vytvorenie kompozitných indikátorov na porovnanie sociálneho a ekonomického rozvoja provincií Indonézie vybraných na základe miery produkcie palmového oleja. Teoretická časť sa zaoberá regionálnym rozvojom a popisuje proces tvorenia kompozitného indikátora. V analytickej časti je následne skonštruovaný kompozitný indikátor. Táto časť práce taktiež obsahuje zhlukovú a korelačnú analýzu. V záverečnej časti sú navrhnuté odporúčania, ako zlepšiť situáciu v oblasti produkcie palmového oleja v Indonézii.

Kľúčové slová: *palmový olej, Indonézia, kompozitný indikátor, socio-ekonomický rozvoj*

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List of abbreviations

BBC	British Broadcasting Corporation
BPS	Indonesian Central Bureau of Statistics
CIA	Central Intelligence Agency
CPO	Crude Palm Oil
CR	Czech Republic
FDI	Foreign Direct Investment
FONAP	Forum for Sustainable Palm Oil
GBG	Global Business Guide
GDP	Gross Domestic Product
GFW	Global Forest Watch
GRDP	Gross Regional Domestic Product
IDR	Indonesian Rupiah
ISPO	Indonesian Sustainable Palm Oil
MT	Metric Tons
NER	Net Enrollment Ratio
NGO	Non-Governmental Organization
OECD	Organization for Economic Co-operation and Development
OFI	Orangutan Foundation International
PCA	Principal Component Analysis
PRB	Population Reference Bureau
RSPO	Roundtable on Sustainable Palm Oil
UN	United Nations

USD	United States Dollar
USDA FAS	United States Department of Agriculture, Foreign Agricultural Service
WB	World Bank
WHO	World Health Organization
WWF	Worldwide Friends

Introduction

Palm oil is an edible vegetable oil obtained from the fruit of oil palm tree native to West Africa. Due to its high yields, long life span, low cost of production and a wide range of industrial usage, palm oil tree is nowadays cultivated as a plantation crop in almost all tropical areas abundant on rainfalls. Palm oil can be found literally everywhere. It is the world´s most consumed vegetable oil, and it is contained in more than half of the packaged products being sold in the Western supermarkets. In recent years, the expanding global demand for palm oil for food, cosmetics as well as for biofuels production has triggered increasing large-scale investment of this crop particularly in Southeast Asia. Nowadays Indonesia, one of the world´s largest economies, dominates the global market with palm oil, having the leading position as the producer as well as the exporter of this commodity.

It is believed that production of palm oil delivers the socio-economic development to regions where it is cultivated. It generates significant revenue for local governments, stimulates economic growth, provides job opportunities, reduces poverty and has an important spillover effects on the improvement of general living conditions. However palm oil plantations are rapidly expanding at the expense of the loss of rainforests' precious biodiversity and increasing amount of greenhouse gasses in the atmosphere. Furthermore, palm oil production has also caused conflicts between palm oil companies and indigenous communities, who seek to defend their land rights against expanding plantations development. Since 2015 a broader public has become more aware of the problems related to the palm oil production, when forest fires ravaged the areas of Sumatra and Kalimantan, having destructive consequences on the environment and human health.

I chose the topic *Assessment of socio-economic development of regions in Indonesia in the context of palm oil production and* deforestation, because I want to find out, if the regions, where the palm oil is produced, are really better off in the socio-economic terms, since the environmental consequences are destructive. In order to assess the level of social and economic development of the Indonesia´s regions, I will use the statistical method of composite indicator.

Composite indicator serves as a statistical measure that enables to analyze and compare the development of individual territorial units. It is increasingly recognized as useful tool for the policy analysis and communication with the public, since it has the ability to integrate large number of information into easily understandable formats for a general audience. In recent years, composite indicator is largely applicated to assess areas such as environmental situation, sustainable development or economic performance.

The thesis is divided into three main parts. First part is literature review, which is divided into two main subchapters. Firstly it characterizes and describes the concept region, its development and regional disparities and secondly it explains the process of composite indicator construction. The second part is analytical part, which is principally focused on the computation of composite indicators for both social and economic development of each of the selected provinces. The context of palm oil production and deforestation is included as well. The closing part of the thesis is focused on the proposal part, which will include my subjective recommendations and suggestion for the improvement of situation with palm oil production in Indonesia.

Objectives

The principal objective of the thesis is to examine the relationship between palm oil production and the standard of living in selected provinces of Indonesia by comparing the economic and social development performance based on the construction of composite indicators. Secondary objective is to examine the relationship between the palm oil production, deforestation and economic indices.

There are 2 hypothesis formulated in the following way:

- Hypothesis 1: Palm oil production contributes to the socio-economic development of regions.

- Hypothesis 2: Production of palm oil results in high level of deforestation.

Methodology

In order to achieve the objectives of the diploma thesis, it is necessary to use specific scientific methods, which enable the processing of the data and the subsequent evaluation and formulation of the conclusions and recommendations. There are several methods used in this thesis. One of them is the review of literature using the books, scientific articles, reports and relevant internet sources related to the topic in order to familiarize with the given issues and to provide suitable theoretical framework. The "Handbook on Constructing Composite Indicators" by OECD provides an useful manual for construction of composite indicator. The other method comprises of analysis of secondary data in order to create the composite indicator. The data are collected from the Internet databases of the World Bank, the Indonesian Central Bureau of Statistics and the Global Forest Watch.

Furthermore, the thesis includes composite indicator analysis, cluster analysis and correlation analysis. Prior to the composite indicator analysis, the normality of data are tested by the Shapiro-Wilk normality test, while outliers are detected though the Grubbs' test. In order to summarize the basic features of the studied data, descriptive statistics and correlation analysis is used. The data are subject to normalization by using the z-scores method. Based on my opinion, to the indicators are assigned weights by method of pairwise comparison to express their importance. The resulting values are aggregated. On the basis of the final results is assessed the impact of palm oil production on both economic and social development. For the classification of the provinces based on their level of socio-economic development is used cluster analysis. For the identification of clusters is used Ward´s method in combination with Squared Euclidian distance. Afterwards is analyzed the relationship between palm oil production, deforestation and economic indices by using the correlation analysis.

The substantial part of the analytical section is processed by the statistical software Statistica, which enables to present the results in the form of tables and charts. Rest of the results and figures are calculated using the spreadsheet Microsoft Excel. In order to provide analysis based on medium-term observation, means of data from 2009 to 2013 are calculated and they are used for the computation in the analytical part. The analysis of long-term period was not possible due to the limited availability of the data.

1 Literature review

1.1 Region, regional development and regional disparities

1.1.1 Region

The notion of region has its origins in Latin word "Regio" having the meaning of border, cardinal direction, administered region or historical term referring to administrative units. Some sources also derive the term region from the Latin word "Regere" which means to rule, or control, or from Latin "Rex" which means King or "Regnum" that means empire. (Dušek, 2011, p. 6)

Nowadays concept of region is understood in different terms and various scientific areas such as geography, politics, sociology or economics, so there is lot of different definitions. (Žižka et al., 2013, p. 30) Specific determination of characteristics for regions depends on the author and the intentions with which the region is identified. (Redlichová, 2013, p. 14) Most generally, region can be seen as area or part of territory with particular characteristics and defined borders. (Skokan, 2004, p. 44) When the social criterions become the priority, the regions are understood as territorial units, in which vital functions of the population including work, housing, education, interests, and social security occur. (Jaderná, 2012, p. 14) Region can be also perceived as a complex dynamic spatial system that originated on the Earth's surface based on the interaction of natural and socio-economic features. (Bašovský and Lauko, 1990, p. 15)

Classification of regions

In literature we can find a number of efforts to create typologies of regions based on various criterions. Regions can be classified according to one or more criterions depending on complexity of the division. (Wokoun 2008, s. 282)

One of these essential classifications is carried out based on the nature of region´s internal structure and distinguishes two basic types of regions - homogenous and heterogonous. Homogenous regions are characterized by similarity of its characteristics, while the demarcation of homogeneous regions aims at detection of resemblance, not at finding the relations. The homogeneity of characteristics can be useful for an analysis of specific criterion without excessive fragmentation and subsequent application of tools of regional policy in order to deal with unsatisfactory situation or on the contrary help to maintain a satisfactory situation. (Redlichová, 2013, p. 14) Homogenous regions generally occur more frequent in physical geography than in socio-economic. Heterogeneous regions are defined based on the interconnection of specific elements and consist of one or more nodal centers. (Wokoun et al., 2009, p. 87) The linkages represent primarily imports and exports of goods and services and movement of people. The interconnection creates networks within the heterogeneous region. Heterogeneous regions are also denoted as function regions, since units are linked to them based on their functions. (Redlichová, 2013, p. 15)

From the view of the delimitation of territorial space, three major types of regions can be defined: supranational, transnational and subnational. (Žižka et al., 2013, p. 39) While supranational and transnational regions usually differ from each other by currency, laws, custom regulations, the subnational regions are characterized by sharing of these institutions with other regions of given country. Subnational region is defined as a part of one state or one national economy, which is usually not separated from other regions by formal boundaries and other economic barriers, so among regions occurs relatively unlimited exchange of goods, capital, people and knowledge. The barriers are perceived only as different economic and social structures, cultural differences and distances. An example of such a region can be cantons in Switzerland. (Ježek, 1999, p. 27-28) Supranational regions represent geographically adjacent groups of countries, such as Latin America, Middle East or Benelux. Transnational regions comprise of part of the territory of two or more states thus transcend national boundaries. These regions usually share common history, ethnical and cultural affinity, similar regime and political and social system. (Žižka et al., 2013, p. 39) An example can be the Euroregion Tyrol, which partially covers the territory of Austria and Italy. (Ježek, 1999, p. 27-28)

In terms of the purpose of the region, two major types of regions are distinguished: administrative and purpose region. Administrative regions are created for purposes of state administration and local self-government, thus it is understood as a political territory. They are established by higher administration through division of the state on a smaller territorial units These regions are relatively stable over time, always cover the whole territory of the specific country and they are always represented by the competent authorities. (Žižka et al., 2013, p. 34) The purpose regions are set up in order to solve specific issues, such as economic backwardness, quality of the environment or protection of natural habitat. These regions tend to have limited lifespan and they may or may not respect boundaries of the administrative regions. These regions are usually represented and managed by special body, not by administrative authority. (Redlichová, 2013, p. 17)

There are many other definitions, concepts and typologies of the regions, however for the purposes of the thesis, region will be further considered under the subnational concept, thus as a part of national territory - territorial unit. Region will be understood as a system comprised of individual elements such as people, capital, natural resources, companies, products, public institutions and infrastructure, among them certain links and relationships exist.

1.1.2 Regional development

Regional development is from the scientific point of view relatively young discipline whose origins date back to the thirties of the 20th century. (Wokoun, 2008, p. 11) Since then different views from various authors have been formed.

Kutscherauer et al. defines regional development as a balanced and dynamic growth of socio-economic as well as environmental potential and region´s competitiveness leading to improvement of quality of life of its inhabitants. He considers the key factors of regional development to be natural resources, physical factors in the form of production potential and infrastructure, innovations and human resources. (2013, p. 3-5)

According to Minařík et al. (2013, p. 17-23), regional development is a process of sustainable improvement of quality of life in region through continuous achievement of economic, social, environmental or other changes in the region without threat or serious deterioration of life of future generations. According to this author, successful regional development generally increases quality of life in the given region.

Hrabánková (2002, p. 56) perceives regional development primarily in terms of the permanent securing of sustainable balanced development of state´s regions and local districts of newly established counties and municipalities. Very important is the coordination of competencies among organs of public administration and local government, which by using of principles of economic and social cohesion continuously contributes to the reduction of disparities between regions based on predetermined objectives and priorities with a preference of regions lagging behind.

Damborský (in Wokoun et al., 2008, p. 11) perceives the concept of regional development from a different perspective and defined two basic approaches to it: practical and academic. Practical approach, typical for self-government or private sector, perceives regional development as a process of better utilization and increasing of the potential of given territory caused as a consequence of spatial optimization of socio-economic activities using of natural resources. This results in improvement quality of life for citizens and state of environment or increased competitiveness of the private sector. Based on this approach, region´s potential can be measured by GDP per capita, unemployment rate, average wage, educational structure and quality and availability of infrastructure. On the other hand academic approach recognizes regional development as application of disciplines involving economy, geography and sociology that deals with processes, phenomenon and relations of territories influenced by natural-geographic, economic and social conditions in the region. This concept of regional development is denoted as regionalism and is typical for academic sphere. It is fundamental to search for causative dependencies, deployment of economic activities, uneven settlement of areas and subsequent creation of instruments to influence these processes.

Buček et.al (2010, p. 63) claim that successful region development is the most effective combination of general principles of compromises, which, however, take into account the current situation and history of the region. Therefore definitions of regional development have widened and nowadays include economic, social, environmental, political and cultural aspects.

According to Liptáková (2007, p. 610) regional development is a process, which creates a viable and productive region. One of its main goals is to boost long-term process of building competitiveness of the region through maximal utilization of local potential and spatial specificities. In regional development is important to support development of sub-activities, which together form the economic foundation of the region, particularly introduction of new technologies, improvement of labor skills and use of new energy sources and materials. Regional development as a result of the effective operation of regional policy should also provide financial and methodological assistance in areas, where the aid is needed.

From the above mentioned definitions follows that regional development can be generally understood as the improvement of existing conditions in the region, including standard of living of the population, technical and transport infrastructure, increase of entrepreneurial activity, rise of quality of environment or increase of region´s attractivity for tourists.

1.1.3 Regional disparities

There are various definitions of regional disparities found in literature, however as the most universal can be the one provided by Kutscheraue et al. (2013, p. 45) According to this author, regional disparities are characterized as a difference or disproportion of various features or processes having a specific territorial area while being situated in at least two entities of defined territorial structure.

Adamčík (1997) defines regional disparities as difference in value of indicators that characterize level of development of regions.

Ministry of Regional Development CR (2006, p. 7) defines regional disparities more precisely and characterizes them as the differences in the level of economic, environmental and social development of the regions at the rate that is socially recognized as undesirable. Regional disparities cannot be considered as differences resulting from diversity between regions and its resulting differences in the quality of life such for example in urban or rural areas where the pros and cons outweigh each other.

Regional disparities are one of the main reasons for the existence of regional policy. Elimination of regional disparities is then the primary purpose of regional development in order to achieve growth in prosperity of region. A crucial role plays economic development based on business development with the support of regional infrastructure along with social and environmental development. (Skokan, 2004, p. 13)

Regional disparities can be basically divided into negative and positive disparities. Negative disparities are characterized by key vulnerabilities, such as lack of resources or insufficient ability to utilize available resources. On the other hand positive disparities are characterized by comparative competitive or comparative advantages, which generally consist in unique and valuable resources and skills to utilize these resources. (Kutscheraue et al., 2013, p. 48-49)

According to Skokan (2013, p. 34) based on the cause of disparity origin, regions can be generally classified among three main types of so-called problem regions:

- regions with insufficient utilization of own resources, usually due to the shortage of own capital
- and regions with stagnate, declining primary industry sectors which belonged in the past to the so-called traditional sectors among developed

The identified regional disparities are based of sphere of occurrence further divided into social disparities that are related to the population in terms of quality of life, living standards and social inequality; economic disparities regarding the economic performance and its structure of development and human potential; and territorial disparities, which reflect position of the region in the context of geographic, natural, technical and transport conditions. (Kutscheraue et al., 2013, p. 54)

Factors of regional development

Factors of regional development are variable over time that is on one hand related to the degree of understanding of socio-economic processes and on the other hand, they are subject to change due to the development of structures and their interaction. (Ministry of Regional Development, 2006, p. 12) There exists number of different factors affecting the development of regions proposed by various authors; however in many cases the causalities are difficult to identify. Generally, regional disparities occur on the basis of more or less interacting factors. Kutscherauer et al. proposes two polarity dimensions of the emergence of regional disparities: spontaneously emerging disparities (spontaneous) and disparities produced by human activities. While spontaneous disparities rise due to the geographic or source asymmetric shocks such as floods, windstorms and calamities, disparities produced by human activities are caused by economic activities, political influences or external economy. (Kutscheraue et al., 2013, p. 53-54)

Klaassen and Vanhove (Klaassen, Vanhove 1987; Vanhove 1999) propose several factors of formation of regional disparities, dividing them into two main groups: primary and secondary factors. Among primary factors belong:

- relatively low labor mobility

Relatively low labor mobility occurs due to the fact that labor force does not respond immediately to differences in wages. Workers react slowly those results in regional deformation in revenue.

- relatively low capital mobility

Capital is theoretically considered very mobile; however in reality the response of capital to the differences in production costs is very rigid, particularly if capital market is not sufficiently developed.

- geographical factors

Geographical factors of disparities are given by natural conditions. Some regions are rich on natural wealth, such as coal or oil, from which they can benefit. In contrast, other regions have poor natural conditions for economic development.

- economic structure of regions

Each region has a typical economic structure. When is the region focused on developed industries, then prospers under normal conditions and the demand for labor force is growing. Some regions, however, are economically based on the decadent industries whose products after demand for products fell and the result is that they have to deal with high unemployment.

- other primary factors

Other primary factors regional disparities include institutional factors (centralization or decentralization of state institutions), political decisions on constitutional and territorial arrangements, psychological factors and others.

The secondary factors stem from primary factors and include:

- external economy

Parameters such as transport system, contact with central authorities, technical and financial infrastructure in the neighboring regions have a huge impact on the influx of new companies to the region and are closely linked to the developing regional poles.

- demographic situation

In terms of the demographic situation, differences in education, age composition or population increments.

- rigidity of costs and prices

Natural adaptation to changes in market supply and demand in some regions is not possible. A typical example is the coal market. If the demand for coal falls down, the price will be not automatically reduced, because the relative wages are rigid.

- environmental factors

An important factor is regional environmental image or attraction. Regions that are appealing attract more investors. On the contrary devastated regions are not so attractive, thus the reconstruction is important in order to become more attractive to foreign capital.

Hudečková et al. (2005, p. 118) suggests a number of factors affecting the formation of regional disparities, which include:

- administrative factors - different structure of regions with different number of population, municipalities and various size of territory
- historical factors - due to the historical circumstances, some regions began to develop sooner, others later
- geographical, climate and geological factors - position of the region within the state, the presence of various natural resources, climate and altitude
- environmental factors - state of environment, agricultural land and forests
- economic factors - structure of the region's economy, income of the population and unemployment
- infrastructural factors - different ability to access existence and possibilities to use of technical and social facilities
- political factors - different political elites in the region and political affiliations of the population
- demographic factors - different population structure and different types of migration
- and socio-cultural factors - different social status of population, education and civic engagement.

According to Skokan (2004, p. 13-14) the development of regions and its structure is affected by number of so-called localization factors, which influence both the settlement structure as well as the location of companies and institutions in the region. Knowledge of these factors allow to influence own regional development. These factors include natural conditions that nowadays receive an importance again; availability of production factors such as land, labor and capital; access to sources of production inputs and market access; spatial distribution of resources and transport infrastructure; the level of technological progress expressed by the existence and further development of technical skills to achieve more effective combination of production factors; presence of large national and multinational companies, or their subsidiaries in the region; agglomeration effects as a result of the concentration of companies and settlements; level of technical and institutional infrastructure and public services; regional environment or climate contributing to the formation and growth of new businesses, to innovation and to communication networks within the region; the presence of skilled workforce, network of suppliers and services and links to markets that are particularly significant for small and medium businesses as well as intangible or soft localization factors such as social environment, the attractiveness of conditions for housing, leisure activities and recreation options.

Liptáková (2007, p. 611-612) considers human resources to be one of the most significant factors of regional development. She wrote that human resources affect the development of regions in two ways. Firstly they act as a source of labor supply, where age and especially qualification structure of population plays an important role that investors take into account in their localization decisions. Secondly the citizens as consumers determine the development of production and range of services in the region. On the other hand, structure of companies operating in the region is an important factor influencing the quality and quantity of regional human resources. The companies contribute to the improvement and extension of educational activities in order to increase the level of regional human resources and to overcome barriers to the development of enterprises in the region. The human potential contributes directly to the labor productivity, adoption of technologies and indirectly improves the health status of the citizens, quality of interpersonal relationships and creation of environment with higher engagement and civic participation.

$$B_{ij} = \frac{X_{ij}}{X_{i\,max}}$$

Similarly Ministry of Regional Development CR (2006, p. 12) perceives human resources to be the most important factor of regional development for post-industrial societies and along with this include natural resources as long-term determinants of regional development, production potential, infrastructure, innovation and information and communication technologies.

Measurement of regional disparities

In scientific literature, there are plenty of models that can be applied to assess regional disparities. Nowadays regional disparities are evaluated principally through methods of interregional comparison, where selected regions are compared based on experience and knowledge or through statistical methods. Kutscherauer et al. (2013, p. 66-72) recognize three major methods for measurement of regional disparities based on explanatory power of obtained results and simpler computational complexity of the method. These methods involve semaphore method, point method and method of standard variables.

The principle of semaphore method is to assign symbols to individual indicators. These symbols are illustrated as three rings in the colors of traffic lights (green, orange and red) and correspond to a certain percentage level of examined indicator. Likewise it can be used in shading of table cell. In this way, synoptic color ranges from minimal to maximal value will originate. Main advantages of this method are good clarity, simplicity of creation and usability in analyzing of various broad categories of indicators.

The aim of point method is to identify a region, which reach minimal (decline of indicator) or maximal (increase of indicator) values. This region is subsequently within scoring rated by 1,000 points, while other regions score points in the interval 0 - 1,000. These points are calculated based on the amount of per mille that represent value of their indicator of the previously set criterion value. The basic equation to calculate the point value of the relevant indicator if the maximum is:

$$B_{ij} = \frac{X_{ij}}{X_{i\,max}}$$

In the case of minimum, the equation is:

$$B_{ij} = \frac{X_{i\,min}}{X_{ij}}$$

where: B_{ij} is the point indicator of i-th indicator for j-th region

X_{ij} is the value of i-th indicator for the j-th region

$X_{i\,max}$ is the maximal value of i-th indicator

$X_{i\,min}$ is the minimal value of i-th indicator

Summation of calculated points gives the final value of the aggregate indicator that is possible to use in order to determine the extent of disparities emerging between regions. Main advantage of point method is the feasibility to assemble together values measured in different units.

Method of normalized variables is based on the formula calculation though which the average value of the standardized variables are calculated. The equation has the following form:

$$U_{ij} = \frac{X_{ij} - X_{i\,max}}{S_{x_i}}$$

or:

$$U_{ij} = \frac{X_{i\,min} - X_{xij}}{S_{x_i}}$$

where: U_{ij} is the normalized value of i-th indicator for j-th region

S_{x_i} is the standard deviation of i-th indicator

Similarly to the previous example, the normative variable is dimensionless. This allows summarization of the calculated values and comparison based on the overall scores. The advantage of this method is consideration of the relative variability of indicators included in the relevant index that allows overcoming the absolute variability that is contained in the point method.

According to Hamada (2014) among other appropriate methods for assessing the regional disparities belongs Gini coefficient that provides information about disparities by using the degree of concentration. Values of Gini coefficient can take a range of values 0 – 1, whereas a lower value indicates more even distribution of values of variables and thus minimal regional differences, while the higher value refers to more significant regional inequalities. Gini coefficient is closely related to the Lorenz curve, which graphically indicates the degree of differentiation. Axes of the graph represent cumulative totals of the percentage share of the studied phenomenon, reaching the values 0 - 100%. (Antonescu, 2010, p. 160-164) One axis represents studied phenomenon, while the second represents their value in percentage. The shape of the concentration curve resulting from joining points expressing the cumulative value of examined phenomenon in percentage reflects their level of differentiation or concentration. As the concentration curve deviates more from the square diagonal, disparities are larger, thus the concentration is stronger and vice versa. The main advantage of this method is its illustration character. (Spienzia, 2003, p. 2-3)

1.2 Composite indicator

Composite indicator is a statistical method valued mainly for its ability to integrate large number of information into easily understandable formats for a general audience. (Freudenberg, 2003, p. 5)

Generally, composite indicators are used to summarize number of substantial individual indicators or variables. Indicator is used to indicate a relative position in a specific area. When measured over time, the direction of change as a quantitative or qualitative measure derived from a series of observations may be identified as well. (Freudenberg, 2003, p. 7) While individual indicators assess the regions from various, often contradictory points of view, composite indicator constructed from them provides more complex, integrated and synthesizing view. (Minařík et al., 2013, p. 125)

Nowadays, composite indicators are increasingly recognized as an important instrument for policy making, and particularly, public communication on countries' relative performance in wide range of areas such as the environment (e.g. the Environmental Performance Index), the economy (e.g. the Internal

Market Index), human development (e.g. the Human Development Index) or technological development (e.g., the Technology Achievement Index). (Cherye et al., 2009, p. 2)

Composite indicators usually compose of number of sub-indicators with different units of measure and various level and variability, while the degree of interdependence between the pairs of particular sub-indicators varies as well. In addition, partial sub-indicators do not always share the equal weights. For these reasons, it is important to follow the procedure of consecutive steps. These steps will be further described. (Minařík et al., 2013, p. 124-125)

1.2.1 Selection of sub-indicators

In order to construct composite indicators, the sub-indicators should be selected the most appropriately. Selection of sub-indicators largely affects the strengths and weaknesses of the composite indicators. (Nardo, 2005a, p. 13) The choice should be determined based on the analytical soundness of the variables, their measurability, and relevance to the phenomenon being measured as well as the mutual relationship among them. (Freudenberg, 2003, p. 8)

From the factual-logical point of view, it is necessary to distinguish between min and max types of indicators, where max type of indicator tries to achieve the highest values (such as economic performance or employment) while min type of indicator efforts to achieve the lowest values (such as crime or malnutrition). Another criterion is the opt type of indicator that is characterized by an effort to reach optimum value, such as for example median of age. The opt type of indicator should be easily convertible to the min type criteria. Furthermore statistical criteria such as skewness, kurtosis, extreme values and correlation should be examined since they could negatively influence the overall result. (Minařík, 2013, p. 123-124)

1.2.2 Detection of missing values

There are many reasons for causes of missing values from accidental causes to religious, ideological or strategic reasons. The approximate share of values in the analysis should not exceed 5%. (Minařík, 2013, p. 124) Data can be missing in a random or non-random fashion. In more detail we can distinguished among three major missing patterns of values: missing completely at random, which do not depend on the variable of interest or any other variable from the dataset; missing values at random that are not dependent on the variable of interest, but on other variable from the dataset; and finally not missing at random that includes data dependent on the values themselves. (Nardo, 2005a, p. 16) According to OECD (2008, p. 24) the problem of missing data can be generally solved in three possible methods: case deletion, single imputation and multiple imputation. The first method of case deletion simply skips the missing records from the analysis, thus it ignores the differences among complete and the incomplete samples and errors may more likely occur. The other two methods consider the missing data as part of the analysis and therefore try to impute values through either single Imputation by means of mean, median and mode substitution, regression imputation or expectation-maximization imputation; and multiple imputations by using for example the Markov Chain Monte Carlo algorithm. (OECD, 2008, p. 24-25) The main advantage of imputation is the minimization of distortion and the use of important data that would otherwise be discarded. However, single imputation underestimates the significance of variance, because it reflects partially the imputation uncertainty. The multiple imputation method providing several values for each missing value may more effectively represent the uncertainty due to imputation. (Nardo, 2005a, p. 17)

1.2.3 Basic characteristics

The first phase of data processing for construction of composite indicator is the calculation of basic statistical characteristics, which describe the change of the statistical features depending on the properties of the data set.

1.2.3.1 Descriptive statistics

Descriptive statistics are used to quantitatively describe and summarize the basic features of the studied data set. The measures used to describe the data include calculation of central tendency, variability, symmetry, concentration, correlation and minimum and maximum value. In the following text are further described these basic characteristics.

Central tendency

The measure of central tendency, also referred to as measure of central location, is a measure that attempts to describe a whole set of data by identifying the central position within that data set with a single value that represents the middle or center of its distribution. The arithmetic mean, mode and median are three most common measures of central tendency. Under different conditions, some measures of central tendency are more suitable to use than others.

The arithmetic mean is defined as the sum of the value of each observation in a dataset divided by the number of observations, represented by a symbol $\bar{x}$. It is most commonly used of all location statistics since its clear meaning and ease of computation. The formula for its computation is (Lane):

$$\bar{x} = \frac{1}{n}\sum_{i=1}^{n} x_i$$

However arithmetic mean is susceptible to the influence of outliers. Outliers are understood as values that are substantially different in comparison to the rest of the data set by being particularly low or high in the numerical value. In addition to arithmetic mean, there is as well geometric mean, harmonic mean and quadratic mean. (Gale, 2008)

The mode is defined as the most frequent score in the analyzed data set and it is represented by a symbol$\hat{x}$. It is used to find not the average, but the typical value of the data set. It is possible to have two modes (bimodal), three modes (trimodal) or more modes within larger sets of numbers. In some cases, mainly where the data are continuous, the distribution may have no mode at all. Graphically, mode is pictured as the peak of histogram. (Rouse, 2014)

The median is the middle value in distribution when the values are sorted in ascending or descending order. It is denoted by symbol $\tilde{x}$. If a data set comprises of odd number of values, then the middle value is the median of the set, while if the set consists of an even number of values, then the median is the average of the two middle values. The main advantage of this measure is its useful property in case of any outliers in the dataset. (Joseph, 2014)

Variability

Variability refers to how is the group of values spread out. Usually it is computed by measures of range, variance, standard deviation, coefficient of variation and minimum and maximum.

Range is the simplest method of variability to measure and it is calculated as a difference between the largest and smallest values in a set of values. Its disadvantage is the susceptibility to the presence of outliers. The formula for computing is: (Gale, 2008)

$$R = x_{max} - x_{min}$$

Variance is used to measure the deviation of a data set from the mean value and it is denoted with a symbol s^2. Variance is rarely useful with an exception to calculate the standard deviation. (Joseph, 2014) The formula for measurement of variance is: (Pezzullo)

$$s^2 = \frac{\sum(x_i - \bar{x})^2}{n-1}$$

Standard deviation is calculated by square rooting the variance of the data, which is of the same unit as the elements of the set. This measure gives a more exact account of the dispersion of values in a set of data and is often used as a trusted statistical quantity to make appropriate statistical calculations. A low value of standard deviation indicates that the data is tightly clustered, while the high value indicates the greatest dispersion of the data set. Its computation formula is: (Joseph, 2014)

$$s = \sqrt{s^2}$$

Coefficient of variation is a measure expressing the range of values around the mean, abbreviated as CV. It reflects how the values vary from the mean (average), thus how densely they are grouped around this average. It can be expressed either as a fraction or as a percentage. The formula for its measurement is: (Orfano, 2012)

$$CV = \frac{s}{\bar{x}}$$

Minimum represents the lowest value in the data file. Its opposite is defined as a *maximum*.

Skewness

Skewness is a measure of symmetry, or more precisely, the lack of symmetry. It measures the extent to which the data are not symmetrical. The formula for coefficient of skewness (k_3) is:

$$k_3 = \sum_{i=1}^{k} \frac{(x_i - \bar{x})^3}{ns^3}$$

A distribution is perfectly symmetric if it looks the same to the left and to the right from the center point and k_3 is equal to 0. If k_3 is bigger than 0, the distribution is assymetric right-sided, while k_3 is lower than 0, we talk about left-sided asymmetry. In both cases, the distribution is skewed.

If the skewness ranges between -0.5 and 0.5, the data are fairly symmetrical, if the skewness is between -1 and – 0.5 or between 0.5 and 1, the data are moderately skewed and in the case the skewness is less than -1 or greater than 1, the data are highly skewed. (McNeese, 2016)

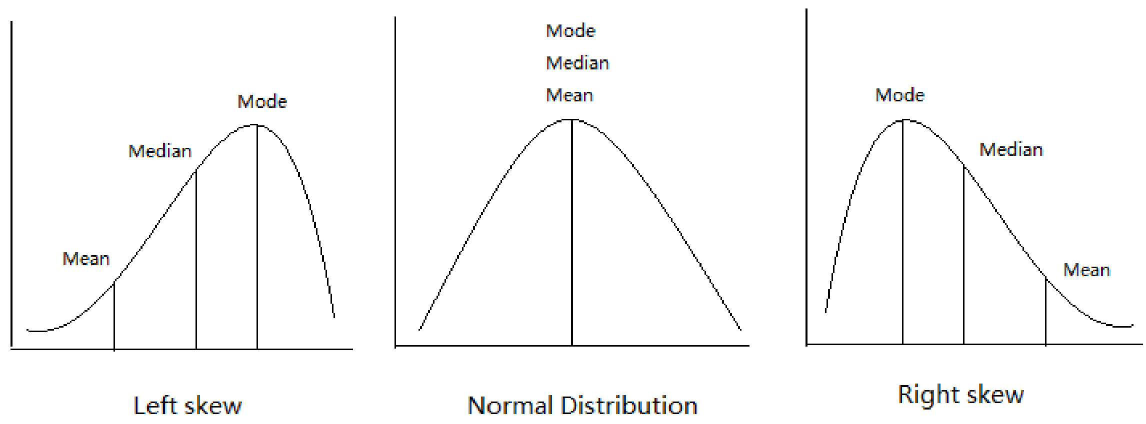

Figure 1: Skewness (Source: McAusland, 2015)

Kurtosis

Kurtosis refers to the degree of peak in a distribution of the data. It provides a measurement about the extremities of the distribution of data, and thus indicates the presence of outliers. The formula for the calculation of coefficient of kurtosis (k_4) is:

$$k_4 = \sum_{i=1}^{k} \frac{(x_i - \bar{x})^4}{ns^4}$$

If k_4 is equal to 0, the kurtosis is normal relative to the normal “Gaussian” distribution. If the k_4 is higher than 0, the distribution is peaked and greater than normal kurtosis, while if the k_4 is lower than 0, it indicates flat distribution, thus the distribution is lower than normal distribution. (McNeese, 2016)

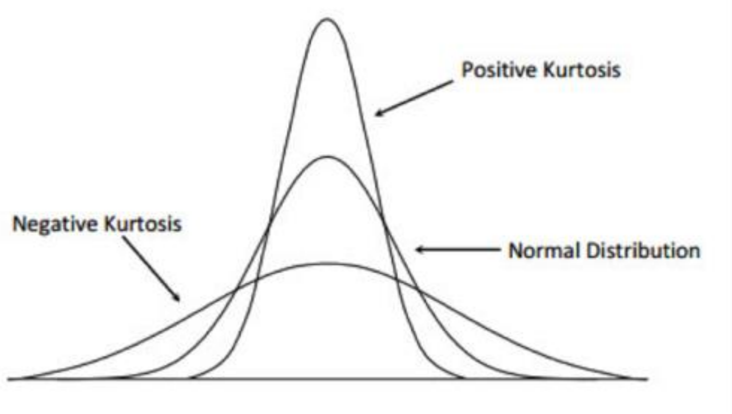

Figure 2: Kurtosis (Source: Tam, 2015)

Histogram is for both the skewness and kurtosis of data an effective and widely used graphical technique.

1.2.3.2 Correlation analysis

Correlation analysis is a statistical method used to study the degree of relationship between two observed variables. It is measured by Pearson coefficient of correlation, which takes the numerical values between (-1.00, +1.00) and is denoted with a symbol *r*. The formula for its computation is (McAusland, 2015):

$$r = \frac{n(\sum xy) - (\sum x)(\sum y)}{\sqrt{\sum(x-\bar{x})^2}\sqrt{\sum(y-\bar{y})^2}}$$

The correlation coefficient is interpreted in the following way:

- values ranging from 0.9 and 1.0 or -0.9 and -1.0 indicate a very high correlation
- values ranging from 0.7 and 0.9 or -0.7 and -0.9 indicate a high correlation
- values ranging from 0.5 and 0.7 or -0.5 and -0.7 indicate a moderate correlation
- values ranging from 0.3 and 0.5 or -0.3 and -0.5 indicate a low correlation
- values between 0.3 to -0.3 have little if any (linear) correlation
- when there is no relationship between variables, it is recognized as a 0 correlation. (Calkins, 2005)

Graphically, a positive slope on a graph indicates a positive relationship between the two variables, thus as one factor increases so does the other. Naturally a negative slope indicates a negative relationship between the two variables and as one factor increases, the other decreases. (McAusland, 2015)

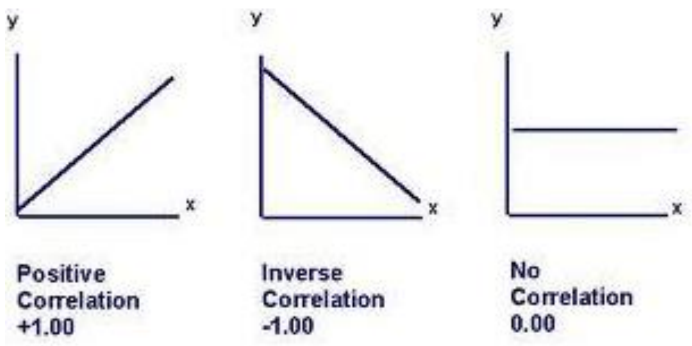

Figure 3: Kurtosis (Source: Tam, 2015)

If the range of values for the indicator is wide or positively skewed, the logarithmic transformation should be used in order to reduce the skewness of the data. (OECD, 2005, p. 84)

1.2.4 Multivariate analysis

Analysis of the relationship between variables is an important part in the creation of composite indicator. Multivariate analysis assesses the suitability of the dataset and to guide the methodological choices such as weighting and aggregation during the development of a composite indicator. (OECD, 2008, p. 15) The Information should be grouped and analyzed by means of adequate multivariate methods along two dimensions of the dataset: along indicators and along constituencies such as sectors, regions, or countries. It is necessary to identify the groups of statistically similar data in order to ensure accurate results of the composite indicator. (European Commission, 2014)

Principal components analysis (PCA) is used for grouping individual indicators according to their degree of correlation. It is a method of data reduction that detects how the variables change in relation to each other and the association among them. (OECD, 2005, p. 25-26) PCA transforms a set of possibly correlated variables into a new set of values of linearly uncorrelated variables - principal components. The main purpose is to find hidden variables, the components that adequately explain the original variability. The number of principal components is therefore always lower or at most equal than the original number of elements. (Dell, 2015b)

Another method is called *Factor analysis*. It is extended version of PCA, however it is based on a rather special model. Unlike the PCA, the FA assumes that the data is based on the elemental factors of the model, and that the variance of data can be decomposed into that represented by common and unique factors. (OECD, 2005, p. 69)

Cluster analysis is used for grouping of information on sectors, regions or countries. It is an exploratory data analysis tool that attempts to group different objects of similar kind into the previously unknown number of groups – clusters, and thus discover a system of organizing observations. The degree of association between objects belonging to one cluster is maximal and minimal otherwise. In other words the objects belonging to one cluster should be maximally homogenous, while being maximally heterogeneous to other clusters. (Dell, 2015a)

There are two major classes of clustering methods: hierarchic and non-hierarchic methods. A non-hierarchical method creates a classification by dividing a dataset, giving a set of non-overlapping groups that have no hierarchical relationships with them. A hierarchical method is used to indicate which small clusters of very similar objectes are nested within larger clusters of less closely-related molecules. The hierarchical method is further divided into agglomerative and divisive methods. The agglomerative methods generate a classification in a bottom-up manner, while divisive methods do it in top-down manner. (Downs, Barnard, 1995)

Hierarchical agglomerative clustering is the most common method in cluster analysis, where the objects are gradually clustered in several steps. The number of the steps is n - 1, where n represents the number of clustered objects. The clusters that are joined together firstly are having the smallest distances. (Statsoft, 2014) The subsequent steps proceed analogically until the only one large cluster, which includes all objects is created. The schedule of clustering is usually illustrated through a graphical representation known as a dendogram. The clustered objects are represented as nodes in the dendogram and the branches illustrate when the cluster method joins subgroups containing that object. The length of the branch shows the distance between the subgroups as they are joined. (Stockburger)

The joining or tree clustering method uses the similarities (dissimilarities) or distances between objects to create the clusters. Similarities are a set of rules serving as criteria for grouping or separating the objects. Among the widely used measures belong:

- *Euclidean distance* measured as geometric distance in the multidimensional space
- *Squared Euclidean distance*
- *City-block (Manhattan) distance*, which is the average difference across dimensions. Usually, this distance measure has a similar result to the simple Euclidean distance. (Dell, 2015a)

In order to perform the clustering, it is important to define how to measure the distance between clusters. Among the methods of hierarchical clustering belong:

- *single linkage (nearest neighbor) clustering,* where the distance between two clusters is determined by the distance of the two closest objects in the different clusters

- *complete-linkage (furthest neighbor) clustering,* which defines the similarity between clusters on the basis of the longest distance between any object from one cluster to any object from another cluster
- *average linkage method* defines the similarity as the average similarity of all objects in one cluster with all objects in another one
- *centroid clustering* measures the similarity among clusters based on the distance between their centroids (mean or median) of the objects in the cluster (Statsoft, 2014)
- *Ward's method* is based on the principle of the analysis of variance and attempts to minimize the sum of square of any two (hypothetical) clusters that can be created at each step. This method is considered to be very efficient; however, it tends to create clusters of small size. (Dell, 2015a)

1.2.5 Normalization

Normalization deals with a dataset that are incommensurate with each other and are expressed in different measurement units, (Nardo, 2005b, p. 11) since it transforms original units into the form of dimensionless and therefore easily aggregatable values. There are various methods of normalization that have different characteristics that lead to different results of evaluated units through creation of composite indicators. Among the most widely used belongs ranking, standardization, re-scaling (Minařík, 2013, p. 128)

The simplest method of normalization is the ranking technique. (Nardo, 2005b, p. 46) Ranking method is based on replacement of values of measureable variable X_j by its ascending order, creating an ordinal variableP_j. To the max type of indicators is assigned the serial number in descending order, while in the case of min type of indicators has the lowest value lowest order. If there is a match in sequence, to the units assigned the averages of the order. (Minařík, 2013, p. 128) The main advantage of this technique is its simplicity and the independence to outliers, while as the major disadvantages consist in loss of information about absolute levels and the impossibility to draw a conclusion on difference in performance. (Nardo, 2005b, p. 46) Furthermore correlations of the original indicators and serial numbers differ. (Minařík, 2013, p. 128)

The standardization or z-scores method lies in the conversion of indicators to a common scale with a mean of zero and standard deviation of one. (OECD, 2008, p. 28) Values of standardization are calculated as the difference of original value X_j and the average $\bar{x}$, whereas this difference is divided by the standard deviation $\sqrt{var\ x_j}$. For min type of indicators, the standardized values are computed as the difference of the average $\bar{x}$ and the original value X_j, divided by the standard deviation $\sqrt{var\ x_j}$. (Minařík, 2013, p. 128) The main disadvantage of this method is the influence of extreme values on the composite indicator that can be, however, corrected in the aggregation methodology by excluding the best and worst individual indicator scores from inclusion in the index or by assigning differential weights based on the "desirability" of the individual indicator scores. (OECD, 2008, p. 28) The absolute values of correlation coefficients remain the same as for original values. (Minařík, 2013, p. 128)

The re-scaling or min-max method transforms the original scale to a hundred-point scale <0, 100>. The indicators of max type are calculated by an equation:

$$\text{Bj} = \frac{X_j - \min\{X_j\}}{\max\{X_j\} - \min\{X_j\}} \cdot 100$$

The normalized value for indicators of min value is calculated as:

$$\text{Bj} = \frac{\max\{X_j\} - X_j}{\max\{X_j\} - \min\{X_j\}} \cdot 100$$

where the min $\{X_j\}$ and max $\{X_j\}$ represent the smallest and the biggest value in the units´ detected value of j-th indicator. (Minařík, 2013, p. 128) The major disadvantage is the possible distortion of transformed indicator by extreme values or outliers. On the other hand, re-scaling could extend the range of indicators lying within a small interval, improving the effect on the composite indicator more than the z-score transformation. (OECD, 2008, p. 28) As well as for z-score method, correlation coefficients do not change in the absolute values. (Minařík, 2013, p. 129)

The last method is the distance to a reference. This method introduces to the unit file a non-existent reference unit, which reaches the best value in all the indicators. Based on the selected metrics, such as Euclidean distance or Hamming distance, the distance of all real units from reference units is determined. The smaller the distance between the units is recognized, the better the rating has and vice versa. (Minařík, 2013, p. 129) The disadvantage of this technique is its basis on extreme values which could be unreliable outliers. (Nardo, 2005b, p. 49)

1.2.6 Weighting

One of the most important parts of the process of composite indicator construction is to assign weights to individual indicators. The weighting can be essentially considered as a value judgment and serve as the opportunity to express the importance of each indicator. There exists number of techniques for determining the weights.

The simplest method is based on assigning equal weight to all sub-indicators, thus all variables are given the same weight. The weights $w_j > 0$; j = 1, 2 ..., m are constant and each of indicator have weight either 1 or $\frac{1}{m}$. The major advantage lies in the possibility of covering the missing data. (Nardo, 2005a, p. 21) Furthermore, there exist several techniques for constructing the unequal weights. Among simplest and most widely used belong rating scales and pairwise comparison matrix.

The rating scale is typically represented by an odd number of grades. The scale is typically represented by an odd number of grades. Each indicator is rated at the scale, as for example 1, 3, 5, 7, 9 that may be expressed in words as low to high seriousness of the indicators. Weights are standardized through dividing the number points scored for each indicator by the sum of points obtained of all indicators. The sum of the weights is equal to one. A possible alternative is to divide the number of points scored by the average number of points for one indicator. In this case, the sum of weights is equal to number of indicators.

Among other method belongs matrix of pairwise comparisons. The calculation is based on symmetrical square table m x m and refers to comparing indicators in pairs. The matrix is filled by rows in pursuance of the importance of individual sub-indicators. If the indicator is considered more important, the value of 1 is assigned to it. In the case of lower significance, the indicator is assigned with 0. If both indicators are assessed to be equally important, they are assigned with value of 0,5. The main diagonal remains blank. Weights are calculated by dividing row sums either by $\frac{m(m-1)}{2}$, producing weights which sum has the value of 1 or by y $\frac{(m-1)}{2}$, producing weights which sum is equal to m. (Minařík, 2013, p. 126-127)

1.2.7 Aggregation

Aggregation is the last step in construction of composite indicators that brings together information conveyed by the different dimensions into a dimensionless composite index. (Nardo, 2005b, p. 12) Aggregation is used regardless the used type of standardization. Sub-indicators are aggregated into the form of composite indicator by two approaches: weighted sum approach and weighted average method. Weighted sum method is used if there are no missing values, while the weighted average method when the missing values are present. The resulting value of composite indicator is affected by the chosen method of normalization, thus different methods lead to different results. (Minařík, 2013, p. 129)

2 Analytical part

The analytical part of the thesis is primarily focused on the examining of the relationship between palm oil production and standard of living in selected provinces of Indonesia through comparing the economic and social development performance. The level of development is assessed based on the construction of composite indicators. The both indicators will comprise of four sub-indicators. In order to provide analysis based on medium-term observation, means of data from 2009 to 2013 are calculated and they are used for the computation in the practical part.

2.1 Palm oil

The oil palm tree belongs to the family of Palmae and subfamily Cocoidae. It is is a member of genus Elaeis containing two major species, Elaeis guineensis know as African oil palm and Elaeis melancocca or American oil palm. (Vergeye, 2010, p. 352) The palm tree has an origin in West Africa, occurring between Angola and Gambia, while the American Oil Palm is native to tropical regions of Central and South America. (Omokaro, Ramesh, 2010, p. 34) Due to its specific requirements, the palm cultivation is limited only to number of places. Cultivation of palm trees has the most favorable conditions in the tropic climate, within 10 degrees north or south of the equator that includes regions of Asia, Africa and South America abundant on tropical rainforests with rich biodiversity. (Garcia-Santos, 2015)

Palm trees are nowadays typically cultivated on large scale uniform areas with the size of 3000-5000 hectares surrounding a central mill to enable quick industrial processing after harvesting. (Vergeye, 2010, p. 350) The planting of the palm trees can be done at any time of year, although, the most successful period is between June and December. (CommodityBasis, 2016) The yield stabilizes approximately after 4 to 6 years of growth. The peak of the palm productivity appears between 8 to 15 years and afterwards the production drops gradually from the 21st year onwards and the old palms are replaced with new ones. A full-grown oil palm tree is on average able to produce clusters of fruit

(FONAP) of approximately 20 kg over 15 times per year. The economically viable lifespan of this crop is generally 22-25 years based on the yield, economically harvestable height and price of the oil. (USDA, 2007)

Palm tree is considered to be the most effective vegetable oil crop in terms of land use. It is able to produce more oil per hectare than any other oilseed commodity, while it requires less sunlight to yield a unit of oil. (USDA, 2007) For comparison, an average yield of palm oil is 3.69 tons per hectare (t/ha) that is 5 times higher than that of soya (0,77 t/ha), 4 times higher than sunflowers (0,86 t/ha) and 3 times higher than rapeseed (1,33 t/ha). (FONAP) However regarding the yield per man-day, this crop is not so competitive, since plantation management and fruit harvesting is labor-intensive. (USDA, 2007)

Products of palm tree

The primary product of the palm tree is its fruit, from which we can utilize both, the fleshy fruit pulp as well as the fruit seed. The most significant part, the fleshy pulp, also called mesocarp, contains 40-57% of oil. From this part is produced the main product of palm tree - the palm oil, which is characterized by light orange color, pleasant odor and sweet taste. (Valíček, 2002, p. 126) Palm oil is widely used in food industry, not only because its low price but also for its good chemical properties. (USDA FAS, 2007) It is semi-solid at room temperature, so it does not need to be solidified with chemicals; it keeps for a relatively very long period of time and it stays particularly stable at high temperatures. These properties clearly clarify why palm oil is so widely used in lot of products. (FONAP) It is used all around the world as cooking oil and shortening as well as it is a common ingredient in foods such as margarine, sauces, spreads, instant foods, snacks, confectionary products or dry and canned soups. (USDA FAS, 2010) Use of palm oil as a biofuel feedstock is another significant reason of palm oil production ant it is highly promoted by sustainable energy campaigns around the globe. (USDA FAS, 2007) Palm oil is also used in products such as cosmetics, soaps, pharmaceuticals, textile, industrial and agro-chemical products. (van Gelder, 2004, p. 11)

The second part of the palm fruit is the seed providing secondary products of palm tree - palm kernel oil and palm kernel cake. (Brown, Jacobson, 2005, p. 6) Palm kernel oil is solid at room temperature; therefore it is applicable in confectionery and chocolate industry. It is also commonly used as a raw material for consumer goods such as soap bars, cosmetics and detergents including shower gels, shampoos, and laundry and cleaning products. (FONAP) Palm kernel cake is major ingredient in the livestock feed manufacture. (Brown, Jacobson, 2005, p. 6)

In addition to palm fruit, sap, leaves and wood can be also used for further handling. Sap is obtained by the tapping of the male inflorescence and is used for the production of palm wine or sugar. (Omokaro, Ramesh, 2010, p. 34) Wood is used as a building material, fuel, and for making the furniture. Leaves can be used for production of various weaving products, while leaf fibers and empty fruit bunches are used to produce plywood and chipboard. (Omokaro, Ramesh, 2010, p. 38-40)

The world's production and trade with palm oil

The first oil palm plantations were established in Malaysia and Indonesia in the beginning of 20th century followed by African countries especially in Nigeria, Congo and Cameroon. (Omokaro, Ramesh, 2010, p. 34) Nowadays palm trees are cultivated in large quantities in almost all the world´s tropical regions including Southeast Asia, Africa and Central America. (FONAP)

The area used for palm oil cultivation has globally quadrupled from the early 1980s to 2014 and enlarged from 4 million to 17 million hectares. This large increase of palm oil cultivating areas is primarily concentrated in Indonesia, where the area more than doubled from 4 million ha in 2000 to 9 million ha in 2013 and it is projected to be 26 million hectares by 2025. Another large increase took place in Malaysia, where the cultivated area raised from 3,25 million ha in 2000 to 5,1 million ha in 2013. (Wetlands) Currently palm oil represents around 35% of the world’s vegetable oil market. (Garcia-Santos, 2015)

The vast majority of world's palm oil is currently produced in Indonesia with production of 33 000 thousand metric tons and Malaysia with production of 20 500 thousand metric tons. Indonesia is also the biggest exporter of palm oil accounting for 24 500 thousand metric tons. These two countries together account for around 85,36% of global production. (Indonesia Investments, 2016; USDA FAS, 2016, p. 16) The leading five palm oil producing countries further involve Thailand, Colombia and Nigeria, although the amount of production is significantly lower. (USDA FAS, 2016, p. 16)

Country	Palm Oil Production in 1000 MT
Indonesia	33 000,00
Malaysia	20 500,00
Thailand	2 200,00
Colombia	1 130,00
Nigeria	970,00
Other	4 875,00

Table 1: Palm Oil Production by Country in 1000 MT in 2015 (Source: USDA FAS, 2016, own work)

The biggest importer as well as the largest consumer is India, importing 9 530 thousand metric tons of palm oil in 2015 that accounts for 21% of total import. The major importing countries further involve the European Union, China, Pakistan, Egypt, Bangladesh and United States.

Country	Importers of Palm Oil in Thousand Metric Ton
India	9 530,00
European Union	6 950,00
China	5 700,00
Pakistan	3 200,00
Egypt	1 500,00
Bangladesh	1 400,00
United States	1 135,00
Other	1 587,00

Table 2: Palm Oil Imports by Country in 1000 MT in 2015 (Source: USDA FAS, 2016; own work)

Palm oil certification

In response to the urgent and pressing global call for sustainably-produced palm oil, a not-for-profit organization Roundtable on Sustainable Palm Oil (RSPO) was established in 2004. Its main objective is to promote the development and use of sustainable oil palm products through credible global standards and involvement of stakeholders. The stakeholders include seven sectors of the palm oil industry – palm oil producers, processors and traders, consumer goods manufacturers, retailers, banks and investors, environmental and nature conservation NGOs and social or developmental NGOs. (RSPO, 2015) Certified sustainable palm oil (CSPO) is cultivated on a plantation that has been managed and certified based on the principles and criteria of the RSPO. It means that the land used for cultivation do not include important biodiversity, wildlife habitat or any other environmental values, and meets the highest environmental, social and economic standards established by the RSPO. (WWF) Headquarter of the association is in Zurich, Switzerland, while the secretariat is currently located in Kuala Lumpur with satellite offices in Jakarta, London and Beijing. Currently 20% of the world's palm oil production is RSPO certified however there is still a long work to be done to improve the credibility of its certification. (RSPO, 2016) Some producers have also adopted the International Sustainability and Carbon Certification standard, which allows them to export to biodiesel markets under the European Union's Renewable Energy Directive. (Pacheco, 2016)

2.2 Indonesia

Indonesia is culturally rich archipelago, consisting of more than 17 000 islands at the strategic crossroads of major trade routes between the Indian and Pacific Oceans. Total territory of the country covers the area of 1 904 569 square kilometers and shares the borders with Timor-Leste, Malaysia and Papua New Guinea. (CIA, 2016) With the population of 256 million inhabitants, Indonesia is the fourth most populous country. (PRB, 2015) Its territory is divided into 34 provinces. (Sheley, 2015) The capital city, Jakarta, is also the largest city with the population exceeding 10 million people. The population of Indonesia is culturally very diverse and consists of more than 300 ethnic groups. The highest number represents Javanese with share of 40.1% and Sundanese with 15.5%, followed by Malay, Batak, Madurese, Betawi and others. The official language is Bahasa Indonesia, although there are spoken more than 700 languages. There are a number of different religions in Indonesia with almost 90% of the population claiming to be Muslim (CIA, 2016), making Indonesia the world´s largest Muslim country of the world.

Indonesia is currently the biggest Southeast Asia's economy (BBC, 2016). This country has a well-balanced economy, where all three major economic sectors - agriculture, industry and service play an important role. (Indonesia Investments, 2016b) Tertiary sectors is responsible for the highest share of the GDP representing 43,6% followed by industrial sector accounting for 42,8% and agricultural sector that represents 13,6% of GDP. (CIA, 2016) The main agricultural products include rubber, palm oil, poultry, beef, forest products, shrimp, cocoa and coffee. Among major industries belong petroleum and natural gas, textiles, automotive, electrical appliances, apparel, footwear and mining.

Over the last decade, the economic growth has significantly increased. GDP of Indonesia was constantly increasing from 160 million USD in 2001 to 917 million USD in 2012. (WB, 2015) Even during the global financial crisis, Indonesia surpassed its regional neighbors and together with India and China recorded positive GDP growth as the only G20 members. (CIA, 2016) However, Indonesia´s economic growth has been on a slowing trend since 2012 reflecting lower volumes and prices for key Indonesian export commodities, such as thermal coal, crude palm oil, rubber and metals. (GBG, 2015) Despite the country´s remarkable economic performance, Indonesia remains a troubled country struggling with issues such as poverty, income inequality, corruption, inadequate infrastructure as well as unequal resource allocation among regions. (CIA, 2016) Almost half the country's population still lives on less than two dollars per day. (Kortschak, 2013) Furthermore insufficient environmental policy of Indonesia in combination with high demand for palm oil and other agricultural products has led to high rates of rainforests deforestation. (BBC, 2016)

2.2.1 Provinces of Indonesia

Indonesia altogether consists of 34 provinces. For the purposes of this thesis, the provinces are classified into 4 major categories based on the volume of palm oil produced:

- provinces producing high volume of palm oil (mean annual production ranging from 1 000 000 to 6 000 000 tons of palm oil)
- provinces producing medium volume of palm oil (mean annual production ranging from 100 000 to 999 999 tons of palm oil)
- provinces producing low volume of palm oil (mean annual production ranging from 14,000 to 99,999 tons of palm oil)
- provinces producing no palm oil

This classification of Indonesia´ provinces is illustrated on Figure 4. We can see that the highest production of palm oil is concentrated on the islands of Sumatra and Kalimantan, while Java, Nusa Tenggara and Bali, on the contrary, represent the areas with the lowest production of palm oil. The Table 14 in Appendix 1 provides the key for the provinces numbered on the Figure 4 and demonstrates that on average, in the period 2009-2013, the majority of palm oil was produced in Riau, representing 24,36% of total production, followed by North Sumatra (16,71%) South Sumatra (10,22%) and Central Kalimantan (9,96%). Maluku began to produce palm oil not until 2013 that corresponds with its smallest share in palm oil production (0,01%). On the contrary provinces such as DKI Jakarta, Central Jawa, D.I. Yogyakarta, East Jawa, Bali, West Nusa Tenggara, East Nusa Tenggara, North Maluku, North Sulawesi and Gorontalo do not produce palm oil.

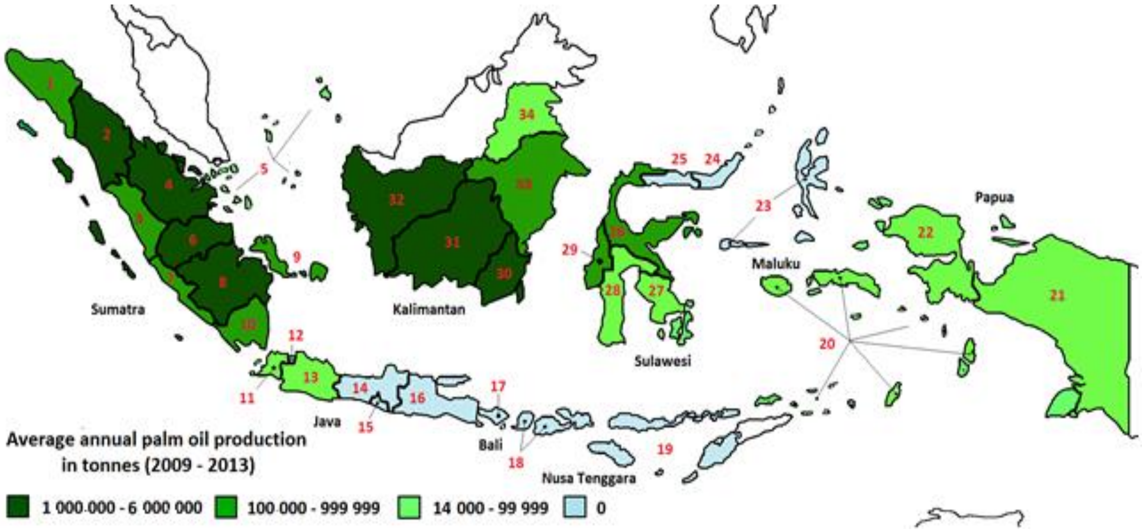

Figure 4: Classification of Indonesia´s provinces according to palm oil production (Source: BPS; own work)

The Table 15 in Appendix 1 further divides provinces of Indonesia based on the volume of tree cover loss and introduces 3 main categories:

- provinces with high level of deforestation (mean annual tree cover loss ranging from 80 000 to 300 000 thousand ha)
- provinces with medium level of deforestation (mean annual tree cover loss ranging from 10 000 to 79 999 thousand ha)
- and provinces with low level of deforestation (mean annual tree cover loss ranging from 0 to 9 999 thousand ha).

The Table 15 further indicates that the highest average percentage of deforestation for 2009-2013 occurs in Riau, representing 16,47% of overall deforestation in Indonesia, followed by West Kalimantan (14,88%), East Kalimantan (13,74%), South Sumatra (11,19%) and Central Kalimantan (9,75%). These provinces are as well characterized as the provinces with highest palm oil production. On the contrary, the lowest and almost none deforestation occurs in the capital city DKI Jakarta and the most tourist Indonesian destination Bali.

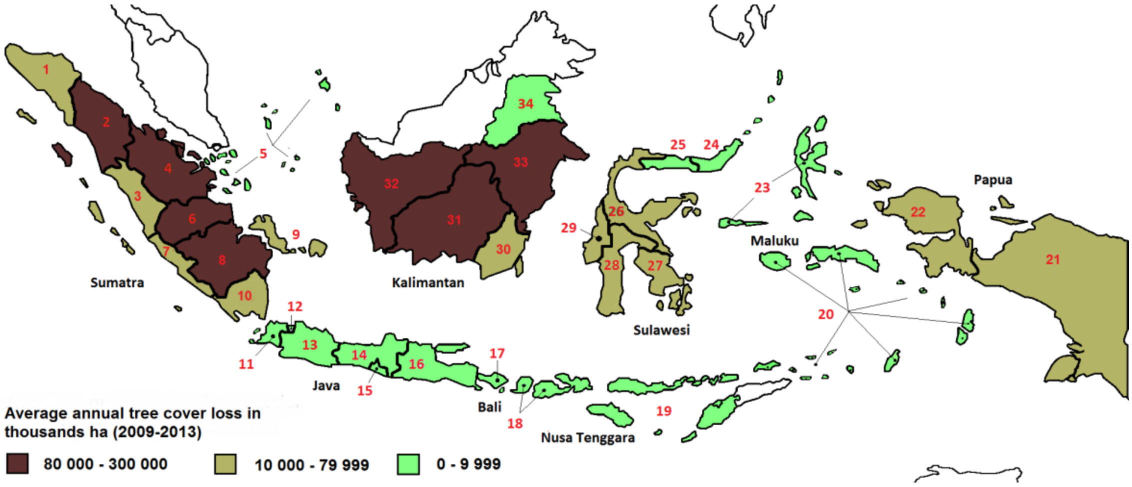

Figure 5: Classification of Indonesia´s provinces based on the average annual tree cover loss 2009-2013 (Source: WFW; own work)

2.2.2 Palm oil production in Indonesia

Nowadays Indonesia is the leading producer as well as exporter of palm oil globally, with Malaysia being a close second. (Indonesia Investments, 2016) Nearly 70% of the palm plantations are situated on the island of Sumatra, while remaining cultivation is concentrated on the Kalimantan. (Indonesia Investments, 2016) Palm oil represents around 11% of Indonesia's export earnings and is the most valuable agricultural export. Overall, it is Indonesia's third largest export earner. (OFI) Large number of Indonesian population is dependent on palm oil for their livelihood. These people are known as smallholders. They cultivate oil palm, sometimes simultaneously with subsistence production of other crops, whereas the whole family is involved in labor. The farm provides the main source of the income and the planted area of oil palm has usually less than 50 hectares. (RSPO)

History of palm oil production

The first large-scale plantations in Indonesia were established in 1911 in North Sumatra and Aceh province covering total area of 5 123 hectares. (Hadinaryanto, 2014) Since then the Dutch became major exporter with a total export of 576 tons of crude palm oil to Europe in 1919, followed by 850 tons in 1923. (Hadinaryanto, 2014, Setiadi, 2009, p. 137) However after the Japanese occupation in the 1940s, the production dropped down considerably. The palm oil production decreased from 250 000 tons in the early 1940s to 56 000 tons between 1948 and 1949. (Hadinaryanto, 2014) After gaining independence in 1945, Indonesia´s plantation system partly collapsed, since Dutch plantation owners had no longer support of the colonial government and labor migration was not encouraged by the new government. Furthermore, newly elected president Sukarno promoted an isolationist policy and nationalized all the foreign companies. Since then Indonesia has had experienced a period of declining production. (van Gelder, 2004, p. 18)

The situation has changed in the 1967 when President Suharto came to the power. The major priority of his policy agenda became the transformation of Indonesia into a politically stable nation with a sustained economic growth. (Say No To Palm Oil) He began to largely support development of oil palm sector through making direct investment via state run companies.(van Gelder, 2004, p. 18) By 1985, 600 000 ha of forest had been transformed to oil palm plantations that accounted for a 10-fold increase over 20 years. (Hadinaryanto, 2014)

In the mid-1980s, by the increasing global demand for palm oil, Indonesian government formulated a policy goal to surpass Malaysia as the world's leading producer of the palm oil. To achieve this, large-scale forest areas were distributed to the big Indonesian business groups and to foreign investors. (van Gelder, 2004, p. 19) Afterwards, several million ha of the Indonesian rainforests were turn into oil palm plantations in order to make Indonesia to become the leading global palm oil producer. Indonesia has eventually overthrown Malaysia´s leading position in production and export of palm oil in 2007 (Say No To Palm Oil)

Negative implications of palm oil production

The production of palm oil in Indonesia has led to a number of serious issues. Large areas of tropical forests are being cleared by transnational palm-oil production companies in order to replace them by palm plantations (Kortschak, 2013) that have devastating impact on the environment. Primarily, deforestation in Indonesia has destructed the natural habitat of flora and fauna (Kodas, 2013) and has contributed to the extinction of endangered wildlife such as orangutans, Sumatran tigers and elephants. (Watts, 2013) Deforestation has also negatively contributed to air and water pollution, soil erosion and even change of global climate. When rainforests are being cut, extra quantities of CO2 emissions are released into the atmosphere, having a negative influence on global climate change (Kodas, 2013) The daily carbon dioxide emissions from Indonesia are often exceeding those of the United States and China. (Cheney, 2015) Another serious problem is the practice of forest clearance known as slash and burn, where land is set on fire as a cheaper technique to clear large tracts of land and to prepare the soil for new planting, since the ash from fires is a natural fertilizer. Peat soil that is found in the majority of the affected areas is highly combustive, causing local fires to spread and making them difficult to stop. These fires produce thick smog and release a huge amount of greenhouse gases. This technique is widely used by smallholders, who do not have proper knowledge about sustainable agricultural practices and thus do not realize how detrimental their behavior to the environment is. (Balch, 2015) Furthermore they do not have financial resources to buy the machines and chemicals required to clear land in a proper way and therefore they incline to burning, that is considerably cheaper alternative. (Shah, 2015) In addition the production of palm oil has caused number of social conflicts with local communities in Indonesia over traditional land rights. Many of local people have been displaced from their customary land holdings and local communities impoverished, resulting in lot of conflict with palm oil concession companies. (OFI)

Government´s efforts

In 2011, the government of Indonesia established the mandatory Indonesian Sustainable Palm Oil certification to promote sustainability in palm oil sector. This standard is based on the pre-existing Indonesian legislation, but it is audited by a third-party. However the illegal status of many smallholders and plantation companies has made it impossible to reach broader development of ISPO, as well as implementing other capacity-building and productivity-enhancing measures. (Pacheco, 2016)

In July 2015, the Indonesian government established the Crude Palm Oil fund, based on the imposing a crude palm oil exports levy as part of the efforts to develop a local biodiesel industry. The money is supposed to be used for the development of the sustainable palm oil sector and to support biodiesel production in Indonesia. (Jakarta Globe)

Furthermore in November 2015, Indonesia together with Malaysia introduced the Council of Palm Oil Producer Countries, of which objective is to manage the global CPO stocks and to harmonize national standards of sustainability. (Pacheco, 2016)

2.3 Construction of composite indicators

2.3.1 Selection of analyzed regions

The selection of analyzed regions was based on the mean volume of palm oil produced in the period 2009-2013 Altogether was chosen following 16 provinces for the analyses:

- Riau, North Sumatra, Central Kalimantan and South Sumatra representing provinces with highest amount of palm oil production (1 000 000–6 000 000 tons)
- Bengkulu, Bangka Belitung, Lampung and Central Sulawesi representing provinces with medium amount of palm oil production (100 000-999 999 tons)
- Southeast Sulawesi, South Sulawesi, West Jawa and Banten representing provinces with low amount of palm oil production (14 000 to 99 999 tons)
- and Central Jawa, East Jawa, North Maluku and North Sulawesi representing provinces with no production of palm oil.

2.3.2 Selection of sub-indicators

The selection of specific sub-indicators of socio-economic development was influenced particularly by the unavailability of some statistical data that would not enable the possibility of medium-term observation. Due to the limited availability, the data covers only the period 2009–2013 The data were collected from the Indonesian Central Bureau of Statistics and from the Indonesia Database for Policy and Economic Research available in the WB database.

Altogether, was for the analysis selected 8 indicators. Both economic and social development performance is represented by 4 sub-indicators. A list of these sub-indicators, their characteristics and the method of calculation are defined below.

Social indicators

Morbidity rate indicates the incidence of a specific disease or overall share diseased people within a population and/or geographic location. It is closely related to the level of available education and medical care. The formula for its computation is a number of diseased people during a specific period of time divided by the number of individuals in the population and multiplied by 100. The result is expressed in percentage. (Diffen, 2016)

Households with improved sanitation indicates the share of households having access to facilities ensuring hygienic separation of human excreta from human contact, including flush or pour-flush toilet/latrine, ventilated improved pit latrine, pit latrine with slab and composting toilet. (Unicef) Inadequate sanitation may result in transmission of diseases such as cholera, diarrhea, dysentery, hepatitis A, typhoid, polio, intestinal worms, schistosomiasis and trachoma. (WHO, 2015) This indicator is computed as the number of households having access to improved sanitation divided by the number of households, multiplied by 100. The result is expressed in percentage. (Unicef)

Poverty rate indicates the percentage of citizens who cannot afford the necessities for living adequate lives. This indicator is calculated as a ratio of the number of people falling below the poverty line and the total population and multiplied by 100, whereas the poverty line stands for half of the median household income. (OECD, 2010)

Net enrolment ratio in primary education shows the extent of coverage in a primary education of children belonging to the official age group corresponding to the primary level of education defined by the national education system. Generally, children entering the primary school are not younger than 5 years or older than 7 years and in principle the primary education covers six years of full-time schooling. The primary education usually covers the basic education in reading, writing and mathematics as well as elementary knowledge of other subjects such as geography, history, social science, natural science, art and music. The NER in primary education is calculated as the number of children of official primary school age enrolled in primary education divided by the total population of children of official primary school age and multiplied by 100. The result is expressed in percentage. A high NER indicates a high degree of coverage for the official primary school-age population. (UN, 2010)

The Table 3 displays indicators of social development. The ordinal numbers of the indicators of economic development have the values from X1 to X4. The fourth column of the table contains division of indicators based on the min or max type.

Ordinal number	Indicator	Unit	Source	Type
X1	Morbidity rate	% of population	WB	MIN
X2	Households with improved sanitation	% of population	BPS	MAX
X3	Poverty rate	% of population	WB	MIN
X4	NER in primary education	% of population	BPS	MAX

Table 3: Summary of indicators of social development performance (Source: Diffen, 2016; Unicef; OECD, 2010; UN, 2010; own work)

The Table 21 in Appendix 1 demonstrates that the lowest morbidity rate occurs in North Maluku (23,05), while the highest in Central Sulawesi (34,14%). Bangka Belitung (69,34%), North Sulawesi (67,43%) and Central Jawa (66,10%) have the dominating position in the percentage of households with improved sanitation, while on the contrary the considerably lowest share is found in Central Kalimantan (35,40%) and Bengkulu (36,76%). Regarding the poverty rate, Bangka Belitung again dominates from all of the studied provinces, with poverty rate of 6,10%. Bengkulu is on the contrary doing the worst again, having 17,97% of its citizens living below the poverty rate, with. Highest NER in primary education is reached in Central Kalimantan (95,67%), while the lowest in Central Sulawesi (91,53%).

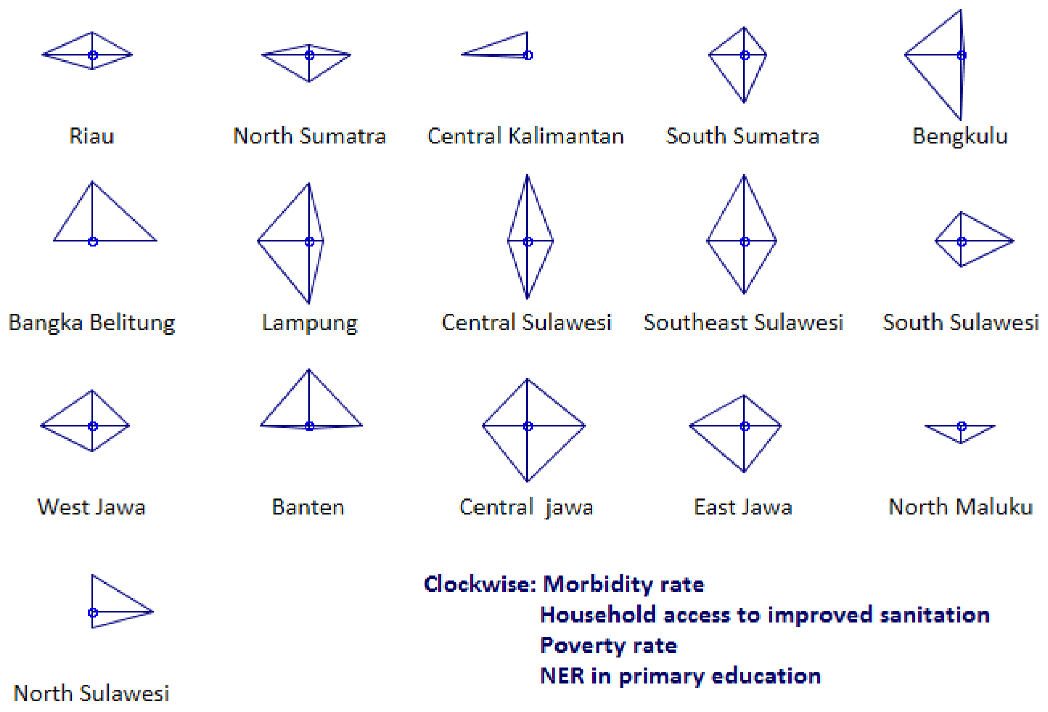

Figure 6: Icon plot of indicators of social development (Source: WB; BPS; own work using Statistica)

Economic indicators

Unemployment rate indicated the share of workers in the labor force who are not currently employed but are actively looking for a job. It is computed as the ratio of unemployed job seekers in the labor force and the total labor force including the employed and unemployed persons, multiplied by 100. The result is expressed in percentage. (EPC)

Gross regional domestic product at current market prices is a subnational gross domestic product measuring the size of that region's economy. This conceptually equivalent indicator to GDP is calculated as the sum of gross value added produced from all sectors in the economy of a region. GRDP based on current price indicates the additional values of goods and services measured using the price in the current year. (BPS, 2016)

Provincial minimum wage per month is the minimum amount of compensation that must be paid to for performing labor for one month. Minimum wages are normally set by the government legislation in order to protect the citizens from exploitation and enabling them to afford their basic needs. (Investopedia) In this indicator was exchanged the currency from IDR to USD based on the annual average exchange rate per respective years provided by the USForex.

Foreign direct investment (FDI) is a form of international capital flow implemented by a company or entity based in one country, into a company or entity based in another country. This investment provides to investors control, management and voting rights if the level of ownership is greater than or equal to 10% of ordinary shares. Shares ownership that is lower than 10% is defined as portfolio investment and it is not characterized as FDI. (Economywatch, 2010) FDI is a principal element in international economic integration since it establishes stable and long-lasting links among economies. FDI is considered to be a significant channel for the transfer of technologies between countries. It promotes international trade through access to foreign markets, and can be an important source of economic development as well. FDI flow is measured as the total value of inward direct investment made by non-resident investors in the reporting economy for a specified period of time. (OECD, 2016) In this indicator was also exchanged the currency from IDR to USD based on the annual average exchange rate per respective years provided by the USForex.

The Table 4 displays the indicators of economic development performance. The ordinal numbers of the indicators have the values from X5 to X8. The fourth column of the table contains division of indicators based on the min or max type.

Ordinal number	Indicator	Unit	Source	Type
X5	Unemployment rate	% of households	WB	MIN
X6	GDRP	USD	BPS	MAX
X7	Provincial minimum wage per month	USD	BPS	MAX
X8	FDI	USD	BPS	MAX

Table 4: Summary of indicators of economic development performance (Source: EPC; BPS; Investopedia; Economywatch, 2010; own work)

The Table 21 in the Appendix 1 demonstrates that the lowest value of unemployment rate is found in Central Kalimantan, where only 3,73% share of workers in the labor force are currently not employed. On the contrary, Banten is characterized with the highest share of unemployment rate, representing 12,42%. Significantly biggest size of the regions´ economies has East Jawa with GDRP of 93,72 billion USD followed by West Jawa with GDRP of 90,75 billion USD. North Maluku has in the comparison to examined regions the smallest economy, with only 0,64 billion USD. The highest monthly minimal wage has Central Kalimantan (122,55 UDS) and second highest North Sulawesi (120,28 USD). The lowest monthly minimal wage is earned in Central Jawa (73,26 USD) and East Jawa (73,45 USD). Regarding FDI, the substantially highest inflow is reported in West Jawa, representing 4 685,80 million USD.

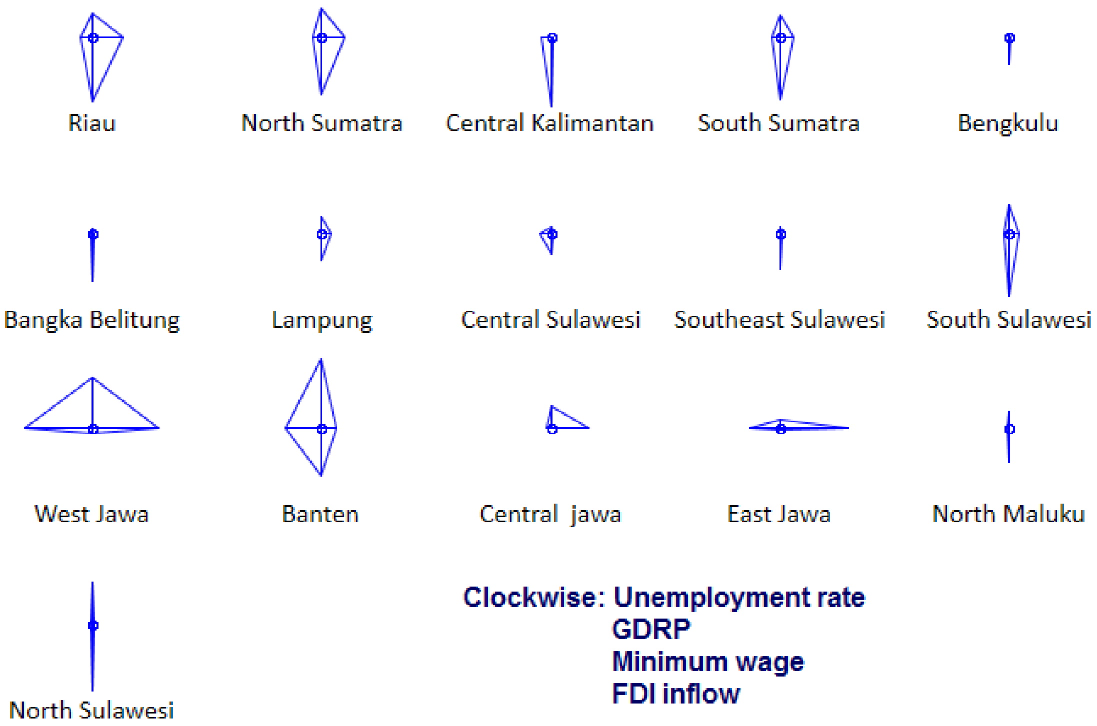

Figure 7: Icon plot of indicators of economic development (Source: WB; BPS; own work using Statistica)

2.3.3 Descriptive statistics and correlations

Before calculating the composite indicators, it is necessary to provide a basic statistical analysis and measure the statistical characteristics such as arithmetic mean, median, minimum, maximum, variance, standard deviation, skewness and kurtosis. These basic characteristics were generated by using the software Statistica.

	Mean	Median	Minimum	Maximum	Variance	Std.Dev.	Coef.Var.	Skewness	Kurtosis
X1	29,29	29,15	23,05	34,14	9,74	3,12	10,66	-0,33	-0,46
X2	54,39	55,14	35,40	69,34	104,25	10,21	18,77	-0,41	-0,47
X3	11,94	10,98	6,10	17,97	16,93	4,12	34,46	0,03	-1,54
X4	93,56	93,99	89,88	95,67	2,07	1,44	1,54	-1,14	1,65
X5	6,25	5,95	3,40	12,42	6,15	2,48	39,68	1,19	1,23
X6	25,26	13,94	0,64	93,72	918,28	30,30	119,97	1,51	1,34
X7	101,05	102,40	73,26	122,55	292,65	17,11	16,93	-0,41	-1,15
X8	865,05	487,61	28,04	4685,80	1534322,22	1238,68	143,19	2,34	5,77

Table 5: Descriptive statistics (Source: WB, BPS; own work using Statistica)

The indicator FDI reaches the highest values of mean, representing 865,05 million of USD as well as the highest value of median representing 487,61 million of USD. On the contrary, the lowest values in those two indicators have the unemployment rate.

The values of the variance, standard deviation as well as variation coefficient are also highest in FDI, meaning that this indicator has the highest variability. Based on those three methods is the lowest variability found in unemployment rate, thus this indicator has the lowest variability.

Distribution of values of poverty rate, unemployment, GRDP and FDI is positively skewed, thus these indicators have a right-sided asymmetry. The rest of the indicators are negatively skewed, having a left-sided asymmetry of the distribution.

Regarding kurtosis, the highest value occurs in indicator FDI accounting for 5,77 that indicates the greatest peak distribution of the indicators. The lowest value is found in the indicator poverty rate that indicates flat distribution.

Distribution of values of FDI, GRDP and unemployment rate is highly positively skewed, thus these indicators are subject to the logarithmic transformation. The following part of the thesis uses the transformed data by the Logarithms of the base 10. The transformed data and their descriptive characteristics are attached in the Appendix 2, Tables 22 and 23.

Prior to construction of the composite indicator, it is essential to detect the dependencies between sub-indicators. Dependencies are identified by using the Pearson coefficient of correlation, which indicates the mutual relationship between variables. This relationship can be of different intensity. The closer the correlation coefficient reaches 1 or -1, the greater the interdependency.

The correlation coefficient does not indicate any significant relationship. The highest correlation was found between FDI and GDRP with correlation coefficient 0,70. The other correlations are of lower importance. Since there are no significant relationships, the data reduction is not necessary and we can use all of the indicators for construction of composite indicator.

	X1	X2	X3	X4	X5	X6	X7	X8
X1	1,000000	0,114234	0,313058	-0,128191	-0,071186	-0,000284	-0,332979	-0,158460
X2	0,114234	1,000000	-0,401219	-0,497734	0,541448	0,243396	0,019012	0,160236
X3	0,313058	-0,401219	1,000000	0,035585	-0,324406	0,081489	-0,556729	-0,307750
X4	-0,128191	-0,497734	0,035585	1,000000	-0,236891	0,323141	-0,242825	0,199710
X5	-0,071186	0,541448	-0,324406	-0,236891	1,000000	0,445976	0,083735	0,499940
X6	-0,000284	0,243396	0,081489	0,323141	0,445976	1,000000	-0,284450	0,702605
X7	-0,332979	0,019012	-0,556729	-0,242825	0,083735	-0,284450	1,000000	-0,138870
X8	-0,158460	0,160236	-0,307750	0,199710	0,499940	0,702605	-0,138870	1,000000

Table 6: Pearson coefficient of correlation (Source: WB; BPS; own work by using Statistica)

2.3.4 Weighting

The Tables 7 and 8 contain calculated weights by using the pairwise comparison. I chose to use this method since there are no missing values in the dataset. Based on my subjective evaluation, I decided which indicators are more and which are less important. If the row indicator was considered to be important than column indicator, "1" was assigned to row indicator and "0" to column indicator and vice versa. If column and row indicators were assumed to be equally important, "0,5" was assigned to both of them. Weights were calculated by dividing the row sums and total sum.

	X1	X2	X3	X4	SUM	WEIGHTS
X1		0,5	0	0,5	1	0,1666667
X2	0,5		0,5	0,5	1,5	0,25
X3	1	0,5		1	2,5	0,4166667
X4	0,5	0,5	0		1	0,1666667

Table 7: Pairwise comparison of social sub-indicators (Source: WB; BPS; own work)

	X5	X6	X7	X8	SUM	WEIGHTS
X5		1	0	0,5	1,5	0,25
X6	0		0	0,5	0,5	0,083333
X7	1	1		1	3	0,5
X8	0,5	0,5	0		1	0,166667

Table 8: Pairwise comparison of economic sub-indicators (Source: WB; BPS; own work)

2.3.5 Normalization

Subsequently, the original units were standardized in order to be able to compare the data in different units. As the most appropriate was chosen the standardization method (Z-scores). This method converts the indicators to a common scale with the value of mean of zero and standard deviation of one. The indicators defined as maximum indicators (the greater the value of the indicator is, the better) were calculated with equation $Z_i \frac{X_i - \bar{x}}{\sqrt{var\ x_i}}$, while min types of indicators (the lowest the value of the indicator is, the better) were calculated as $Z_i \frac{\bar{x} - X_i}{\sqrt{var\ x_j}}$. The results of the normalization for the economic and social sub-indicators are interpreted in the Table 24 in the Appendix 2.

2.3.6 Aggregation and presentation of the results

Next step is the multiplying of normalized values by subjectively selected weights and the aggregation of sub-indicators into the form of composite. This step is carried out by using the weighted sum method, since there are no missing values. The calculations are displayed in the Appendix 2 in the Tables 25 and 26. Based on the results, the final ranking of the level of social and economic development for each province is computed. The results are displayed on the Table 9 and Table 10, where the ranking and the value of province with highest and lowest composite indicator is highlighted in red.

The Table 9 indicates that the highest as well as the lowest social development performance is found in provinces belonging to the group of provinces with medium volume of palm oil production. Bangka Belitung, producing 2,02% of palm oil ranks first, while Central Sulawesi, producing 0,78% of palm oil ranks last. None of the final rankings of the provinces indicates positive relationship among palm oil production of social development. For example South Sumatra, producing 10,22% of palm oil, is classified into the provinces with the highest production of palm oil, but it is the fifth province with the lowest social development. Similarly Bengkulu belongs to the medium volume palm oil producing provinces, however it has the second worst position in social development. On the contrary, Banten, the province producing one of the lowest amount of palm oil representing 0,11% of the country´s production ranked second place in the social development. Furthermore North Maluku, country with zero production of palm oil ranked fourth in the social development. These results indicate that palm oil does not contribute to the improvement of social development of the provinces where it is produced.

Province	Sum	Rank
Highest production of palm oil		
Riau	0,60	**3**
North Sumatra	0,47	**5**
Central Kalimantan	0,45	**6**
South Sumatra	-0,42	**12**
Medium production of palm oil		
Bengkulu	-0,94	**15**
Bangka Belitung	0,75	**1**
Lampung	-0,87	**14**
Central Sulawesi	-1,05	**16**
Low production of palm oil		
Southeast Sulawesi	-0,54	**13**
South Sulawesi	0,23	**8**
West Jawa	0,27	**7**
Banten	0,67	**2**
No production of palm oil		
Central Jawa	-0,15	**11**
East Jawa	-0,05	**10**
North Maluku	0,51	**4**
North Sulawesi	0,22	**9**

Table 9: Result of aggregation of sub-indicators of social development (Source: BPS; WB; own work)

The Table 10 demonstrates that the highest development in economic area is achieved in provinces, where the highest amount of palm oil is produced – Riau, North Sumatra, Central Kalimantan and South Sumatra, thus these regions have the highest level of economic development. These four countries together produce 15 006,92 thousand tons of palm oil that account for 61,24% of the total Indonesian palm oil production. The worst rating gained Central Jawa that belongs to the provinces with no palm oil production. The rest of the provinces do not seem to be significantly influenced by the volume of palm oil produced.

Province	Sum	Rank
Highest production of palm oil		
Riau	0,62	**2**
North Sumatra	0,38	**4**
Central Kalimantan	1,01	**1**
South Sumatra	0,51	**3**
Medium production of palm oil		
Bengkulu	-0,33	**12**
Bangka Belitung	0,20	**6**
Lampung	-0,38	**14**
Central Sulawesi	-0,14	**10**
Low producion of palm oil		
Southeast Sulawesi	-0,12	**9**
South Sulawesi	0,38	**5**
West Jawa	-0,66	**15**
Banten	-0,10	**8**
No production of palm oil		
Central Jawa	-0,81	**16**
East Jawa	-0,30	**11**
North Maluku	-0,34	**13**
North Sulawesi	0,10	**7**

Table 10: Result of aggregation of sub-indicators of economic development (Source: BPS; WB; own work)

The Table 21 in Appendix 2 indicates that Bangka Belitung, the province with the highest ranking in social development received the best results in indicators households with improved sanitation and poverty rate, while having second worst position in morbidity rate and average value of NER in primary education. This province belongs to the provinces producing the medium volume of palm oil and has the medium amount of tree cover loss.

Central Sulawesi, having the worst position in the social development is characterized by the highest percentage of morbidity rate, fifth lowest percentage of household with access to improved sanitation, third highest number of people living below poverty rate and the second lowest number of children visiting the primary school from the examined provinces. This province is characterized among provinces with medium volume of palm oil production and is characterized by the medium volume of deforestation.

Central Kalimantan, the province with the highest ranking in economic development received the best results in indicators unemployment rate and monthly minimal wage, while having average position in GDRP and FDI. Central Kalimantan is the fourth largest palm oil producer from the studied provinces and has the third largest tree cover loss.

Central Jawa, having the worst position in the economic development is characterized by the lowest monthly minimal wage, the third smallest size of the economy and averaged values of FDI inflows and unemployment rate. This province does not produce palm oil and has the second lowest loss of tree cover among the examined provinces.

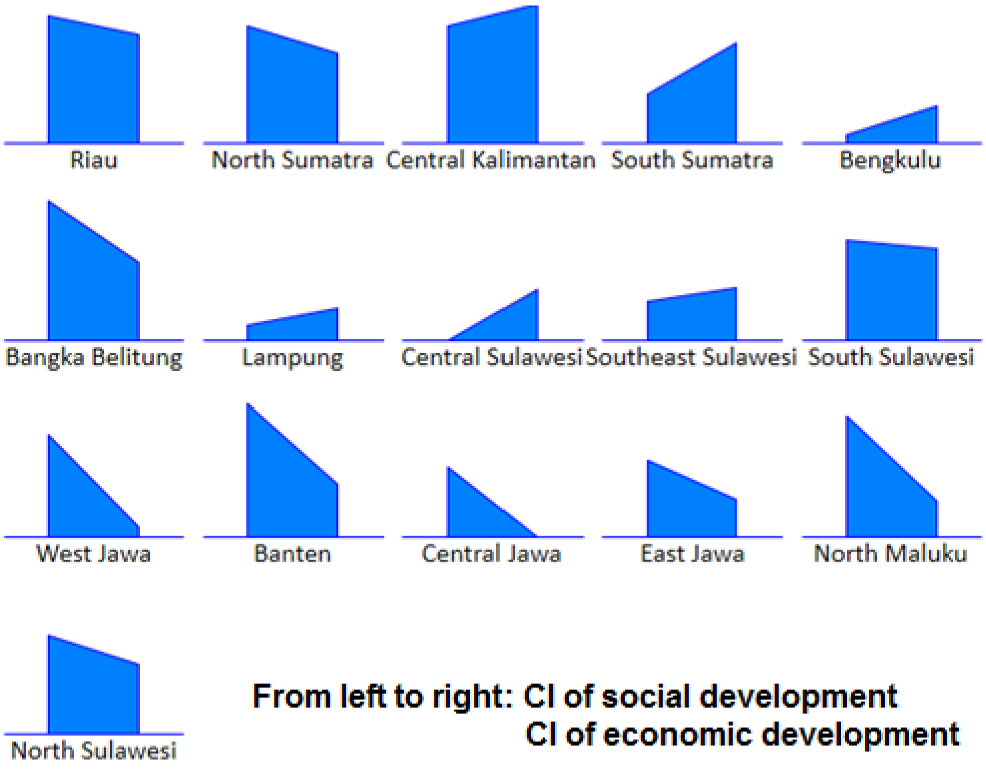

Figure 8: Icon plot of CI of social and economic development (Source: WB; BPS; own work using Statistica)

2.4 Cluster analysis

This part of thesis deals with the classification of provinces into the groups based on their results of economic and social CI. For this classification is used cluster analysis, which groups different objects of similar kind into the previously unknown number of groups – clusters.

In order to measure the similarity between provinces, I use the method of distance measure of Squared Euclidean distance. The Squared Euclidian distance Matrix displayed on the Table 27 in the Appendix 3 indicates that Lampung and Bengkulu are provinces with the lowest distance equaled to 0,0077 and thus they have the greatest similarity in the economic and social development. These two provinces are characterized by one of the weakest economic and social development and belong to the provinces with medium production of palm oil. On the contrary, the greatest dissimilarity occurs between Bengka Belitung and Central Sulawei, whose Squared Euclidian distance equals 3,37.

For measuring the distance between clusters is used the Ward´s method that is considered to be very efficient. Ward´s method in combination with Squared Euclidian distance measure shows how the clusters should be joined together. This process of joining is visually represented by tree diagram displayed in Figure 13, Appendix 3. The horizontal axis represents the distance or dissimilarity among clusters. The dendrogram along with amalgamation schedule (see Appendix 3, Table 28) shows the process of the clusters creation. In first steps of the clusters creation were gradually created pairs with the closest distances. Firstly was created the pair Lampung and Bengkulu with linkage distance of 0,01, subsequently North Sumatra and South Sulawesi with linkage distance of 0,06, followed by Banten and North Maluku with linkage distance of 0,08.

Since deciding the number of clusters is based on the decision of the researcher, after consideration, 6 clusters were retained with the linkage distance 0,65. (see Appendix 3, Figure 15)

Province	Cluster membership
Riau	3
North Sumatra	2
Central Kalimantan	3
South Sumatra	1
Bengkulu	6
Bangka Belitung	5
Lampung	6
Central Sulawesi	6
Southeast Sulawesi	6
South Sulawesi	2
West Jawa	4
Banten	5
Central Jawa	4
East Jawa	4
North Maluku	5
North Sulawesi	2

Table 11: Cluster membership (Source: WB; BPS; own work)

The first cluster is created only by one province – South Sumatra. This province belongs to the group of largest producers of palm oil. It has the fifth lowest level of social development and third highest level of economic development.

The second cluster comprises of North Sumatra, South Sulawesi and North Sulawesi. Each of these provinces belongs to different group of palm oil production – high, low and no palm oil production. These provinces are characterized by medium level of social as well as the economic development.

The third cluster includes the provinces Riau and Central Kalimantan. These two provinces belong to the group of the largest producers of palm oil and have medium high level of social development and the highest level of economic development.

The fourth cluster is created by Central Jawa and East Jawa, belonging to the group of provinces with no palm oil production and West Jawa, which produces low volume of palm oil. These provinces have medium level of social development. Centra Jawa and West Jawa have the lowest level of the economic development, whereas East Jawa has the medium level of economic development.

The fifth group comprises of Bengka Belitung, Banten and North Maluku. Each of these provinces belongs to different group – medium, low and no palm oil production. This group is characterized by the highest social development. Bengka Belitung and Banten have the medium economic development, while North Maluku has the fourth lowest economic development.

The sixth cluster includes three provinces with medium palm oil production - Bengkulu, Lampung, and Central Sulawesi and one province belonging to the group of low volume of palm oil producing countries - Southeast Sulawesi. This last group is characterized by the lowest social development from all of the examined provinces. Bengkulu, Central Sulawesi and Southeast Sulawesi have the medium level of economic development whereas Lampung is characterized by the third lowest economic development.

The mean plot with whiskers (see Appendix 3, Figure 16) shows the within cluster variance of observed cases. The closer the cases within the cluster are to the center – mean, less they deviate from the center, thus the smaller the whiskers are. The most homogenous cluster in terms of in terms of economic as well as social development is logically Cluster 1, since it comprises of only one province – South Sumatra. Leaving aside this cluster, the most similar characteristics of social developments shares cluster 3 (Riau and Central Kalimantan), and Cluster 6 (Bengkulu, Lampung, Central Sulawesi, Southeast Sulawesi) in the economic development.

The classification of provinces based on economic and social CI indicates that high production of palm oil does not necessarily generate the same socio-economic development. The Table 11 shows that Riau and Central Kalimantan, provinces with the highest production of palm oil have the same level of socio-economic development, while the combination of provinces such as North Sumatra – the second largest producer of palm oil, South Sulawesi – province with one of the lowest volume of palm oil production and North Sulawesi – province producing no palm oil, demonstrates the opposite.

2.5 Relationship between indicators of economic development, palm oil production and deforestation

This part of the theses analyzes the relationship between palm oil production, tree cover loss, GRDP, FDI, unemployment rate and minimal wage by using the correlation analysis.

The coefficient of correlation indicates that there is a very high positive correlation between palm oil production and tree cover loss with the coefficient of correlation 0,91 that means that production of palm oil directly contributes to the deforestation and thus overall deterioration of environmental conditions. Figure 9 illustrates that all four countries belonging to the group of provinces with the highest production of palm oil are responsible for the highest losses of tree cover.

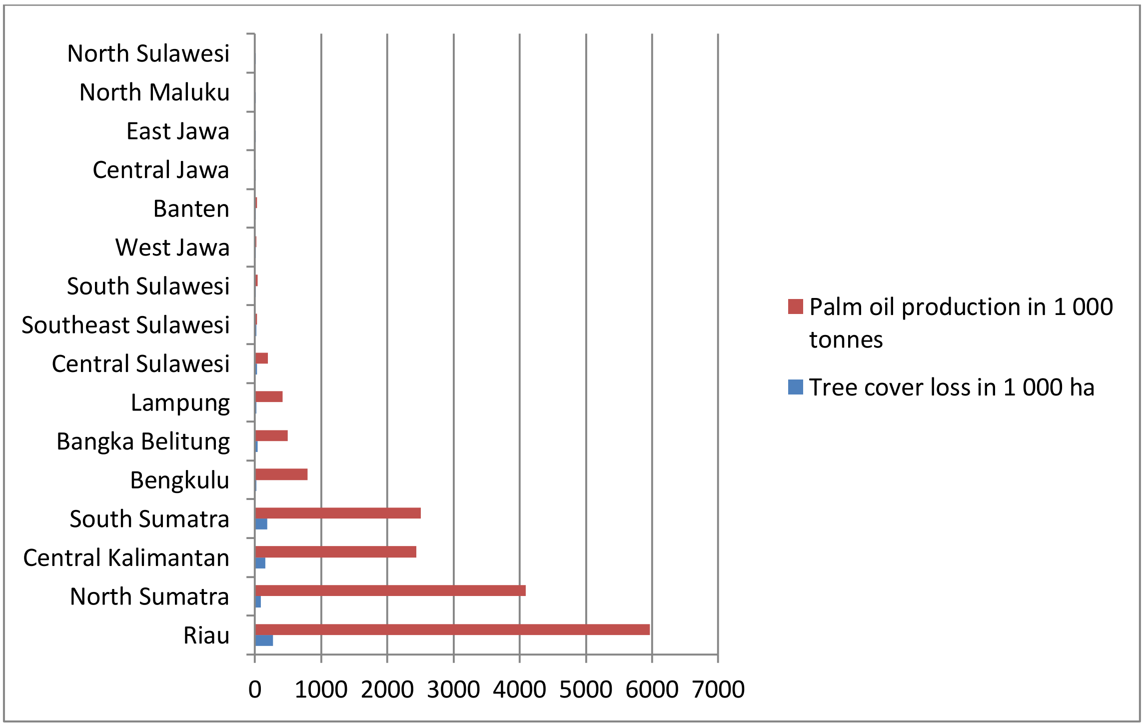

Figure 9: Production of palm oil in 1 000 ha tons and tree cover loss in 1 000 ha (Source: BPS; GFW; own work)

Correlation analysis further demonstrates that production of palm oil does not significantly contribute to the improvement of any of the individual economic indicators. The only indicator having higher interdependence with palm oil production in comparison to others is the minimal wage. However the correlation coefficient only equals to 0,53 that indicates insignificant moderate correlation. There is also found moderate positive correlation between tree cover loss and minimal wage, with a slightly higher coefficient of correlation than in the previous case accounting for the value 0,56 of correlation coefficient.

	Palm oil production in thousands of tons	Tree cover loss
Palm oil production in thousands of tons	1,000000	0,913003
Tree cover loss	0,913003	1,000000
Unemployment rate	-0,082677	-0,173203
GRDP	0,042505	-0,035195
Minimal wage	0,529647	0,569807
FDI	-0,116988	-0,130337

Table 12: Pearson coefficient of correlation (Source: BPS; GFW; WB; own work using Statistica)

Proposal part

In the palm oil producing provinces of Indonesia are the tropical forests disappearing at an alarming rate. Forests fires, loss of precious biodiversity as well as the greenhouse gas emissions are all the issues being driven by deforestation. The destruction of forests also significantly contributes to the global climate change, since forests are considered to be the largest „absorbers“ of climate-harming carbon dioxide gasses. Halting deforestation is one of the quickest and most cost effective ways to attenuate global warming and climate change.

The possibilities how to solve the problem of deforestation in Indonesia are not simple at all, since palm oil has a wide range of use globally and because there is a lack of economically competitive alternatives that could substitute this commodity. An effective collaboration among the Indonesian government, civil society organizations and stakeholders involved in palm oil sector will be necessary for improving the situation.

Research and development

The best solution to halt deforestation appears to be a global reduction of the consumption of palm oil, however due to its ever-increasing consumption, it does not seem to be likely in the foreseeable future. The increase in demand means that an extra land for palm oil plantations is needful. Furthermore given the economic significance of palm oil sector for Indonesia, it is important to search for ways how to increase the industry´s productivity without increasing the deforestation. Therefore the focus on the research to increase productivity of this crop on the already established plantations could be seen as the most viable solution so far. A new technology that would enable more palm oil extraction per tree would significantly decrease the impact on the environment. Such improvements could also create a more profitable industry, and thus increase the welfare of people producing palm oil. Furthermore the government should promote the creation of programs at the universities and other higher education institutions focused on the palm oil sector in order to prepare capable human resources for the development of innovations. At the same time, the government should also promote research and development in this area and create exquisite palm oil research institutes, which would interact together at a high level.

Better management of supply chain

The companies should introduce zero deforestation policy and besides commitments, they should make sure that no part of their supply chain is accountable for the destructive forest practices. The companies usually buy portion of the raw palm oil from smallholder farmers, who often lack financial resources and knowledge about environmentally sustainable agricultural practices. Therefore they should provide financial and other capacity-building services to their suppliers as a part of the strategies for reaching the sustainability in their supply chain management. All the companies should be held fully accountable for their supply chain starting from the origin of the raw palm oil materials.

Support and education for farmers

The government should focus on the support of smallholder and medium-scale palm oil producers and implement the policy of providing agricultural education about more effective techniques in palm oil cultivation. At the same time government should grant subsidies and supporting those farmers who adhere to higher production standards. Vast majority of these farmers needs assistance and incentives to carry out alternative and less damaging methods in the forest management. The provision of proper skills and training would make them more aware about the production sustainability and thus it would enable to balance the economic growth with healthy forests and conscious population. It would decrease the use of harmful fertilizers and simultaneously increase the productivity of the crop. Growth in productivity would reduce the need for farmers to extend the palm cultivation into new areas and it would help to end the practice of slash and burn method, which has destructive implications for the ecosystems. If all the corporations would commit to buy only certified products, the smallholders with certification would get much more market opportunities and their profits would increase. They would be fully integrated into the sustainable global supply chain and a long-term, traceable relationship among those actors could be established.

Strengthening institutional framework

It is necessary to strengthen the institutional authorities to ensure that companies comply with the relevant legal, environmental, and management standards. The government of Indonesia should reinforce the rules and penalties against the improper forest and agricultural practices and at the same time strengthen the institutional capacity to put them into effect. This requires greater collaboration between relevant institutions. The government should also support NGOs to become key supervisors in monitoring the standards compliance of the companies and to assist them in creating the proper policies towards sustainable measures. Eradicating the corruption is the prerequisite to reach the maximum effectiveness of the standards. The improvement of transparency measures as well as the support of institution building for controlling corruption is another important part in reaching the sustainability.

Palm oil certification

Using the certified palm oil, instead of using the conventional palm oil is another significant step for reaching the sustainability in palm oil sector. The implementation of RSPO and ISPO standards is already being done by many companies. Both RSPO as well as ISPO certification need a credible high-quality auditing on a periodic basis made by external accreditation institutions and it is necessary to assure that they are not being influenced by politics and private-sector actors. In addition it would is better to have only one comprehensive and properly supervised system of certification with strong standards for all stakeholders of supply chain, since more systems created are more costly confusing to the market. The EU, as the developed single market and the second largest importer of palm oil, should pressure for sustainable palm oil production and import only certified products. Taking into consideration the size and capability of EU to influence global markets, a 100% CSPO would support more farmers to implement more sustainable production practices, while making the CSPO more attractive and accessible to other big economies. The pressure for production of sustainable palm oil from developed countries such as the EU is one of the keys to reach the sustainability in this sector.

Value-added products

The Indonesian government should focus on the generating of higher value-added palm oil products for export, since it brings more economic benefits to the country than export of simple crude palm oil, and even without increasing deforestation. It would accelerate other economic sub-sector development related to palm oil, providing more job opportunities and further social development for the Indonesian population. The cooperation among research centers, companies, organizations and other actors involved in this sector is a vital precondition for the realization. The government should establish supportive policy environment to encourage the value added production through lowering the interest rates and improving the infrastructure. The effective trade policies would subsequently promote the leading position of Indonesian palm oil export in the global market.

Stop using palm oil for production of biofuel

Palm oil is increasingly used for the production of biofuel. Its popularity increases mainly in the EU because of their legislative and financial support. The raising demand for biofuels is only adding fuel to the flames and it significantly contributes to the already large-scale deforestation. The biofuels production requires large area of land and thus represents not only lost to food production, but also to nature. Biofuels should be produced in a sustainable way and its production should not compete with the food crops. Therefore the countries producing the biofuels from palm oil, particularly the EU, should reconsider its current policy of biofuels support. The energy efficient biofuels made from renewable resources, which do not harm the environment, really have the potential to become sustainable sources of energy. However it is not the case of palm oil.

Conclusion

The major objective of the thesis was to examine the relationship between palm oil production and standard of living in selected provinces of Indonesia and to suggest several solutions on how to improve the situation. In order to measure the level of the standard of living, the economic and social development performance was compared using composite indicators. For both social and economic development were chosen four sub-indicators to cover broader scope of the given area. The secondary aim was to examine the relationship between the palm oil production, deforestation and economic indices.

The first part of the thesis provided deeper insight to the topic of regional development and described the process of composite indicator creation.

The analytical part was primarily focused on the construction of composite indicators in order to compare the economic and social development performance of selected Indonesian provinces. Furthermore cluster analysis was included in order to classify provinces into the groups based on their results of economic and social CI. Finally was assessed relationship between palm oil production, deforestation and economic indices by using the correlation analysis. Based on these analyses were detected several findings that enabled to verify given hypothesis:

- Hypothesis 1: Palm oil production contributes to the socio-economic development of regions.
- Hypothesis 2: Production of palm is results in high level of deforestation.

The first hypothesis was not confirmed. It was proved that palm oil is for Indonesia an important commodity from an economic perspective, but it does not have a spillover effects on the social development. Based on the composite indicator, the highest level of economic development was found in provinces, where the highest volume of palm oil is produced – Riau, North Sumatra, Central Kalimantan and South Sumatra. The worst rating in the economic area gained the province Central Jawa, which does not produce palm oil. On the other hand, the performed analysis did not prove any relation between palm oil production and social development.

The second hypothesis was confirmed. It was proved that palm oil production is directly related to the destruction of the forests in Indonesia. Only four provinces producing the largest volume of palm oil are responsible for 56% of deforestation in Indonesia. Furthermore, it was detected that production of palm oil does not significantly contribute to the improvement of any of the individual economic indicators including unemployment rate, minimal wage, FDI inflow and GDRP.

The closing part suggested several subjective recommendations on the improvement of situation with palm oil production in Indonesia in the areas of research and development, supply chain management, education, institutional framework, certification of palm oil, value-added production and biofuel policy.

The main problem related to palm oil is rooted in the fact that the production is generally done in an unsustainable way. When cultivated properly, palm oil represents one of the most viable options for meeting the global needs, while maintain the principles of sustainability. Given its high yields in a small space and the lowest production cost, it is the most suitable crop for the production of vegetable oil. Actually, moving away from palm oil to less efficient crops would have much greater negative environmental consequences in terms of land use and land degradation. Therefore, rather than a threat to the environment, palm oil could be a viable solution for environmental challenges.

Some progress has been made as consumers have become more aware of the problems that palm oil production is causing. The increasing pressure from various civil society organizations forced many of the companies to begin implementing their operations within socially responsible and environmentally sustainable practices in order not to lose their profits due to bad reputation.

The transparency is a prerequisite for reaching the sustainability in the palm oil industry. The companies should invest and develop innovations and technologies to gain efficiency and raise profits, whereas government should be able to protect its national interests and natural capital. The production of palm oil has to contribute to Indonesia´s development rather than destroying the future for its population.

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Appendix 1: Raw data

Number	Province	2009	2010	2011	2012	2013	Average	%
1	Aceh	693,00	616,50	592,20	676,98	817,53	679,24	2,77
2	North Sumatra	3 862,40	3 899,60	4 010,70	4 147,65	4 549,20	4 093,91	16,71
3	West Sumatra	896,30	985,90	927,40	960,43	1 022,33	958,47	3,91
4	Riau	5 311,40	5 496,00	5 895,50	6 499,82	6 641,00	5 968,74	24,36
5	Riau Islands	11,30	14,10	15,20	38,46	36,77	23,17	0,09
6	Jambi	1 499,90	1 644,10	1 773,10	1 760,35	1 749,62	1 685,41	6,88
7	Bengkulu	736,00	796,00	827,10	825,76	787,10	794,39	3,24
8	South Sumatra	2 313,50	2 542,80	2 417,70	2 552,41	2 690,62	2 503,41	10,22
9	Bangka Belitung	446,60	490,20	504,60	522,07	508,13	494,32	2,02
10	Lampung	389,30	405,70	424,00	459,73	424,06	420,56	1,72
11	Banten	25,10	26,00	21,80	29,86	27,08	25,97	0,11
12	DKI Jakarta	0,00	0,00	0,00	0,00	0,00	0,00	0,00
13	West Java	20,70	16,40	22,10	24,86	32,64	23,34	0,10
14	Central Java	0,00	0,00	0,00	0,00	0,00	0,00	0,00
15	D.I. Yogyakarta	0,00	0,00	0,00	0,00	0,00	0,00	0,00
16	East Java	0,00	0,00	0,00	0,00	0,00	0,00	0,00
17	Bali	0,00	0,00	0,00	0,00	0,00	0,00	0,00
18	West Nusa Tenggara	0,00	0,00	0,00	0,00	0,00	0,00	0,00
19	East Nusa Tenggara	0,00	0,00	0,00	0,00	0,00	0,00	0,00
20	Maluku	0,00	0,00	0,00	0,00	0,00	0,00	0,00
21	Papua	66,70	136,40	103,10	97,70	93,48	99,47	0,41
22	West Papua	57,70	66,20	54,10	54,83	53,72	57,31	0,23
23	North Maluku	0,00	0,00	0,00	0,00	0,00	0,00	0,00
24	North Sulawesi	0,00	0,00	0,00	0,00	0,00	0,00	0,00
25	Gorontalo	0,00	0,00	0,00	0,00	0,00	0,00	0,00
26	Central Sulawesi	144,30	145,80	185,10	237,53	244,07	191,36	0,78
27	Southeast Sulawesi	0,00	15,20	16,20	30,03	71,28	26,54	0,11
28	South Sulawesi	28,20	34,90	42,70	48,91	49,82	40,91	0,17
29	West Sulawesi	260,50	264,40	249,30	257,50	282,74	262,89	1,07
30	South Kalimantan	1 041,40	1 049,20	1 045,20	1 279,65	1 244,04	1 131,90	4,62
31	Central Kalimantan	1 798,10	1 724,70	2 499,30	3 055,05	3 127,14	2 440,86	9,96
32	West Kalimantan	1 331,70	1 426,90	1 443,90	1 942,15	1 794,47	1 587,82	6,48
33	East Kalimantan	456,40	700,00	905,50	1 393,72	1 349,78	961,08	3,92
34	North Kalimantan	0,00	0,00	0,00	0,00	164,73	32,95	0,13

Table 13: Production of palm oil and its percentage share by province of Indonesia 2009-2013 in 1 000 of (Source: BPS; own work)

Province	Tree cover loss (average 2009-2013)	% of tree cover loss
High level of deforestation (80 000 - 300 000)		
Riau	269 206,00	16,47%
West Kalimantan	243 217,90	14,88%
East Kalimantan	224 619,50	13,74%
South Sumatra	182 849,70	11,19%
Central Kalimantan	159 321,70	9,75%
North Sumatra	92 415,95	5,65%
Jambi	86 553,70	5,29%
Medium level of deforestation (10 000 - 79 999)		
Aceh	49 582,42	3,03%
South Kalimantan	47 620,13	2,91%
Bangka-Belitung	35 362,29	2,16%
Central Sulawesi	33 123,17	2,03%
West Sumatra	32 698,27	2,00%
Papua	31 393,46	1,92%
Bengkulu	20 347,28	1,24%
Southeast Sulawesi	19 821,35	1,21%
Lampung	17 795,28	1,09%
South Sulawesi	14 425,93	0,88%
West Papua	11 908,63	0,73%
West Sulawesi	10 971,32	0,67%
Low level of deforestation (0 - 9 999)		
Maluku	8 876,45	0,54%
North Maluku	8 250,48	0,50%
Kepulauan Riau	6 231,82	0,38%
Gorontalo	5 098,26	0,31%
East Jawa	4 569,83	0,28%
Nusa Tenggara Timur	4 456,67	0,27%
West Jawa	3 454,60	0,21%
North Sulawesi	3 312,33	0,20%
Central Jawa	2 506,64	0,15%
Banten	2 365,11	0,14%
Nusa Tenggara Barat	2 017,23	0,12%
Bali	387,26	0,02%
Jakarta	1,55	0,00%

Table 14: Division of provinces based on the volume of tree cover loss expressed in ha (Source: GFW; own work)

Province	X1	X2	X3	X4	X5	X6	X7	X8
Riau	29,95	52,75	9,48	95,52	8,76	28,53	86,57	86,60
North Sumatra	29,22	51,92	11,51	94,46	8,35	22,69	86,90	181,10
Central Kalimantan	28,09	25,78	7,02	96,14	4,58	3,57	83,83	546,60
South Sumatra	32,38	41,48	16,28	93,61	8,00	13,19	79,19	186,30
Bengkulu	31,62	34,66	18,59	94,98	5,20	1,57	70,57	25,10
Bangka Belitung	43,17	60,66	7,46	92,52	5,48	2,21	81,62	22,00
Lampung	37,55	38,43	20,22	94,79	6,40	8,54	66,35	30,70
Central Sulawesi	37,63	42,02	18,98	92,98	5,27	3,12	69,13	138,50
Southeast Sulawesi	36,00	45,91	18,93	94,71	5,06	2,46	73,94	14,00
South Sulawesi	31,80	57,58	12,31	92,27	8,82	9,60	86,90	441,80
West Jawa	32,35	52,17	11,96	94,56	11,41	66,24	60,32	1 692,00
Banten	37,78	58,82	7,64	94,07	14,94	14,65	88,10	1 544,20
Central Jawa	32,60	62,83	17,72	95,63	7,31	38,21	55,21	59,10
East Jawa	32,12	51,07	16,68	95,27	5,48	65,95	54,73	1 769,20
North Maluku	27,60	43,18	10,36	93,39	6,69	0,45	73,94	246,00
North Sulawesi	35,82	63,59	9,79	91,90	10,60	3,17	89,25	226,80

Table 15: Raw data of social and economic development for 2009 (Source: BPS; WB; own work)

Province	X1	X2	X3	X4	X5	X6	X7	X8
Riau	30,90	54,27	8,65	96,24	7,97	38,06	111,82	212,30
North Sumatra	26,68	57,10	11,31	95,33	7,72	30,27	106,21	753,70
Central Kalimantan	31,03	35,14	6,77	96,63	4,01	4,69	108,58	543,70
South Sumatra	29,68	44,36	15,47	94,17	6,60	17,36	102,12	557,30
Bengkulu	33,73	41,64	18,30	95,53	4,33	2,05	85,85	43,10
Bangka Belitung	33,97	65,06	6,51	92,86	4,94	2,94	100,15	146,00
Lampung	34,65	43,85	18,94	95,20	5,76	11,93	84,47	79,50
Central Sulawesi	39,05	48,25	18,07	93,54	4,75	4,11	85,57	370,40
Southeast Sulawesi	35,75	50,87	17,05	95,06	4,69	3,12	94,65	17,00
South Sulawesi	30,64	61,45	11,60	92,86	8,18	12,97	110,06	89,60
West Jawa	28,00	55,57	11,27	95,02	10,45	84,92	73,90	3 839,40
Banten	33,01	63,78	7,16	94,73	13,91	18,90	105,14	2 171,70
Central Jawa	28,71	64,54	16,56	95,93	6,54	48,94	72,64	175,00
East Jawa	28,46	52,96	15,26	95,63	4,58	85,69	69,34	1 312,00
North Maluku	32,10	53,26	9,42	93,97	6,03	0,59	93,22	129,80
North Sulawesi	32,54	64,87	9,10	92,25	10,05	4,05	110,06	220,20

Table 16: Raw data of social and economic development for 2010 (Source: BPS; WB; own work)

Province	X1	X2	X3	X4	X5	X6	X7	X8
Riau	30,90	53,29	8,47	91,63	6,25	47,32	128,11	1 152,90
North Sumatra	26,68	56,47	11,33	91,61	6,78	35,96	118,44	645,30
Central Kalimantan	31,03	33,72	6,56	92,15	3,11	5,61	129,77	524,70
South Sumatra	29,68	47,36	14,24	89,57	5,92	20,86	119,92	786,40
Bengkulu	33,73	39,22	17,50	92,60	2,89	2,43	93,22	30,40
Bangka Belitung	33,97	67,64	5,75	90,92	3,43	3,49	117,13	59,20
Lampung	34,65	44,33	16,93	91,63	5,51	14,63	97,80	114,30
Central Sulawesi	34,02	48,39	15,83	90,08	4,14	5,07	94,65	806,50
Southeast Sulawesi	26,00	51,43	14,56	88,55	3,70	3,67	106,37	35,70
South Sulawesi	30,64	62,02	10,29	89,48	6,63	15,73	125,82	582,60
West Jawa	28,00	52,50	10,65	92,26	9,84	98,62	83,73	4 210,70
Banten	33,01	64,15	6,32	92,41	13,28	22,00	114,38	2 716,30
Central Jawa	30,15	64,52	15,76	90,20	6,00	57,05	77,21	241,50
East Jawa	28,46	54,21	14,23	91,90	4,17	101,17	80,64	2 298,80
North Maluku	32,10	52,53	9,18	89,83	5,59	0,69	101,72	90,30
North Sulawesi	32,54	67,23	8,51	85,88	8,91	4,78	120,10	46,70

Table 17: Raw data of social and economic development for 2011 (Source: BPS; WB; own work)

Province	X1	X2	X3	X4	X5	X6	X7	X8
Riau	24,40	58,38	8,22	92,62	4,77	50,06	132,12	1 304,90
North Sumatra	20,55	59,70	10,67	93,35	6,30	37,47	128,07	887,50
Central Kalimantan	25,00	38,31	6,51	96,03	2,93	5,96	141,67	481,60
South Sumatra	24,88	53,59	13,78	92,79	5,63	22,02	127,56	485,90
Bengkulu	28,62	35,93	17,70	94,10	2,88	2,57	99,25	22,30
Bangka Belitung	28,72	75,40	5,53	94,12	3,11	3,68	118,46	112,40
Lampung	31,67	43,72	16,18	93,50	5,16	15,44	104,05	46,80
Central Sulawesi	30,30	54,12	15,40	90,79	3,84	5,45	94,45	855,00
Southeast Sulawesi	29,40	55,17	13,71	92,54	3,62	3,91	110,17	86,40
South Sulawesi	25,56	63,33	10,11	90,61	6,24	17,06	128,07	462,80
West Jawa	28,45	55,41	10,09	93,41	9,43	101,36	83,24	7 124,90
Banten	30,40	61,35	5,85	93,67	10,34	22,75	111,20	3 720,20
Central Jawa	31,66	70,70	14,44	92,05	5,77	59,80	79,58	464,30
East Jawa	26,93	56,92	13,40	92,93	4,12	106,85	79,51	3 396,30
North Maluku	18,53	55,52	8,47	92,59	5,07	0,74	102,51	268,50
North Sulawesi	27,98	69,19	8,18	87,78	8,15	5,04	133,40	65,70

Table 18: Raw data of social and economic development for 2012 (Source: BPS; WB; own work)

Province	X1	X2	X3	X4	X5	X6	X7	X8
Riau	23,87	63,44	8,42	95,33	4,84	50,07	134,22	1 369,50
North Sumatra	21,14	61,92	10,39	95,64	6,27	38,73	131,83	550,80
Central Kalimantan	23,79	44,05	6,23	97,41	2,41	6,09	148,91	951,00
South Sumatra	24,16	51,66	14,06	95,12	5,13	22,21	156,28	1 056,50
Bengkulu	27,83	32,37	17,75	97,37	3,36	2,63	115,05	19,30
Bangka Belitung	27,35	77,95	5,25	95,72	3,44	3,73	121,28	105,00
Lampung	28,65	45,86	14,39	97,41	5,38	15,76	110,26	156,50
Central Sulawesi	29,70	54,21	14,32	90,27	3,43	5,62	95,40	1 494,20
Southeast Sulawesi	27,92	59,24	13,73	95,15	3,91	3,91	107,88	161,80
South Sulawesi	23,95	69,51	10,32	95,67	5,49	17,72	138,06	280,90
West Jawa	27,55	60,18	9,61	97,08	9,02	102,60	81,49	6 562,00
Banten	28,57	67,27	5,89	96,24	9,66	23,45	112,17	2 034,60
Central Jawa	31,66	70,70	14,44	95,68	5,77	59,80	79,58	463,40
East Jawa	27,37	60,38	12,73	96,10	4,14	108,95	83,05	1 802,50
North Maluku	15,34	57,72	7,64	95,47	4,65	0,74	115,11	98,70
North Sulawesi	23,85	72,28	8,50	91,61	7,15	5,12	148,61	98,40

Table 19: Raw data of social and economic development for 2013 (Source: BPS; WB; own work)

	X1	X2	X3	X4	X5	X6	X7	X8
Riau	26,79	56,43	8,65	94,27	6,52	42,81	118,57	825,24
North Sumatra	24,60	57,42	11,04	94,08	7,08	33,02	114,29	603,68
Central Kalimantan	26,81	35,40	6,62	95,67	3,40	5,18	122,55	609,52
South Sumatra	27,66	47,69	14,77	93,05	6,25	19,13	117,01	614,48
Bengkulu	30,50	36,76	17,97	94,92	3,73	2,25	92,79	28,04
Bangka Belitung	32,89	69,34	6,10	93,23	4,08	3,21	107,73	88,92
Lampung	32,62	43,24	17,33	94,51	5,64	13,26	92,59	85,56
Central Sulawesi	34,14	49,40	16,52	91,53	4,29	4,67	87,84	732,92
Southeast Sulawesi	31,20	52,52	15,60	93,20	4,20	3,41	98,60	62,98
South Sulawesi	27,89	62,78	10,93	92,18	7,07	14,62	117,78	371,54
West Jawa	29,06	55,17	10,72	94,47	10,03	90,75	76,54	4 685,80
Banten	32,76	63,07	6,57	94,22	12,42	20,35	106,20	2 437,40
Central jawa	30,93	66,10	15,96	93,90	6,27	52,68	73,26	280,66
East Jawa	28,41	55,11	14,46	94,73	4,50	93,72	73,45	2 115,76
North Maluku	23,05	52,44	9,01	93,05	5,60	0,64	97,30	166,66
North Sulawesi	29,25	67,43	8,82	89,88	8,97	4,43	120,28	131,56

Table 20: Averaged raw data of social and economic indicators 2009-2013 (Source: WB; BPS; own work)

Appendix 2: Construction of composite indicators

	X1	X2	X3	X4	X5	X6	X7	X8
Riau	26,79	56,43	8,65	94,27	0,81	1,63	118,57	2,92
North Sumatra	24,60	57,42	11,04	94,08	0,85	1,52	114,29	2,78
Central Kalimantan	26,81	35,40	6,62	95,67	0,53	0,71	122,55	2,78
South Sumatra	27,66	47,69	14,77	93,05	0,80	1,28	117,01	2,79
Bengkulu	30,50	36,76	17,97	94,92	0,57	0,35	92,79	1,45
Bangka Belitung	32,89	69,34	6,10	93,23	0,61	0,51	107,73	1,95
Lampung	32,62	43,24	17,33	94,51	0,75	1,12	92,59	1,93
Central Sulawesi	34,14	49,40	16,52	91,53	0,63	0,67	87,84	2,87
Southeast Sulawesi	31,20	52,52	15,60	93,20	0,62	0,53	98,60	1,80
South Sulawesi	27,89	62,78	10,93	92,18	0,85	1,16	117,78	2,57
West Jawa	29,06	55,17	10,72	94,47	1,00	1,96	76,54	3,67
Banten	32,76	63,07	6,57	94,22	1,09	1,31	106,20	3,39
Central jawa	30,93	66,10	15,96	93,90	0,80	1,72	73,26	2,45
East Jawa	28,41	55,11	14,46	94,73	0,65	1,97	73,45	3,33
North Maluku	23,05	52,44	9,01	93,05	0,75	-0,19	97,30	2,22
North Sulawesi	29,25	67,43	8,82	89,88	0,95	0,65	120,28	2,12

Table 21: Transformed data by Log10 (Source: BPS; WB; own work)

	Mean	Median	Minimum	Maximum	Variance	Std.Dev.	Coef.Var.	Skewness	Kurtosis
X1	29,47	29,15	23,05	34,14	11,03	3,32	11,27	-0,24	-0,69
X2	54,39	55,14	35,40	69,34	104,25	10,21	18,77	-0,41	-0,47
X3	11,94	10,98	6,10	17,97	16,93	4,12	34,46	0,03	-1,54
X4	93,56	93,99	89,88	95,67	2,07	1,44	1,54	-1,14	1,65
X5	0,77	0,77	0,53	1,09	0,03	0,16	20,87	0,45	-0,41
X6	1,06	1,14	-0,19	1,97	0,39	0,62	59,00	-0,21	-0,66
X7	101,05	102,40	73,26	122,55	292,65	17,11	16,93	-0,41	-1,15
X8	2,56	2,68	1,45	3,67	0,39	0,62	24,22	0,01	-0,64

Table 22: Descriptive statistics of transformed data (Source: BPS; WB; own work by using Statistica)

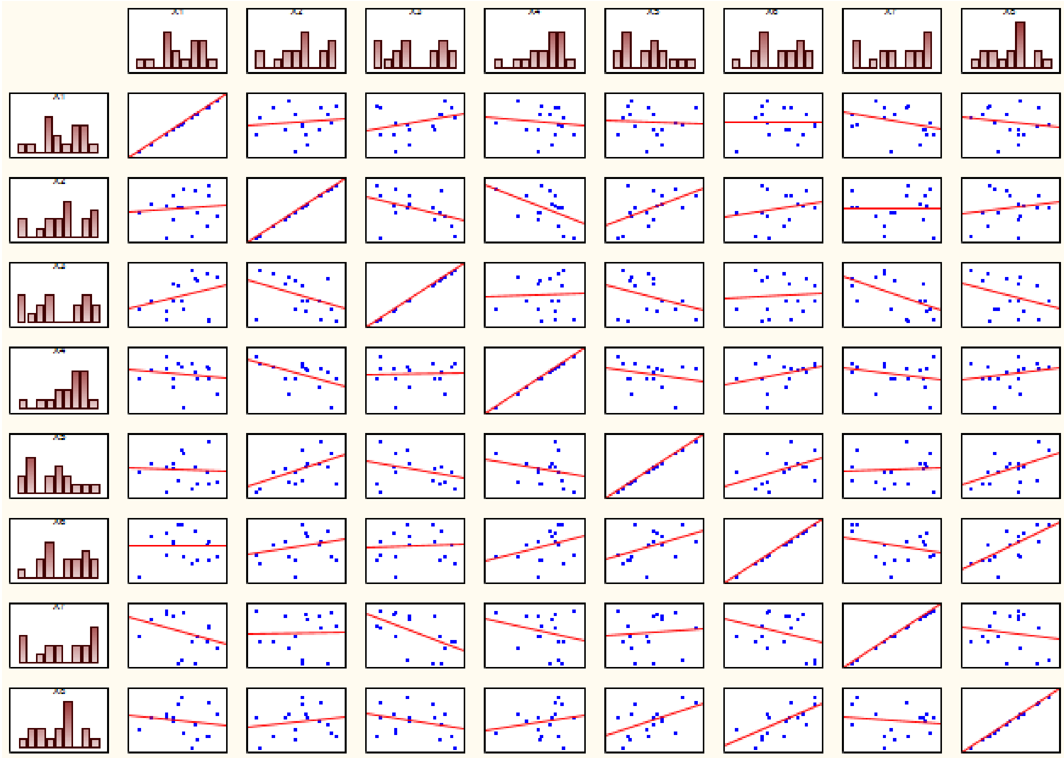

Figure 10: Correlation matrix (Source: BPS; WB; own work by using Statistica)

	X1	X2	X3	x4	X5	X6	X7	X8
Riau	0,81	0,20	0,80	0,50	-0,27	0,92	1,02	0,57
North Sumatra	1,47	0,30	0,22	0,36	-0,52	0,74	0,77	0,35
Central Kalimantan	0,80	-1,86	1,29	1,47	1,48	-0,56	1,26	0,36
South Sumatra	0,55	-0,66	-0,69	-0,35	-0,20	0,36	0,93	0,36
Bengkulu	-0,31	-1,73	-1,46	0,95	1,23	-1,13	-0,48	-1,80
Bangka Belitung	-1,03	1,46	1,42	-0,23	0,98	-0,88	0,39	-0,99
Lampung	-0,95	-1,09	-1,31	0,66	0,11	0,10	-0,49	-1,02
Central Sulawesi	-1,41	-0,49	-1,11	-1,41	0,86	-0,62	-0,77	0,49
Southeast Sulawesi	-0,52	-0,18	-0,89	-0,25	0,92	-0,84	-0,14	-1,23
South Sulawesi	0,48	0,82	0,25	-0,96	-0,52	0,17	0,98	0,01
West Jawa	0,12	0,08	0,30	0,63	-1,45	1,45	-1,43	1,78
Banten	-0,99	0,85	1,30	0,47	-2,02	0,41	0,30	1,33
Central Jawa	-0,44	1,15	-0,98	0,24	-0,20	1,06	-1,62	-0,18
East Jawa	0,32	0,07	-0,61	0,82	0,73	1,46	-1,61	1,23
North Maluku	1,93	-0,19	0,71	-0,35	0,11	-2,00	-0,22	-0,55
North Sulawesi	0,07	1,28	0,76	-2,55	-1,14	-0,65	1,12	-0,71

Table 23: Standardized values based on Z-scores (Source: BPS; WB; own work)

	X1*w1	X2*w2	X3*w3	x4*w4	SUM	RANK
Riau	0,1344	0,04976	0,33344	0,08263	0,6002	**3**
North Sumatra	0,2442	0,07414	0,09104	0,0606	0,47	**5**
Central Kalimantan	0,1333	-0,4651	0,53898	0,2454	0,4526	**6**
South Sumatra	0,0909	-0,1642	-0,286	-0,0583	-0,4176	**12**
Bengkulu	-0,0519	-0,4317	-0,6102	0,15776	-0,936	**15**
Bangka Belitung	-0,1718	0,36601	0,59142	-0,0379	0,7477	**1**
Lampung	-0,1582	-0,2732	-0,5458	0,11022	-0,8669	**14**
Central Sulawesi	-0,2343	-0,1223	-0,4636	-0,2346	-1,0549	**16**
Southeast Sulawesi	-0,087	-0,0458	-0,3701	-0,041	-0,5438	**13**
South Sulawesi	0,0792	0,20529	0,10278	-0,1597	0,2276	**8**
West Jawa	0,0208	0,0189	0,12405	0,10559	0,2693	**7**
Banten	-0,1649	0,21253	0,54363	0,07753	0,6688	**2**
Central Jawa	-0,0734	0,2866	-0,4073	0,03974	-0,1544	**11**
East Jawa	0,053	0,01748	-0,255	0,13619	-0,0484	**10**
North Maluku	0,322	-0,0478	0,29638	-0,0586	0,5121	**4**
North Sulawesi	0,0111	0,31924	0,31642	-0,4256	0,2211	**9**

Table 24: Weighting and aggregation of indicators of social development (Source: BPS; WB; own work)

	X5*w5	X6*w6	X7*w7	X8*w7	Sum	Rank
Riau	-0,0667	0,07659	0,51212	0,09496	0,61698	**2**
North Sumatra	-0,1291	0,06189	0,38703	0,05851	0,37828	**4**
Central Kalimantan	0,37041	-0,0464	0,62845	0,05963	1,01213	**1**
South Sumatra	-0,0511	0,02982	0,46653	0,06057	0,50583	**3**
Bengkulu	0,30797	-0,0945	-0,2414	-0,2994	-0,3273	**12**
Bangka Belitung	0,24552	-0,0731	0,19529	-0,1648	0,2029	**6**
Lampung	0,02697	0,00843	-0,2472	-0,1693	-0,3811	**14**
Central Sulawesi	0,2143	-0,0517	-0,3861	0,08113	-0,1423	**10**
Southeast Sulawesi	0,22991	-0,0704	-0,0716	-0,2051	-0,1171	**9**
South Sulawesi	-0,1291	0,01378	0,48903	0,00191	0,37558	**5**
West Jawa	-0,3633	0,12069	-0,7163	0,29746	-0,6615	**15**
Banten	-0,5038	0,03383	0,15057	0,22125	-0,0982	**8**
Central Jawa	-0,0511	0,08862	-0,8122	-0,0308	-0,8055	**16**
East Jawa	0,18308	0,12202	-0,8066	0,20475	-0,2968	**11**
North Maluku	0,02697	-0,1666	-0,1096	-0,0916	-0,3408	**13**
North Sulawesi	-0,2853	-0,0544	0,5621	-0,1192	0,10333	**7**

Table 25: Weighting and aggregation of data for indicators of economic development (Source: BPS; WB; own work)

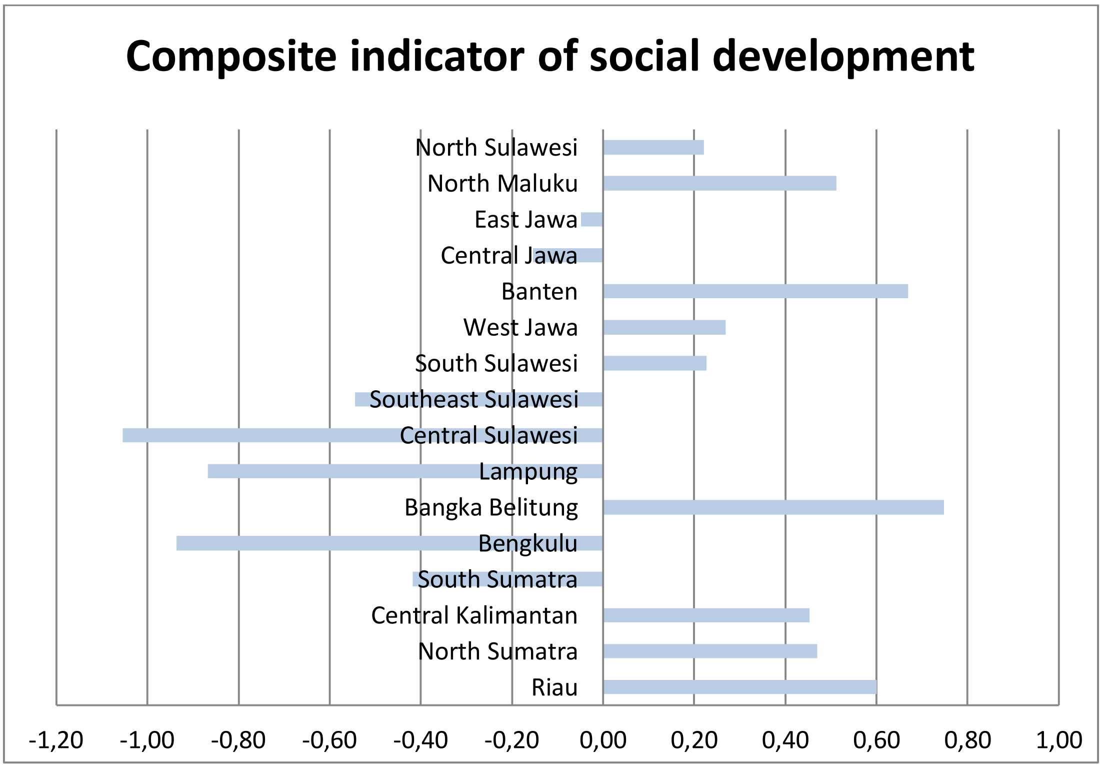

Figure 11: Graphical comparison of results of CI for social development (Source: WB; BPS; own work)

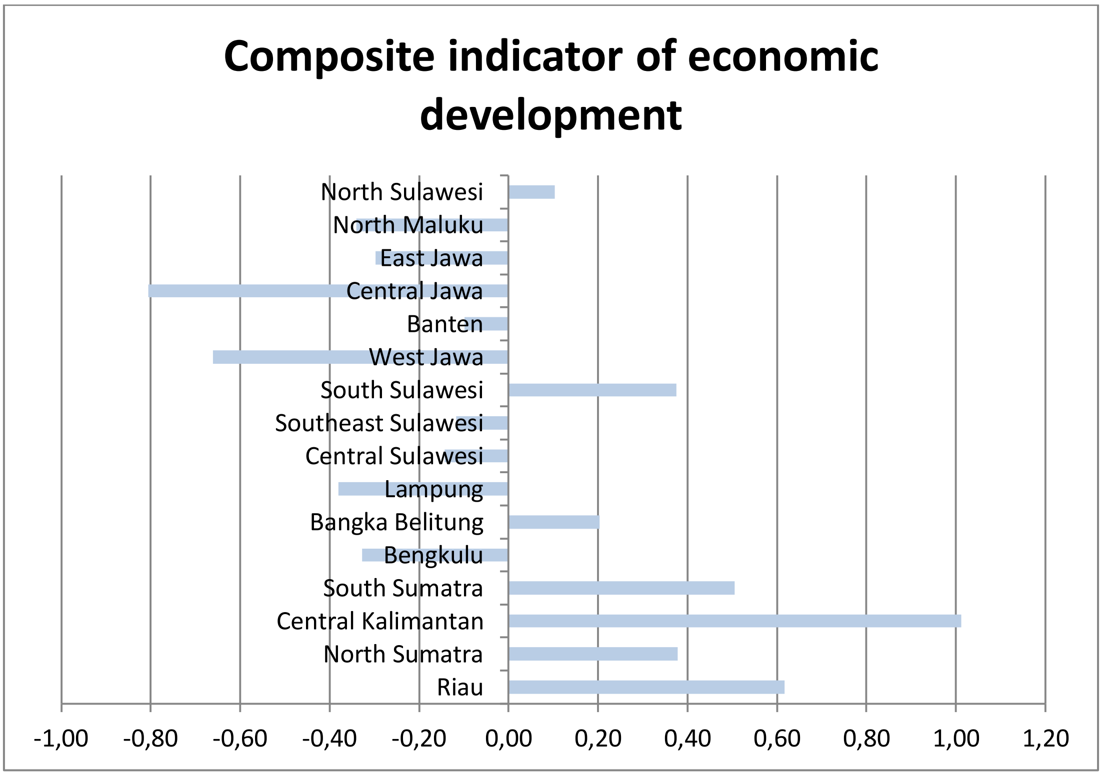

Figure 12: Graphical comparison of results of CI for economic development (Source: WB; BPS; own work)

Appendix 3: Cluster analysis

	1 Riau	2 North Sumatra	3 Central Kalimantan	4 South Sumatra	5 Bengkulu	6 Bangka Belitung	7 Lampung	8 Central Sulawesi	9 Southeast Sulawesi	10 South Sulawesi	11 West Jawa	12 Banten	13 Central Jawa	14 East Jawa	15 North Maluku	16 North Sulawesi
Riau	0,0000	0,0739	0,1779	1,0483	3,2515	0,1932	3,1486	3,3159	1,8476	0,1971	1,7439	0,5161	2,5927	1,2556	0,9251	0,4076
North Sumatra	0,0739	0,0000	0,4021	0,8041	2,4747	0,1079	2,3640	2,5963	1,2732	0,0588	1,1214	0,2665	1,7911	0,7245	0,5188	0,1376
Central Kalimantan	0,1779	0,4021	0,0000	1,0136	3,7222	0,7419	3,6823	3,6053	2,2680	0,4558	2,8346	1,2795	3,6721	1,9643	1,8339	0,8795
South Sumatra	1,0483	0,8041	1,0136	0,0000	0,9628	1,4497	0,9886	0,8263	0,4040	0,4332	1,8344	1,5451	1,7888	0,7805	1,5811	0,5699
Bengkulu	3,2515	2,4747	3,7222	0,9628	0,0000	3,1159	0,0077	0,0483	0,1980	1,8480	1,5644	2,6279	0,8396	0,7888	2,0972	1,5243
Bangka Belitung	0,1932	0,1079	0,7419	1,4497	3,1159	0,0000	2,9480	3,3685	1,7704	0,3003	0,9760	0,0969	1,8306	0,8835	0,3511	0,2872
Lampung	3,1486	2,3640	3,6823	0,9886	0,0077	2,9480	0,0000	0,0924	0,1741	1,7706	1,3695	2,4385	0,6877	0,6771	1,9033	1,4185
Central Sulawesi	3,3159	2,5963	3,6053	0,8263	0,0483	3,3685	0,0924	0,0000	0,2619	1,9130	2,0230	2,9731	1,2507	1,0369	2,4949	1,6885
Southeast Sulawesi	1,8476	1,2732	2,2680	0,4040	0,1980	1,7704	0,1741	0,2619	0,0000	0,8378	0,9575	1,4708	0,6255	0,2777	1,1650	0,6337
South Sulawesi	0,1971	0,0588	0,4558	0,4332	1,8480	0,3003	1,7706	1,9130	0,8378	0,0000	1,0772	0,4191	1,5408	0,5283	0,5941	0,0742
West Jawa	1,7439	1,1214	2,8346	1,8344	1,5644	0,9760	1,3695	2,0230	0,9575	1,0772	0,0000	0,4769	0,2003	0,2339	0,1618	0,5873
Banten	0,5161	0,2665	1,2795	1,5451	2,6279	0,0969	2,4385	2,9731	1,4708	0,4191	0,4769	0,0000	1,1779	0,5538	0,0834	0,2410
Central Jawa	2,5927	1,7911	3,6721	1,7888	0,8396	1,8306	0,6877	1,2507	0,6255	1,5408	0,2003	1,1779	0,0000	0,2700	0,6601	0,9669
East Jawa	1,2556	0,7245	1,9643	0,7805	0,7888	0,8835	0,6771	1,0369	0,2777	0,5283	0,2339	0,5538	0,2700	0,0000	0,3161	0,2327
North Maluku	0,9251	0,5188	1,8339	1,5811	2,0972	0,3511	1,9033	2,4949	1,1650	0,5941	0,1618	0,0834	0,6601	0,3161	0,0000	0,2819
North Sulawesi	0,4076	0,1376	0,8795	0,5699	1,5243	0,2872	1,4185	1,6885	0,6337	0,0742	0,5873	0,2410	0,9669	0,2327	0,2819	0,0000

Table 26: Squared Euclidian Distances (Source: WB; BPS; own work using Statistica)

linkage distance	Obj. No. 1	Obj. No. 2	Obj. No. 3	Obj. No. 4	Obj. No. 5	Obj. No. 6	Obj. No. 7	Obj. No. 8	Obj. No. 9	Obj. No. 10	Obj. No. 11	Obj. No. 12	Obj. No. 13	Obj. No. 14	Obj. No. 15	Obj. No. 16
,0076757	Bengkulu	Lampung														
,0587651	North Sumatra	South Sulawesi														
,0834291	Banten	North Maluku														
,0912590	Bengkulu	Lampung	Central Sulawesi													
,1215556	North Sumatra	South Sulawesi	North Sulawesi													
,1779348	Riau	Central Kalimantan														
,2002519	West Jawa	Central Jawa														
,2691915	West Jawa	Central Jawa	East Jawa													
,2708331	Bangka Belitung	Banten	North Maluku													
,2922446	Bengkulu	Lampung	Central Sulawesi	Southeast Sulawesi												
,7383471	North Sumatra	South Sulawesi	North Sulawesi	Bangka Belitung	Banten	North Maluku										
1,194420	South Sumatra	Bengkulu	Lampung	Central Sulawesi	Southeast Sulawesi											
1,524751	Riau	Central Kalimantan	North Sumatra	South Sulawesi	North Sulawesi	Bangka Belitung	Banten	North Maluku								
3,237499	South Sumatra	Bengkulu	Lampung	Central Sulawesi	Southeast Sulawesi	West Jawa	Central Jawa	East Jawa								
9,824994	Riau	Central Kalimantan	North Sumatra	South Sulawesi	North Sulawesi	Bangka Belitung	Banten	North Maluku	South Sumatra	Bengkulu	Lampung	Central Sulawesi	Southeast Sulawesi	West Jawa	Central Jawa	East Jawa

Table 27: Amalgamation schedule (Source: WB; BPS; own work using Statistica)

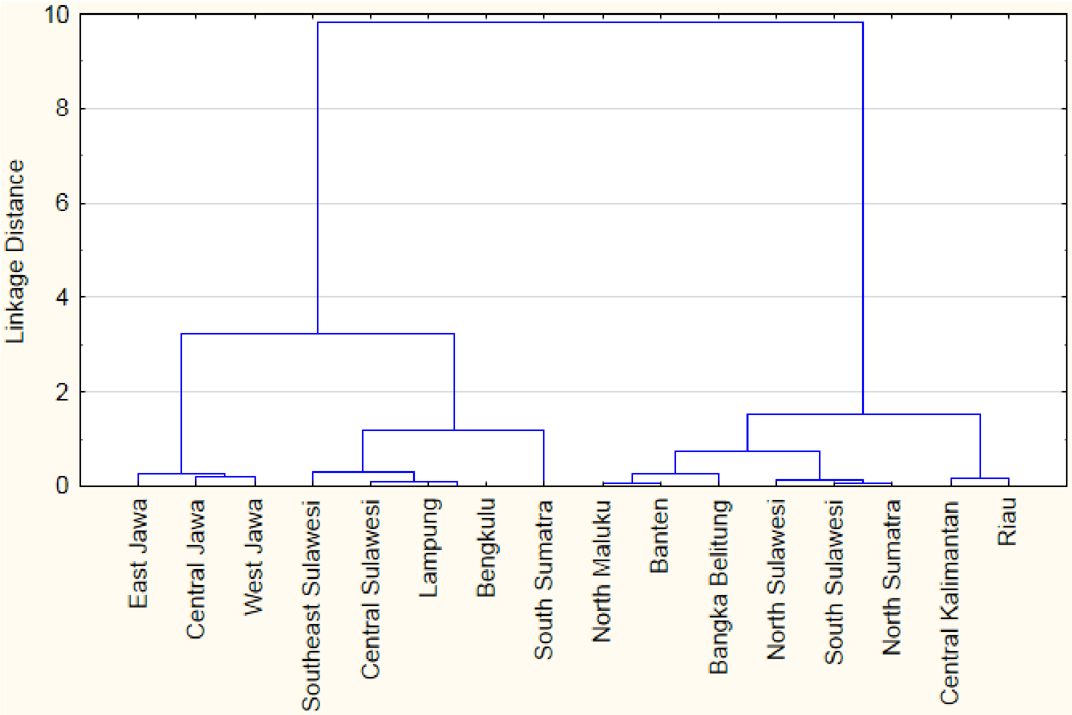

Figure 13: Dendogram (Source: WB; BPS; own work using Statistica)

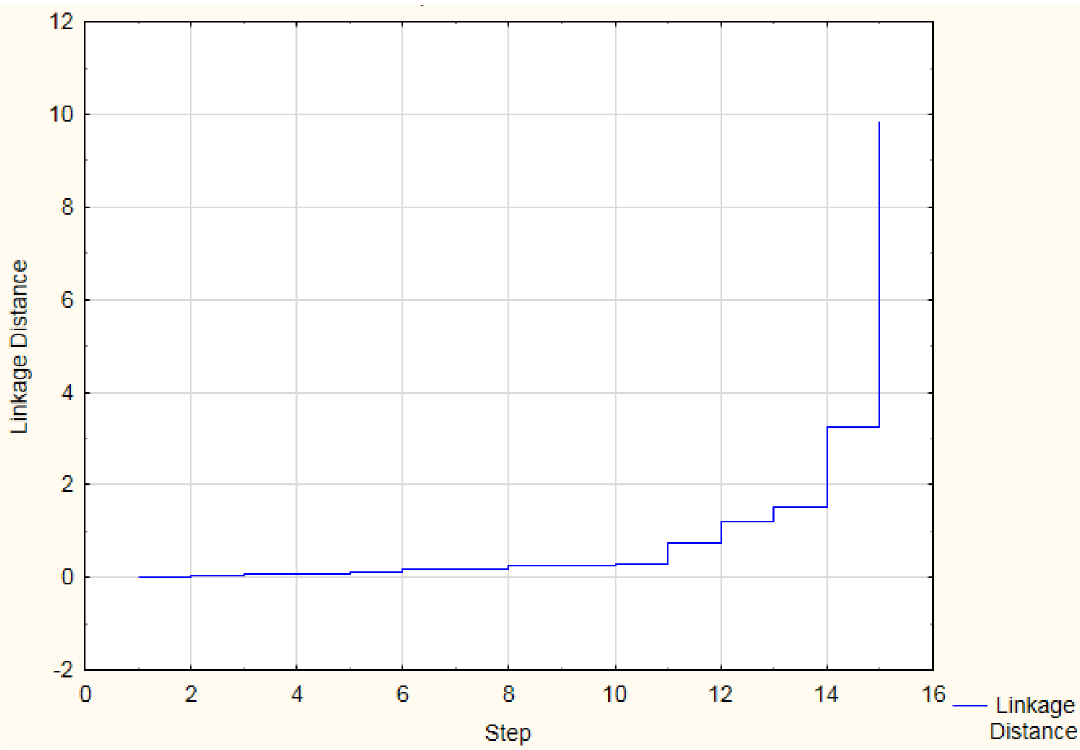

Figure 14: Graph of amalgamation schedule (Source: WB; BPS; own work using Statistica)

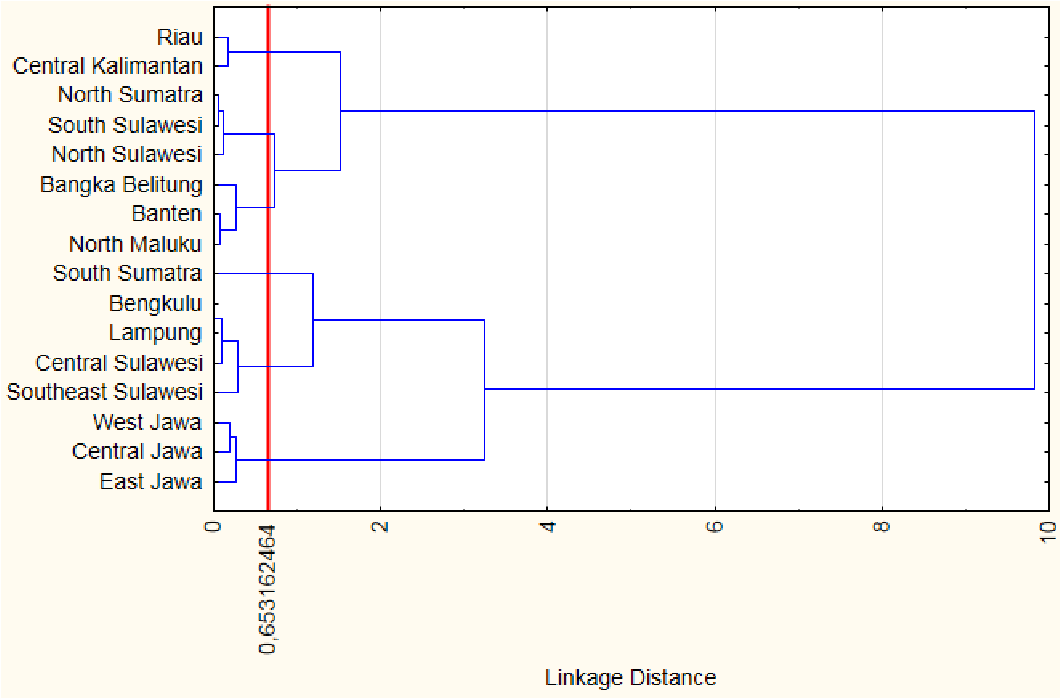

Figure 15: Cut in dendogram (Source: WB; BPS; own work using Statistica)

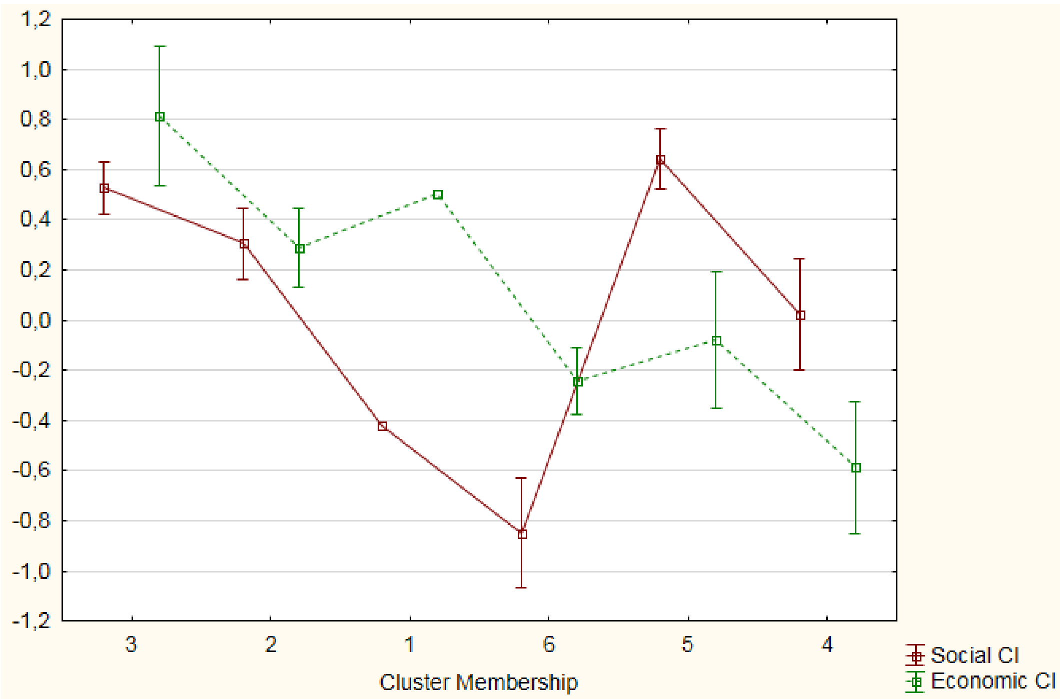

Figure 16: Profile diagram (Source: WB; BPS; own work using Statistica)