Classification of Economic Characteristics based on Klassen Typology using Multilayer Perceptron Neural Network

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ABSTRACT: Urban development in Java is undergone rapidly during the last two decades. One factor driving urban development is economic characteristics. The autonomy policy in Indonesia might bring economic disparity among districts in Java. This study aims to develop the classification of economic characteristics based on Klassen typology in Java using multilayer perceptron neural networks. Two aspects will be considered in building model i.e. demography and physical. Economics data, demographics data, and physical data was acquired. The economy characteristics of districts in Java was classified based on Klassen typology using economic data. We designed the neural networks based on the multilayer perceptron (MLP) to classify the economic characteristics. In the framework of the neural networks, the physical data and demographic data were used as the input of the networks. The economy characteristics based on Klassen typology then used as the output of the networks. The parameters were varied to assess the performance. In the experiments, the results indicated that our proposed method works efficiently to classify economic characteristics based on Klassen typology in almost regions.

1. INTRODUCTION

1.1 Background

Urban development in Java is undergone rapidly during the last two decades. One factor driving urban development is economic characteristics. The autonomy policy in Indonesia might bring economic disparity among districts in Java. The economic characteristics could figure the difference of development growth among districts. This would very beneficial in mitigating the steps which should be taken by the central government to gain economic equity.

The island of Java consists of 6 provinces i.e. West Java, Central Java, East Java, Banten, Special Region of Yogyakarta, and Special Capital Region of Jakarta with 119 districts which consist of 85 regencies and 34 cities. With the area of 138,793.6 sq. km and the population of 160,293,748 people (2015) bring Java Island as the most populous island in the world with population density of 1,155 people/sq. km.

Klassen Typology is an analytical tool for identifying the sectors, subsectors of business, or commodities or featured a priority area. Klassen Typology analysis tool is a combination or blend of tools Location Quotient (LQ) and Growth Ratio Model (MRP). Klassen Typology can be used through two approaches, namely the sectoral and regional levels. The data used in this analysis is data Gross Regional Domestic Product (GRDP).

Klassen Typology sectoral approaches yield four classification of sectors with different characteristics. The data used is the rate of growth and the contribution of each sector. Four classifications are: Leading Sector/mainstay, is the forward sector and grow rapidly classified in Quadrant I; Potential Sector, classified in Quadrant II; sector is growing rapidly, are classified in Quadrant III; and sector is relatively disadvantages/backward classified in Quadrant IV.

A second approach to Klassen Typology analysis is the regional approach that has a similar concept with a sectoral approach, but the difference is the type of data used is the data rate and

per capita income growth. In this approach, the area is divided according to the classification of the area in the quadrant as follows: The area of advanced and fast-growing (rapid growth region) are classified in Quadrant I, Regional advanced but depressed (retarded region) are classified in Quadrant II, The area is growing fast (growing region) are classified in Quadrant III, and the area is relatively lagging behind (relatively backward region) are classified in Quadrant IV.

This grouping is dynamic because it depends on the progress of development activities in the district and the city concerned. This means that in a few years, the grouping will change according to the development and the growth rate of per capita income level of the region concerned. The change will easily occur in the area where conditions have been close to the limit of the average of the growth rate and per capita income community

1.2 Objectives

This paper aims to analyze the economic characteristics of districts in Java and to analyze the performance of MLP in classifying based on demography and physical aspects.

1.3 Benefits

By conducting this research, it will produce better understanding about the economic characteristics of districts in Java. Furthermore, the optimum model of multilayer perceptron neural network for depicting the economic characteristics based on demography and physical aspects also depicted.

1.4 Study Area

Java Island located in west-southern part of Indonesia (Fig. 1). The island of Java consists of 6 provinces i.e. West Java, Central Java, East Java, Banten, Special Region of Yogyakarta, and Special Capital Region of Jakarta with 119 districts which consist of 85 regencies and 34 cities (Fig. 2).

Fig. 1 The location of Java in Indonesia.

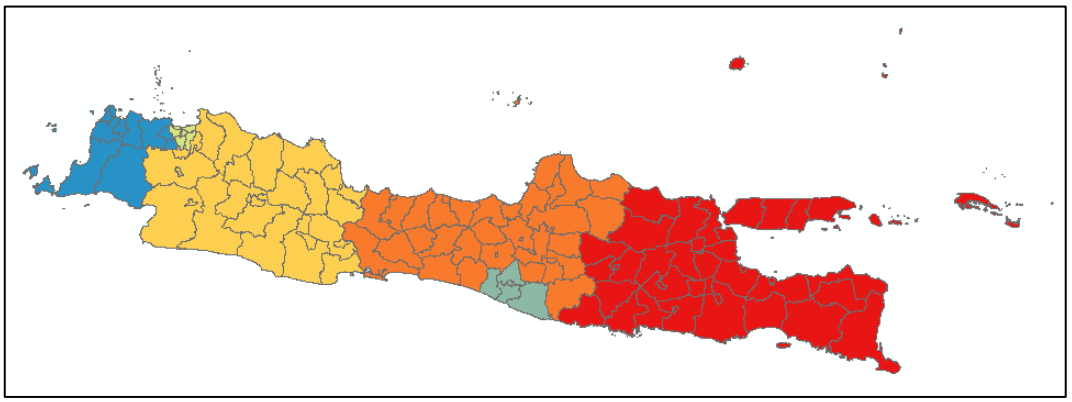

Fig. 2 Administrative divisions in Java at province and district level.

2. METHODOLOGY

2.1 Data Collection

The data mainly obtained from Statistics Indonesia (*Badan Pusat Statistik*/BPS). The data including economic, demography, and physical aspects.

1. Economic data
   a. Per Capita Gross Regional Domestic Product (GRDP) at current market prices of districts in Java
   b. GRDP growth rate at 2010 constant market prices of districts in Java
2. Demography data
   a. Population density.
   b. Literacy rate
   c. Poverty index
3. Physical data
   a. Urban area
   b. Paddy field area

The data will be in district level.

2.2 Analysis of Economic Characteristics

The characteristics of the economy state will be classified based on Klassen typology as herewith.

1. High income and high growth: GRDP and GRDP growth rate of districts are higher than their province.
2. High income but low growth: higher GRDP but lower GRDP growth rate of districts than their province.
3. Low income but high growth: lower GRDP but higher GRDP growth rate of districts than their province.
4. Low income and low growth: GRDP and GRDP growth rate of districts are lower than their province.

2.3 Building Model of MLP Neural Network

The classification will use multilayer perceptron as the classifier. Accuracy assessment then performed. The number of input node and hidden layer will be varied based on 2 aspects i.e. demography and physical. Here are the parameters of the neural networks:

1. Number of input node: varied, number of output node: 1
2. Number of hidden layer and node: varied
3. Learning rate: 0.01
4. Activation function: rectified linear unit (ReLU)

3. RESULTS AND DISCUSSION

3.1 Data Collection

Below is the list of collected data.

1. Economy data:
   a. Per Capita Gross Regional Domestic Product (GRDP) at current market prices of districts in Java
   b. GRDP growth rate at 2010 constant market prices of districts in Java
2. Demography data:
   a. Population density
   b. Literacy rate
   c. Poverty index
3. Physical data:
   a. Urban area
   b. Paddy field area

3.2 Analysis of Economic Characteristics

The result of economic characteristics analysis is shown in Table 1.

Table 1 Economic Characteristics of Districts in Java

ID	Cities/Regencies	Per Capita GRDP (Thousand IDR)	GRDP Growth Rate	Class	
1	Kepulauan Seribu	303,101	1.22	High Income	Low Growth
2	Kota Jakarta Pusat	242,492	6.32	High Income	High Growth
3	Kota Jakarta Utara	145,877	6.21	Low Income	Low Growth
4	Kota Jakarta Barat	641,080	6.02	High Income	Low Growth
5	Kota Jakarta Selatan	158,312	6.41	Low Income	High Growth
6	Kota Jakarta Timur	255,315	6.36	High Income	High Growth
7	Bogor	35,238	5.96	Low Income	High Growth
8	Sukabumi	22,532	5.14	Low Income	Low Growth
9	Cianjur	17,083	5.72	Low Income	High Growth
10	Bandung	28,260	6.17	Low Income	High Growth
11	Garut	18,538	4.89	Low Income	Low Growth
12	Tasikmalaya	17,468	5.95	Low Income	High Growth
13	Ciamis	22,458	5.21	Low Income	Low Growth
14	Kuningan	19,142	6.36	Low Income	High Growth
15	Cirebon	19,424	5.05	Low Income	Low Growth
16	Majalengka	21,294	6.81	Low Income	High Growth
17	Sumedang	25,853	6.23	Low Income	High Growth
18	Indramayu	40,833	1.45	High Income	Low Growth
19	Subang	21,867	5.1	Low Income	Low Growth
20	Purwakarta	62,037	5.12	High Income	Low Growth
21	Karawang	85,067	5.76	High Income	High Growth
22	Bekasi	80,705	5.78	High Income	High Growth
23	Bandung Barat	24,136	5.21	Low Income	Low Growth
24	Pangandaran	23,794	5.1	Low Income	Low Growth
25	Kota Bogor	35,621	6.12	Low Income	High Growth
26	Kota Sukabumi	32,601	5.43	Low Income	High Growth
27	Kota Bandung	96,123	7.21	High Income	High Growth
28	Kota Cirebon	63,001	5.79	High Income	High Growth

29	Kota Bekasi	29,139	5.73	Low Income	High Growth
30	Kota Depok	25,879	6.65	Low Income	High Growth
31	Kota Cimahi	44,142	5.36	High Income	High Growth
32	Kota Tasikmalaya	27,696	6.07	Low Income	High Growth
33	Kota Banjar	21,432	5.12	Low Income	Low Growth
34	Cilacap	61,737	2.45	High Income	Low Growth
35	Banyumas	27,379	6.34	Low Income	High Growth
36	Purbalingga	23,425	5.12	Low Income	Low Growth
37	Banjarnegara	20,768	5.42	Low Income	High Growth
38	Kebumen	20,108	4.89	Low Income	Low Growth
39	Purworejo	22,538	5.14	Low Income	Low Growth
40	Wonosobo	20,767	3.16	Low Income	Low Growth
41	Magelang	22,111	5.06	Low Income	Low Growth
42	Boyolali	29,244	5.52	Low Income	High Growth
43	Klaten	29,288	5.07	Low Income	Low Growth
44	Sukoharjo	36,107	5.72	High Income	High Growth
45	Wonogiri	26,292	5.17	Low Income	Low Growth
46	Karanganyar	36,462	5.52	High Income	High Growth
47	Sragen	36,450	5.81	High Income	High Growth
48	Grobogan	17,260	5.65	Low Income	High Growth
49	Blora	25,379	5.84	Low Income	High Growth
50	Rembang	25,781	6.18	Low Income	High Growth
51	Pati	29,360	5.4	Low Income	High Growth
52	Kudus	114,524	2.97	High Income	Low Growth
53	Jepara	21,146	5.13	Low Income	Low Growth
54	Demak	19,807	5.56	Low Income	High Growth
55	Semarang	41,832	5.47	High Income	High Growth
56	Temanggung	24,809	4.68	Low Income	Low Growth
57	Kendal	38,078	5.57	High Income	High Growth
58	Batang	24,732	5.29	Low Income	High Growth
59	Pekalongan	22,301	5.28	Low Income	High Growth
60	Pemalang	16,836	5.39	Low Income	High Growth
61	Tegal	21,195	5.38	Low Income	High Growth
62	Brebes	22,318	5.47	Low Income	High Growth
63	Kota Magelang	62,883	5.18	High Income	Low Growth
64	Kota Surakarta	79,570	5.33	High Income	High Growth
65	Kota Salatiga	60,545	5.21	High Income	Low Growth
66	Kota Semarang	91,738	5.64	High Income	High Growth
67	Kota Pekalongan	30,768	5.32	Low Income	High Growth
68	Kota Tegal	52,432	5.46	High Income	High Growth
69	Kulon Progo	21,513	5.97	Low Income	High Growth
70	Bantul	22,741	5.1	Low Income	Low Growth
71	Gunung Kidul	22,221	5	Low Income	Low Growth
72	Sleman	33,588	5.35	High Income	High Growth
73	Kota Yogyakarta	74,063	5.24	High Income	Low Growth
74	Pacitan	24,956	4.98	Low Income	Low Growth
75	Ponorogo	20,417	5.1	Low Income	Low Growth
76	Trenggalek	23,253	5.02	Low Income	Low Growth
77	Tulungagung	32,732	5.08	Low Income	Low Growth

78	Blitar	27,435	5.07	Low Income	Low Growth
79	Kediri	22,973	4.9	Low Income	Low Growth
80	Malang	34,612	5.43	Low Income	Low Growth
81	Lumajang	27,684	5.05	Low Income	Low Growth
82	Jember	27,766	5.11	Low Income	Low Growth
83	Banyuwangi	45,016	5.45	Low Income	High Growth
84	Bondowoso	22,313	5.03	Low Income	Low Growth
85	Situbondo	25,927	5.07	Low Income	Low Growth
86	Probolinggo	25,964	4.46	Low Income	Low Growth
87	Pasuruan	77,854	5.72	High Income	High Growth
88	Sidoarjo	79,810	5.8	High Income	High Growth
89	Mojokerto	64,450	5.74	High Income	High Growth
90	Jombang	27,883	5.36	Low Income	Low Growth
91	Nganjuk	21,827	5.26	Low Income	Low Growth
92	Madiun	24,148	5.42	Low Income	Low Growth
93	Magetan	25,999	5.09	Low Income	Low Growth
94	Ngawi	21,461	5.07	Low Income	Low Growth
95	Bojonegoro	52,163	10.26	High Income	High Growth
96	Tuban	48,557	5	Low Income	Low Growth
97	Lamongan	28,920	5.52	Low Income	High Growth
98	Gresik	92,313	5.83	High Income	High Growth
99	Bangkalan	22,324	3.53	Low Income	Low Growth
100	Sampang	18,482	4.69	Low Income	Low Growth
101	Pamekasan	16,965	5.04	Low Income	Low Growth
102	Sumenep	28,282	2.86	Low Income	Low Growth
103	Kota Kediri	408,658	5.14	High Income	Low Growth
104	Kota Blitar	41,447	5.78	Low Income	High Growth
105	Kota Malang	72,392	5.69	High Income	High Growth
106	Kota Probolinggo	41,523	5.88	Low Income	High Growth
107	Kota Pasuruan	36,041	5.47	Low Income	High Growth
108	Kota Mojokerto	45,948	5.65	Low Income	High Growth
109	Kota Madiun	68,940	5.93	High Income	High Growth
110	Kota Surabaya	172,207	6.13	High Income	High Growth
111	Kota Batu	70,351	6.56	High Income	High Growth
112	Pandeglang	20,226	6.05	Low Income	High Growth
113	Lebak	19,215	6.05	Low Income	High Growth
114	Tangerang	33,278	5.84	Low Income	High Growth
115	Serang	44,222	5.21	Low Income	Low Growth
116	Kota Tangerang	69,826	5.91	High Income	High Growth
117	Kota Cilegon	209,696	5.59	High Income	Low Growth
118	Kota Serang	39,728	6.41	Low Income	High Growth
119	Kota Tangerang Selatan	41,533	7.43	Low Income	High Growth

The summary of economic characteristics classification (Fig. 3).

1. High income and high growth 26 districts.
2. High income but low growth 11 districts.
3. Low income but high growth 39 districts.
4. Low income and low growth 43 districts.

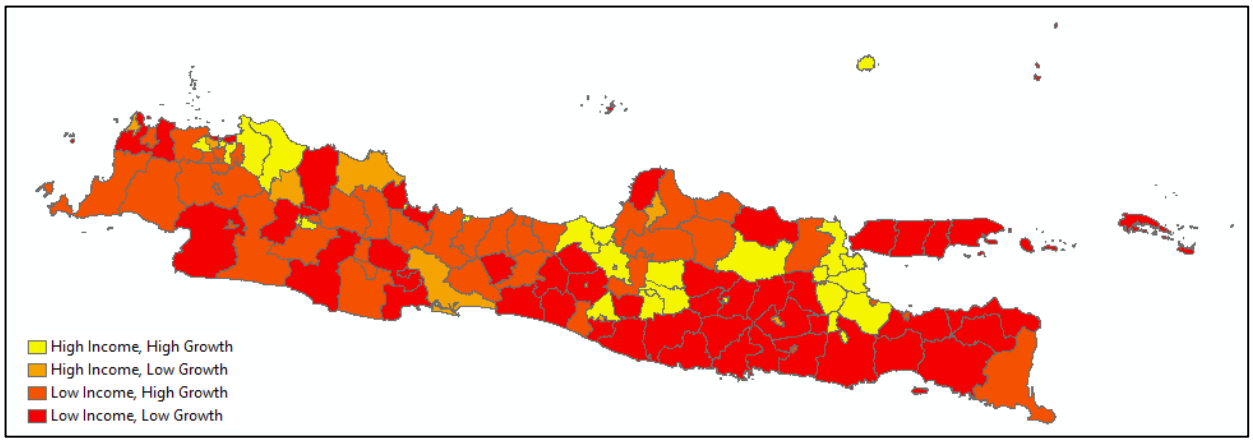

Fig. 3 Economic Characteristics Classification Result

3.3 Building Model of MLP Neural Network

1. Demography aspects (population density, literacy rate, poverty index)
   The accuracy of the neural network in varied hidden layers is presented in Table 2.

Table 2 Accuracy of Demography Aspects

Hidden Layer	Accuracy
[10]	0.17
[10, 10]	0.21
[10, 10, 10]	0.21
[10, 10, 10, 10]	0.17
[10, 10, 10, 10, 10]	0.09
[100]	0.17
[100, 100]	0.17
[100, 100, 100]	0.17
[100, 100, 100, 100]	0.13
[100, 100, 100, 100, 100]	0.13

2. Physical aspects (urban area and paddy field area)
   The accuracy of the neural network in varied hidden layers is presented in Table 3.

Table 3 Accuracy of Demography Aspects

Hidden Layer	Accuracy
[10]	0.46
[10, 10]	0.08
[10, 10, 10]	0.08
[10, 10, 10, 10]	0.08
[10, 10, 10, 10, 10]	0.17
[100]	0.13
[100, 100]	0.08
[100, 100, 100]	0.08
[100, 100, 100, 100]	0.08
[100, 100, 100, 100, 100]	0.08

The best MLP neural network model using demographic aspects inputs for classifying economic characteristics of districts in Java Island consist of 2 or 3 hidden layers ([10, 10] or [10, 10, 10]). The result was not good enough which produced 21% accuracy. Moreover, for physical aspects, the result was moderately good i.e. 46% accuracy by utilizing 1 hidden layer [10].

The results presented poor result. It can be inferred that demographic aspects are not good enough to describe economic characteristics. Meanwhile, urban area and paddy field area are better in describing them. Furthermore, agriculture is still the major income in almost rural area of Java Island.

4. CONCLUSION

The economic characteristics of districts in Java Island can be summarized as the following.

a. High income and high growth 26 districts (22%)
b. High income but low growth 11 districts (9%)
c. Low income but high growth 39 districts (33%)
d. Low income and low growth 43 districts (36%)

In this research, MLP neural network model produced low accuracy of 21% by utilizing demographic aspects as inputs. This model consists of 2 or 3 hidden layers ([10, 10] or [10, 10, 10]). Moreover, for physical aspects, the result was moderately good i.e. 46% accuracy by utilizing 1 hidden layer [10].

Future works are expected to perform different model of neural network. Another aspects might be considered as the input e.g. economic crops and the night time data.

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