

Data Mining

by Meilany Meilany

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Applying Data Mining to Analysis of Mismatch Between Education and Labor Market in Indonesia

Meilany Nonsi Tentua*^{1,2}, Edi Winarko²

¹Teknik Informatika, Fakultas Teknik, Universitas PGRI Yogyakarta, Indonesia

²Department of Computer Science and Electronics, FMIPA UGM, Yogyakarta, Indonesia

*meilany@upy.ac.id, ²ewinarko@ugm.ac.id

Abstract. One of the labor problems in Indonesia is the occurrence of mismatch (incompatibility between education and job). The incompatibility of education and job (labor market) can be categorized into several criteria such as vertical mismatch, horizontal mismatch, overqualification, under qualification, over skilling, under skilling, credentialism and economic skills. In several countries, analysis of mismatch between education and labor market can be used with several methods such as the Maximum Likelihood equation, the Mincer-type income equation, and the use of clustering algorithms in data mining. Indonesia can adopt a method of measuring the mismatch between education and labor market which suitable with the condition in Indonesia. The use of the K-Means algorithm or the hierarchical clustering algorithm will be able to see how much mismatch is occurring in Indonesia. Clustering is carried out referring to the Republic of Indonesia's Presidential Regulation No. 8/2012 and the Indonesian Classification of Work (KBJI).

1. Introduction

One of the labor problems in Indonesia is the occurrence of mismatch (incompatibility between education and job). The incompatibility of education and job (labor market) can be categorized into several criteria such as [1], vertical mismatch, horizontal mismatch, overqualification, under qualification, over skilling, under skilling, credentialism and economic skills.

This mismatch phenomenon is due to the transformation of the labor market in Indonesia. The first transformation occurred in the early 1990s which was marked by changes in the primary sector to the secondary sector in the labor market [2]. This condition is in line with the economic transformation from the agricultural sector to the industrial sector. There has been a decline in demand for labor from the agricultural sector and shifting to the industrial sector [3]. The second transformation occurred in the early 2000s. The rapid development of information technology and science has increased the absorption of labor in the service sector. Figure 1 shows a decrease in the demand for labor from the agricultural sector to the industrial sector in Indonesia from 2009 to 2016 [4].



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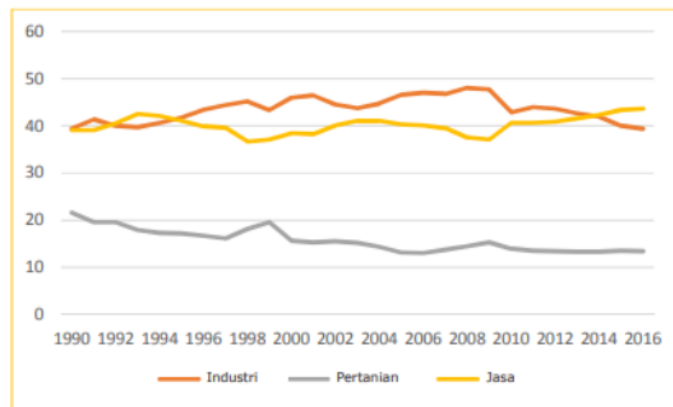
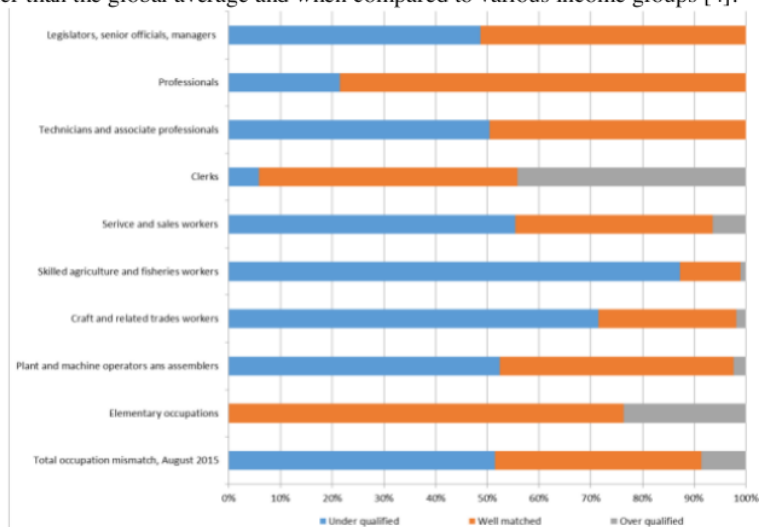


Figure 1. Workforce requirements per sector year in 1990-2016

On the supply side of labor market, there has been a large change with the growth of population and an increase in the level of education. Increasing the level of education in the workforce is an impact of the increasing access to education for the people of Indonesia. There is a gap between the highest level of education completed by staff with educational qualifications for certain types of work in the labor market. This is what causes overeducation and undereducation in the labor market. The phenomenon of overeducation and undereducation shows the existence of labor market imbalances in terms of supply and demand. In terms of the long term, this is a dilemma because it will lead to open unemployment, income problems, labor regulations, and education policies.

Statistical data shows that the labor force in Indonesia based on the ILO survey in 2018 was 125 million people or around 64.2% [5]. According to the 2015 national labor force survey processed by the University of Indonesia Demographic Institute, vertical mismatch or work mismatches with education and wages reached 53.33 percent. Meanwhile, horizontal mismatch or job qualification mismatch with educational background reaches 60.52 percent [6]. The youth unemployment rate in Indonesia is also much higher than the global average and when compared to various income groups [4].



Source: BPS (2015) Labor force situation: August 2015, Badan Pusat Statistik, Jakarta. * ADB staff calculations based on revised population estimates. ** Excludes armed forces occupations.

Figure 2. Mismatch Between Education and Labor Market in Indonesia

The mismatch between the education system and labor market needs is a very serious problem for economic growth and development. The difference between supply and demand for labor ultimately results in a decrease in the relevance of labor and inadequate use of the most important manufacturing factors. Figure 2 seen that mismatch between education and labor market in Indonesia in 2015 [7].

Several approaches have been used to analyse the mismatch of education and job [8]. Some of the causes of job mismatches with education level are inadequate skills of job seekers. "Functional" skills that must be completed in the education and training system can be divided into three main categories: [9]

- a) Self-assessment (direct approach) is an approach based on direct interviews with workers about the education needed for the current job position.
- b) Job analysis (normative approach) is the use of a measurement of the relationship between work and education needed based on job analysis evaluation.
- c) Realized match (statistical approach) by measuring the amount of education available to the job offered.

Some developed countries have made a discrepancy between the education system and the job that is very much considered by making a calculation model. This hospitality model will measure the level of discrepancy between education and employment. Several approaches are used in measuring to analysis mismatches between education and job.

In this article, we will review several models of measuring that have been carried out in several countries. Based on the review, a model that uses a data mining algorithm will be proposed to analyze the existing mismatch in Indonesia.

2. Literatur Review

Mismatch occurs when the level of education someone has is not suitable for the job. Vertical incompatibility can occur in two ways, excessive education or undereducation. Excess education is when someone is recruited for a job that requires a lower level of education than that of the individual. On the other hand, low education is where individuals have lower levels of education than expected for the job. The logical result of vertical mismatch is the presence of too many educated workers who bring skills to their jobs beyond the skills needed for the job, or the skills of less-educated workers are lower than those needed for that particular job [10]. Figure 2 shows the relationship between discrepancies that exist in education and labor market [11].

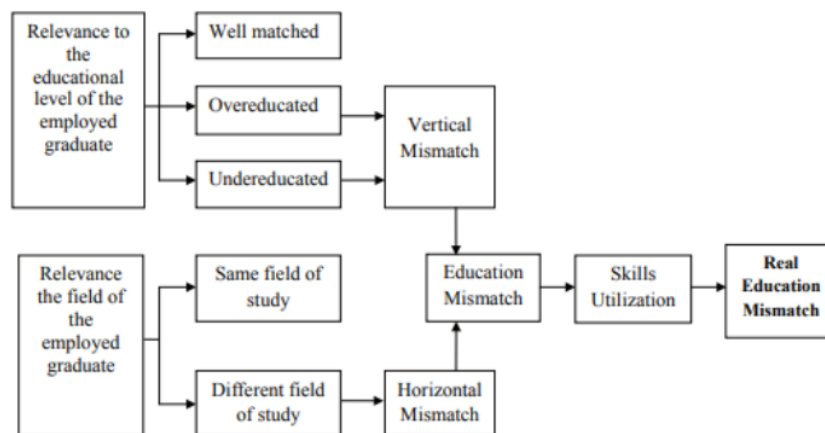


Figure 3. Relationship of mismatch that exist in Education and Job

- a. Vertical mismatch
A situation in which the level of education or skill is less or more than the required level of education or skill [12] [13]. There are several labor measurements for vertical mismatches such as subjective methods, empirical methods, job evaluation methods [14].
- b. Horizontal mismatch
A situation in which the level of education or skill matches job requirements, but the type of education or skill is inappropriate for the current job [15].
- c. Overqualification
A situation in which an individual has a higher qualification than the current job requires [16] [17] [18] [19].
- d. Underqualification
A situation in which an individual has a lower qualification than the current job requires [20] [21] [22].
- e. Overskilling
A situation in which an individual is not able to fully utilise his or her skill and abilities in the current job [23] [24].
- f. Underskilling
A situation in which an individual lacks the skill and abilities necessary to perform on the current job to acceptable standards [25] [26].
- g. Credentialism
A situation in which the level of education required to obtain the job exceeds the level of education required to perform the job adequately. It relies upon a belief of the employer that the possession of certificates and diploma implies higher productivity on the part of the individual [27] [28].
- h. Economic skill obsolescence
A situation in which skills previously utilised in a job is no longer required or have diminished in importance [22].

Several calculation models are conducted to see the amount of discrepancy between education and job in several countries. The results of this calculation are usually used to consider existing education policies. In Spain, especially in Barcelona, the calculation of inconsistencies between education and work is done by considering the availability of private transport to represent potential determinants. The equation model uses the Limited Information Maximum Likelihood equation, namely:[29]

$$mismatch_i = \alpha + \beta'Xi + \gamma.pta_i + \delta.nca_i + \varepsilon_i \quad (1)$$

Equation (1) associates job-education mismatch with control variable vector (Xi) and with work accessibility with public transportation (PTA) and with private transportation (NCA). In the Netherlands, the calculation of nonconformity is done using the formulation of human capital H_{ct} available for company c in year t on the entrepreneur's perception of the mct match between skill demand and supply of skills in the company. The equation is written as:

$$m_{ct} = \alpha_0 + \alpha_1 H_{ct} + \alpha_2 X_{ct} + \eta_t + \eta_s + \varepsilon_{ct} \quad (2)$$

where m_{ct} is equal to 1 if company $c \in \{1, 2, \dots, N\}$ reports mismatch in year t , and 0 otherwise; X_{ct} constitutes a vector of company characteristics; η_t and η_s represent, respectively, region and sector fixed effects and ε_{ct} is the error term. [30]

More than a quarter of Australian graduates were found to be unsuitable. Graduates from fields of study and work were found. Mismatches are analyzed by looking at the income earned. The Ordinary Least Squares regression model is used in this calculation, which can be stated as:

$$\ln(sal) = X\beta + M + \varepsilon \quad (3)$$

where $\ln(sal)$ denotes annual salary, expressed in natural logarithmic format. The vector M are dummy variables that represent the three forms of mismatch, namely, i) vertically mismatched; ii) horizontally

mismatched, and; iii) residual skills mismatched. In order to address the endogeneity of the mismatch variables in the earnings models, the two-stage residual inclusion approach of Terza et al [12].

2.1 Using Mincer-type income equation to analysis mismatch between education and job

The use of the variable labor income associated with a mismatch between employment and fields of study is usually estimated by the Mincer-type income equation in the country of Brazil. The equation used, i.e.

$$\ln(w_i) = \beta_0 + \beta_1 X_i + \beta_2 F_i + \beta_3 M_i + \beta_4 P_i + \beta_5 Dist_i + e_i. \quad (4)$$

where w_i represents hourly labor income, X_i is a vector of demographic characteristics, F_i represents the field of study, M_i is the value of work not related to their field of study (0 or 1), P_i shows those who are partially suitable for employment, and u_i is an error term. [31]

Almost the same as the country of Brazil, in New Zeland the measurement of the mismatch of education and labor market also uses income as a variable. The formula used is also almost the same shape but uses variables

$$\ln(E_i) = \beta_0 + \beta_1 S_i + \beta_2 Exp_i + \beta_3 Exp_i^2 + \beta_4 M_i + \alpha_4 X_i + u_i. \quad (5)$$

E_i represents individual income, S_i is the level of education achieved, Exp_i is post-school labor market experience, X_i is a vector of variables that defines the individual (other than education or experience) and u_i is a random error term. This specification reflects labor market outcomes based on employee information and is therefore entirely dependent on information about educational attainment from the supply side. [32]

Mismatch analysis in the United States also uses income as a benchmark in seeing how large the mismatch is between education and job.

$$\ln w_i = \delta_r S_i^r + \delta_0 S_i^0 + \delta_u S_i^u + x_i' \beta + \varepsilon_i \quad (6)$$

where w_i denotes wages, S_r is the year of education needed for the job, S_0 the year of excessive education, and S_u the year without education. x_i is a vector of control variables including experience and the square of experience. δ_r , δ_0 , and δ_u are returns for the required education years, excessive years of education, and fewer years of education. [33]

Demographic characteristics are represented by age, age squared, sex, race, and distance between work and residence. Some other countries such as Armenia, Georgia, Macedonia, Ukraine [8] Jepang [16] dan Afrika [34], also use Mincer-type income equality exchanges to analyze the mismatch of education and job.

2.2 Using data mining to analysis mismatch between education and job

Some mismatch analysis at this time has begun to use existing algorithms in data mining. As in Hungary [35], the analysis was carried out by utilizing an integrated database of the National Tax Administration, the National Health Insurance Fund, and higher education information systems. Several clustering methods including the BRIM algorithm [36] (bipartite, recursively induced modules) developed specifically for bipartite graphs, were chosen in analyzing the distribution of over education that is spread across several regions of the Hungarian country.

In the United Kingdom [37], education and work mismatch analysis are carried out using the clustering method in grouping work data at an individual level and looking at trends in overeducation that occur. The algorithm used in classifying is K-Median Clustering [38]. Machine Learning [39] is used in analyzing how graduates are employed in the country of Spain. Predictive models are built using machine learning algorithms. The data they used was taken from the Spanish Observatory for Employability and Employment (OEEU).

3. Method

We propose the K-Means algorithm or the hierarchical clustering algorithm approach in clustering mismatch between education and labor market. K-means is a method for dividing a set of observations into a user-defined number of subsets, based on how close the observations are to each other in the

feature space[38]. There are k the number of subsets. The grouping is divided into five groups namely mismatch by level education, a field of study, job-specific level, level of basic skills and level of portable skills.

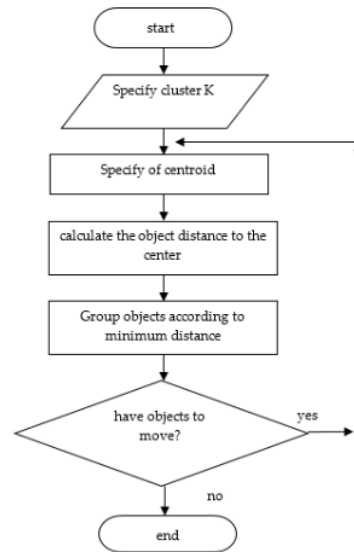


Figure 4. Flowchart of the K-means algorithm

The steps of the K-means algorithm are as follows, 1) Setting the initial midpoint value, 2) Calculating the distance of an object to a centroid using the Euclid distance formula, 3) Clustering an object by entering each object into a cluster (group) based on its minimum distance, 4) determine the centroid, based on the members of each group, 5) calculates the distance of the object to the new centroid until the grouping of each object has a minimum distance.

4. Discussion

Based on the 2016 Asian Development Bank report [7] job mismatches that occur in Indonesia tend to be related to the low level of education of workers who qualify for their jobs. Lack of qualifications is also a challenge in higher-level jobs. The low level of qualifications and the low level of over-qualifications lead to the problem of lack of skills. This is an important issue because high levels of skills and qualification mismatch are usually associated with lower levels of labor productivity.

With the importance of the mismatch problem between education and labor market, an analysis is needed that can measure the extent of the mismatch that occurs in Indonesia. Some methods that have been used to analyze in several countries are the Maximum Likelihood equation, the Mincer-type income equation, and the use of clustering algorithms in data mining.

Analysis of the measurement of education and work world mismatch that has been used in several countries pay attention to criteria related to education such as education level, experience, length of education and demographic factors. Demographic factors are represented by age, age squared, sex, race, and distance between workplace and residence. A mismatch analysis on education and types of work in Indonesia can be done by taking into account Presidential Regulation of the Republic of Indonesia Number 8 of 2012 [41] Concerning the Indonesian National Qualification Framework (KKNI) or based on the Indonesian Classification of Work Standard (KBJI) [42] made by BPS. The Indonesian National Qualification Framework (KKNI). KKNI provides nine qualification levels, starting from the 1st level qualification as the lowest qualification and the 9th level qualification as the highest qualification.

Table 1. Education, KKNI, and Level of Job

Education	KKNI	Level of Job
Basic Education (SD, SMP)	Level 1	Operator
Middle Education (SMA/MA/SMK)	Level 2	Operator
Diploma I	Level 3	Operator
Diploma II	Level 4	Technician/Analyst
Diploma III	Level 5	Technician/Analyst
Diploma IV/Bachelor	Level 6	Technician/Analyst
Profession	Level 7 or 8	Expert
S2	Level 8	Expert
Specialist	Level 8 or 9	Expert
S3	Level 9	Expert

Source: Presidential Regulation of the Republic of Indonesia Number 8 of 2012

Based on Table 1, it can be seen that there are 9 levels of KKNI according to Presidential Regulation of the Republic of Indonesia Number 8 of 2012. Basic, middle, and Diploma I have 1, 2, and 3 levels of KKNI with occupational positions as operators. Education DII, DIII, DIV / Bachelor have KKNI levels 4, 5, and 6 with a job position as a technician/analyst. As for professional education, S2, specialist, and S3 have KKNI levels 7, 8, and 9 with occupational positions as experts/professionals. The division into these three occupational positions is still considered to be less detailed.

The division of types of work in detail can be based on the Indonesian Classification of Occupational Classification (KBJI) issued by BPS. Based on KBJI 2000_1 there are 8 types of work ranging from professionals to operators and others. The types of work are in the order of types of work from the highest to with the lowest. The combination of KKNI levels with KBJI 2000_1 can be connected between the types of work and the level of education needed.

By observing the Republic of Indonesia's Presidential Regulation No. 8/2012 and the Indonesian Classification of Work (KBJI) Classification, classification can be made for workers in Indonesia. Analysis of mismatch measurements between education and labor market in Indonesia can see clustering using the K-Means algorithm or the hierarchical clustering algorithm. The use of clustering with the algorithm refers to Hungary, the United Kingdom and countries in Europe. Clustering can be done by grouping the types of mismatch that occur in Indonesia, as shown in Figure 4.

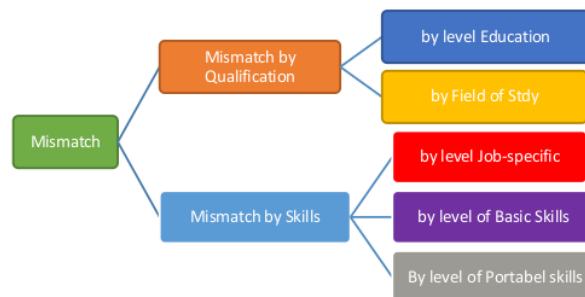


Figure 5. Clustering on the mismatch between education and labor market

The mismatch is grouped into parts namely mismatch based on qualifications seen based on the type of education and the field of study and based on the skills seen based on specific job level, basic skill level and level of portable skill. The data needed for classification and clustering are: personal data (date of birth, county of address, citizenship, gender)

- a) occupational data (employment relationship, occupation, gross wage, etc.)
- b) employer data (county of company headquarters, company size, company activity, etc.)
- c) educational data (institute, faculty, program where the graduate graduated)
- d) certification (skill)

5. Conclusion

Almost all countries have problems with the mismatch of education and labor market. In overcoming these problems they need analysis with several methods to measure how big the mismatch of education and labor market that occurs in the country. The method used is the Maximum Likelihood equation, the Mincer-type income equation, and the use of clustering algorithms in data mining.

Indonesia as a developing country is also inseparable from this problem. This mismatch phenomenon is due to the transformation of the labor market in Indonesia. The first transformation occurred in the early 1990s which was marked by changes in the primary sector to the secondary sector in the labor market.

Based on measurements that have been made in several countries, Indonesia can adopt a method of measuring the mismatch between education and labour market. The use of the K-Means algorithm or the hierarchical clustering algorithm will be able to see how much mismatch is occurring in Indonesia. Clustering is carried out referring to the Republic of Indonesia's Presidential Regulation No. 8/2012 and the Indonesian Classification of Work (KBJI).

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