Demographic Spatial Data Management in Indonesia with the Approach of Geographic Information System Model

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Abstract

Background/Objectives: Indonesia becomes one of the countries which have the biggest population in the world. The most significant demographic problem in Indonesia is high rate of population. **Methods:** The study is proposed to give solution of demographic data that will be nationally used as a monitor device toward population development to control the population in the form of area mapping visualization based on geographic information system. **Findings:** It is noted that in 2012, the number of populations were 243.3 million people; placing Indonesia in the 4th rank as the most populated country in the world and the 3rd rank in Asia. The number of population in Indonesia increases year by year. It is predicted that in several incoming years, population problem will keep increasing if the government does not try to overcome the problem comprehensively, and the society does not have awareness related to the problem. It is predicted that in 2016 and 2025 the number of population in Indonesia can reach 255.7 and 278 million people. It causes dense population with disputable quality. The success of government's program in improving people's living quality should be supported by the existence of national demographic data to apply high quality governmental programs. **Application/Improvements:** The use of demographic data should be applied to monitor the development of population number in every provincial area within the support of geographic information system (GIS) model as well as to control the number of populations. Further research, we do fixes this problem by an expert system to repair algorithm with GIS approach.

Keywords: Demography, Geographic Information System, Indonesia, Populations, Yogyakarta

1. Introduction

More rapid population growth in a particular area will gradually cause complex problem to the society and its environment[1-3]. Indonesia becomes the 4th rank of most populated country in the world[4]. Based on the result of population census in 2013, the number of populations in Indonesia was 240.5 million people. It means that Indonesia can be included as a country with the biggest population number among other developing countries after China and India. If it is compared with the census in 2000, it shows population expansion in Indonesia with approximate value 1.98% per year[5-7].

Based on the projection result of the population, the number of populations in Indonesia in 2050 is predicted to reach 366 million people[3]. Based on the data from World Population Datasheet, here it is the table of most populated countries in the world and the future projection in 2050 Table 1.

The impact of over load population is closely related to the width of the occupied area in a particular country. Big population can trigger some problems, and it can become the asset of a country as well. The most prominent issue

Tabel 1. Population number and word projection.

No.	Countries	Number (In Millions)			
		1997	2000	2015	2050
1	China	1.236,7	1.255	1.372	1.366
2	India	969,7	1.016	1.314	1.660
3	USA	267,7	276	321	398
4	**Indonesia**	244,3	206	256	366
5	Brazil	160,3	172	205	224
6	Russia	147,3	150	144	-
7	Pakistan	137,8	148	199	344
8	Japan	126,1	127	127,5	-
9	Bangladesh	122,2	132	160	202
10	Mexico	107,1	128	182	397

(Source: World Population Datasheet, 2015)

is that big population can be the most influential asset of a country if human resource quality of the population is high[8-11]. Although Indonesia becomes the 4th rank of its population number, Indonesia is in the 121st position in the world of its human resource quality (year 2014). Indonesia is still far left behind from China which has the highest number of population in the world[9], with its high quality population. The problem of population quality should be the government's concern in handling the most prominent factor of prosperity and living quality to all citizens[12,13].

Astronomically, Indonesia is located in 94° 45' EL until 141° 05' EL and 6° 08' NL until 11° 15' SL, in which equator area 1° is equivalent with 111 km. It means that Indonesian extends ±7,700,000 km² with its land total area ±1,826,440 km², and it is divided into 34 provinces. As the fourth country with the biggest population of the world with the population number ±238,452,952 people in the middle of 2015, the average population in every 1 km² in Indonesia was occupied around 131 people /km². Of course, a system to ease periodical monitoring about demography other than using census is significantly needed[9].

The width of Indonesia area in the map of population distribution seems uneven in 34 provinces. Based on the census result in 2010, there was 60% population occupying Java Island. However, Java Island is only 7% from the total area of Indonesia. On the other hand, Kalimantan Island which has bigger area was only occupied by 5% of Indonesia total population. Here they are some demographic problems in Indonesia[7]:

1. Problem of Total Fertility Rate (TFR).

   - The increase of fertility rate will be the government's burden in accommodating physical aspects like health facilities rather than its intellectual aspect.

   - The increase of fertility will cause high rate of population improvement in developing countries that will negatively correlate to the prosperity of the population.

2. Problem of Mortality Rate (MR). The high rate of life expectancy of the population requires bigger role of the government to provide any shelter facilities.

3. Problem of Population Composition (PC). Indonesia has imbalance population composition that can cause new population problems.

By the existence of those problems, the researchers were motivated to conduct a study about demographic data management in Indonesia with the approach of geographic information system (GIS) model. Although the discussion related to demographic data management has widely been discussed in some other researches, the focus of the study, however, is to emphasize on demographic data management as a device of data monitoring and projection of population density with the approach of GIS model in order to control the population. The model of the system is expected to have a particular strength in monitoring demographic data and its control in every provincial area in Indonesia.

2. Proposed Method

The study was conducted to obtain a system that can be used to monitor the demographic data by using GIS model approach. The study was divided into three steps, as following:

1. Spatial data and demographic data initiation.
2. Spatial and non spatial data integration. It is the step in correlating spatial data and demographic data into the database.
3. Indonesian demographic data visualization.

The system was designed as user friendly as it is expected by common people toward Information Technology (IT) to be able to access demographic data through web Figure 1.

3. Demography Theatrical

Some related researches have been done like the research who investigated about map making process by using Scalable Vector Graphic (SVG). In their study emphasize on SVG technology as the visualization of area mapping. In
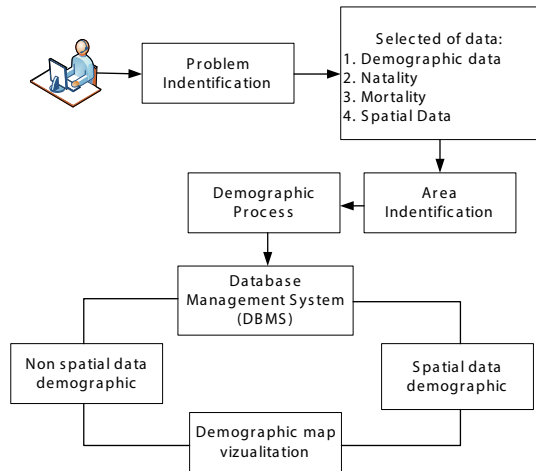
Figure 1. Proposed method.

its development, SVG has become programming language to build interesting sites[14]. SVG is a web graphic file format to present the graphics and to describe 2 dimension pictures base on eXtensible Markup Language (XML)[7].

Another study investigated demographic problems in Indonesia. The focus of the study is demographical problem faced by the government as well as the impact of population nationally[13,15,16]. Another problem analyzed is about employment showing that 77% employees in Indonesia are still in low education level. The impact toward per capita income will significantly influence toward the citizens' living quality. Other demographical features also become the concern of the study such as the rate of divorce and marriage that will influence on fertility and mortality rate that can be the indicator as a country's prosperity[9].

The indicators of prosperity in a country can be significantly influenced by several factors such as the rate of fertility and mortality as they are noted by Statistical Bureau. In simple way it can be explained that people are the subjects as well as the objects of development. Thus, if there is no initial anticipation, it will cause national imbalance[17]. In further, based on the literature review presented above monitoring is importantly needed toward population development in order to keep the balance of the population and the suitability of government's program to reach national prosperity by using geographical information system that will be developed further[6].

Demography is a scientific study related to demographical number, population spread and composition as well as how those factors change from time to time. Demographic science can be in the form of quantitative and qualitative data. Quantitative demography mostly uses statistical numbers and mathematical number. On the other hand, qualitative demography explains demographic aspects within the method of analytical description. In addition, demographic studies examine the development, phenomena, and problems related to demography and the social situation around its environment systematically. Demographic science that needs our attention concerns more to inter discipline studies integrated with demographic analysis that people may know as social demography[18-20].

There are several opinions mentioning about the definition of demography: 1. It is a science studying population in any particular area within its number, structure (composition) and development (change)[9]; 2. It is a science examining the number, distribution, territorial, population composition, and the change as well as the causes that usually appear because of the rate of fertility, mortality, migration, and social mobility[17,20]; 3. It is a mathematical and statistical studies toward numbers, composition, spatial distribution of the population, and the change of the previous aspects that always happen as the impact of fertility, mortality, marriage, migration, and social mobility[17,18,21]. The studies of demography can be made into this following scheme:

Here are three important aspects in studying demography such as fertility, mortality, and migration as it can be seen in Figure 2. In addition, there are two supporting aspects in demography; those are social mobility and the rate of marriage. The data of population number can be obtained from these several ways: 1. Population census. It is a whole process from gathering, processing, presenting, and assessing demographic data that relate to the characters of demography, social economy, and environment, 2. Registration of the population is the process of population data recording conducted by individual party when there is population change. It is done by domestic affair ministry through local village offices, and 3. Population survey is the process of information
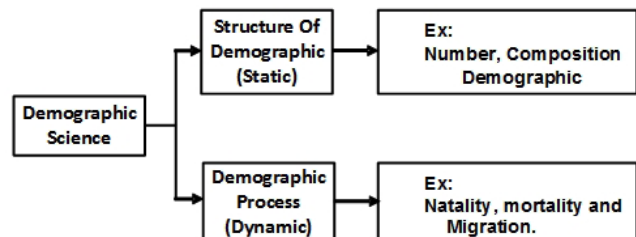

Figure 2. Demographic study.

recording related to the population based on the specialty of wider and deeper studies. The example is mobility survey of Yogyakarta citizens, and fertility survey of Yogyakarta citizens[7,21,22]. Population survey was done because population census and registration have limitation and weakness. Demographic information can be obtained through census. In addition, the data used in the study is secondary data from Statistic Bureau as a simulation. The spatial data of Indonesian area is adopted from Google Maps API from www.google.com.

4. Result and Discussion

4.1 Context Diagram in System Design

System design is made by using the concept of Data Flow Diagram (DFD). This following Figure 3 is the context of research framework.

The data administrator is informed demograpic spatial data by some demographic data such as the number of data, number natality, mortality number, male population number, female population number, population of foreign nationals. While general public will make the process of data input to be processed on the system and generate output folder demograpic.

4.2 DFD Process

The outer entity of the admin has a duty to process the system. However, outer entity of the user is public society who can use the system to request demographic information by inputting the personal data beforehand. In further, the diagram context is developed to be DFD level 1 and DFD level 2. Here it is DFD Level 1 that is developed from the diagram context Figure 4.
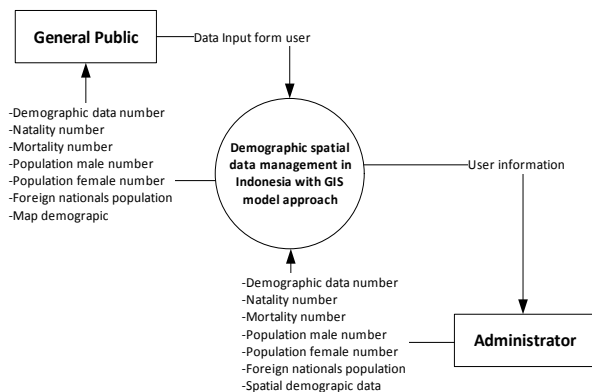

Figure 3. Context diagram of processing data of demographic spatial data through GIS approach.

Data flow diagram for level 1 above consists of 6 main processes i. e. demographic data processing, map area making, geographical map data editing, data editing of demographic map spatial, data editing of demographic non spatial. The further step is the discussion related to DFD Level 2 in sub process of demographic data processing that will be discussed further Figure 5.

Dataflow diagram for level 2 above consists of 4 main processes i. e. administrator validation, data input of spatial demography, data input of non spatial demography, and demographic map visualization.

5. Implementation Result

Here it is the discussion of implementation result of processing system of demographic spatial data with GIS approach.

5.1 Presentation of Location Mapping

Location mapping is visualization from population in a particular area. Symbols and colors indicate the rate of population density with very Demographic Map Menu
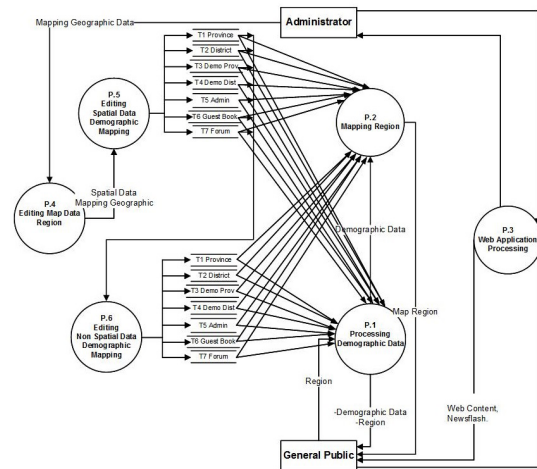

Figure 4. Data flow diagram level 1 of processing system of demographic spatial data.
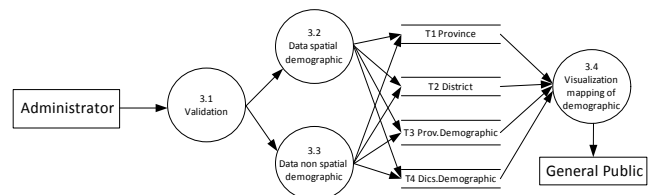

Figure 5. Data flow diagram for level 2 of demographic data processing subsystem.

Demographic map menu in Indonesia consists of the choices toward demographic map consisting of the map of population number, the map of fertility and mortality, the map of foreign citizen demography. Each menu is divided into two map choices i. e. map choice for regencies, map choice for provinces, and symbolic presentation of demography in Indonesia suitable to map Figure 6 category that has been chosen. Here it is the presentation of demographic map menu for application system, as in Figure 7 in the menu system as follows.

In Figure 7 shows a menu list of data to produce information to the user. Where the information given user: male and female who are in the provinces and districts in Yogyakarta.

5.2 Population in Yogyakarta Province

Table 1 presentation of foreign citizen population based on provincial area contains the information about how many foreign citizens living in Yogyakarta Province area that is fatherly elaborated to be five regencies within the number and density category. Here it is the presentation of composition table of population in Yogyakarta province in regency (Table 2).

Figure 6. Data flow diagram level 1 of processing system of demographic spatial data.
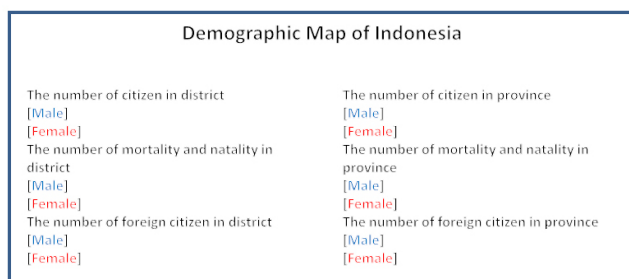
Figure 7. The Presentation of demographic map menu in applications

Table 2. Presentation of foreign citizen population in every regency Yogyakarta.

No.	Distric are	Total population	Category
1	Sleman	443	dense
2	Yogya City	731	very dense
3	Bantul	321	medium
4	GunungKidul	282	medium
5	KulonProgo	117	enough

6. Conclusion

The concept of demographic data management system was able to be applied to conduct the control of population density in every area in Indonesia. The system presents geographical information supported by demographic data in the form of the data of the population, fertility rate, mortality rate, male and female population, foreigner population, and population density map. Map visualization was able to give interactive information by using Google Maps API.

7. Future Works

Based on the test result, management system of demographic data with the approach of GIS model can be applied to develop significant recommendation toward any area in a dense population as the solution of dense population problem by using expert system in its algorithm.

8. Acknowledgment

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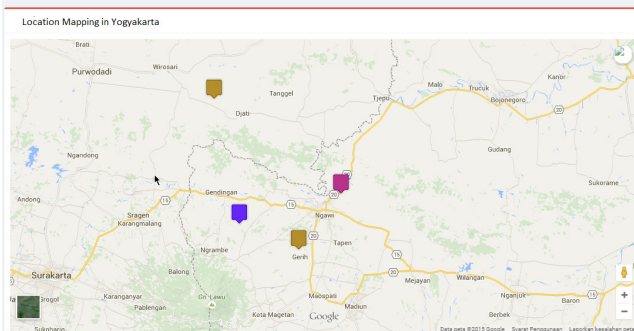
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