Small Area Estimation For Mapping Human Development Index

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Abstract. HumanDevelopmentIndex(HDI) is one ofthe indicators that usedto determine thehuman developmentofa country. The calculationofthe value ofHDI inIndonesia is carried outuntilthescale ofthe districteachyear. Sincethe implementation ofregional autonomy policy,the calculation ofthe HDIvalueis requiredwitha smallerscalein thedistrict. The calculation ofHDIvalueswithsub-scale is difficult becausethe sampleis toosmallto estimatethe value ofHDIperdistrict. One of the componentstocalculate thevalue ofHDIis an indexof purchasing powerthatapproximated bythe value ofpercapita expenditure.SmallAreaEstimationisone of theindirectestimatesthat usedtoestimate theparameter valuesof thesubpopulation. On this research, Small AreaEstimation (SAE) is a statistics methode for estimate small sampel .The research purpose to estimate per capita expenditurefor HDI in Demak District. The results of the estimation with SAE methods in Demak District indicates that the Demak Sub-district has the largest per capita expenditure that can be said have the highest HDI value while Kebonagung Sub-district has the smallest per capita expenditure that can be said have the lowest HDI value.

INTRODUCTION

United Nations Development Programme (UNDP) developed the method to calculation the Human Development Index (HDI) which is used to measure the success of human development in each country. HDI is a composite index that is calculated as the simple average of the life expectancy index, education index, and living standards index. HDI publication issued by UNDP in 2015 put Indonesia in ranked 108 out of 177 countries. This rating is worse than in 2007 where Indonesia stand in ranks 107. This rank puts Indonesia under Singapore (ranked 27), Brunei (ranked 37), Malaysia (ranked 57), Thailand (ranked 92) and the Philippines (ranked 97). Every year, central bureau of statistics (BPS) calculating the HDI, but only up to a scale of district/city. Since the construction is likely to be directed at the pattern of regional autonomy, it is required the HDI calculation in sub-district scale to assist local governments in the distribution of equitable development efforts in the region. Thus, the calculation of the HDI should be calculated in detail in a small area to the sub-district level and village.

Unavailability of HDI at sub-district level is due to the limited information (data) for the calculation of the value of its components at the sub-district level. Life expectancy index is measured by life expectancy at birth; education index is measured by the literacy rate of the population aged 15 years or older and the average length of the school; and living standards index is measured by the adjusted real per capita expenditures. Often the source of the data that used in this research is the National Socioeconomic Survey (SUSENAS) which not all sub-districts are taken as samples or samples are drawn so few that cause the estimate to be biased. One of the efforts is to increase the number of samples but the costsinvolved are quite expensive.

Small area statistics are in great demand in various fields at this time. Small area estimation is needed to obtain information on a small area, such as the scope of the city/district, sub-district, or village.The information is essential to the development of regional autonomy in Indonesia because it can be used as a reference for developing a system of planning, monitoring, and other government policies without having to incur huge costs to collect the data themselves.The methodwhich constantly being developed to estimate small area statistics is Small Area Estimation (SAE) with techniques to utilize the information from small area.

SAE is a statistical technique for estimating the parameters of a subpopulation of its small sample size. The estimation techniques utilizing data from large domains (such as census data, the Susenas data) to estimate variables of concern to the smaller domain. SAE-called indirect estimation because in the estimated using the techniques to borrowed information in the area and outside the area. Simple estimation of small area called direct estimation, in which the direct estimation is not able to provide sufficient accuracy when the sample size in a small area of concern

is to small/small size, so that the resulting statistics will have a large variance or even the estimation can not be done because it is not represented in the survey (Rao, 2003).

Various studies related to small area estimation have been carried out, among others are Darsyah (2013) using the SAE Kernel-Bootstrap for estimating per capita expenditure in Sumenep District, Darsyah and Wasono (2013) using the SAE to estimate the level of poverty in Sumenep District and estimating HDI on small area in the city of Semarang.

This SAE further research aimed to estimate the HDI in Demak District, located in Central Java Province, wherein the east is bordered by Kudus District and in the west is bordered by the city of Semarang. The city of Semarang and Kudus District is a region that has the highest per capita expenditure whereas Demak District has the lowest per capita expenditure in Central Java. Per capita expenditure can describe the purchasing power that produced by each region depend on the natural resources and factors of production areas. The high per capita expenditure of a region indicates the level of social welfare and economic conditions of the area.

RESEARCH METHOD

Small area models with SAE approach is applied to estimate the per capita expenditure at the level of sub-districts in Demak. The following variables were used in the study:

1. Response Variable
   Estimation observed in this study is the calculation of the HDI at sub-district level in Demak District that calculated by the approach of per capita expenditure.
2. Concomitant Variable
   In this research, concomitant variables that will be used is per capita expenditure with the technique of "borrowing the information".

Table 1 Research Variables

No	Variable	Information	Operational Definition
1	*X*	Per Capita Expenditure	The amount of expenditure of each household member within one month
2	*Y*	HDI	Measured by the amount of expenditure per capita approach

The source of data which will be used in this research is secondary data from the BPS. For the response variable of per capita expenditure at the level of Demak Districts in the data is obtained from the National Socioeconomic Survey (SUSENAS) BPS in 2012 and for the concomitant variables derived from the data of Demak District in Figure 2013.

The stages of the analysis conducted in this study are described as follows. Estimate the per capita expenditure per sub-district in Demak with SAE approach Kernel (Mukhopadhyay & Maiti, 2004).Here are the steps of SAE-algorithm Kernel approach:

1. Using the predictor data variables (x_i) and the response variable (y_i), count: $\hat{m}_h(x) = \frac{1}{m}\sum_{i=1}^{m} W_{hi}(x) y_i$
2. Count $\hat{\sigma}_u^2 = \max\left\{0, \frac{1}{m-1}\sum_{i=1}^{m} W_{hi}(x)[y_i - \hat{m}(x_i)]^2 - 1\right\}$
3. Substitute $\hat{\theta}_i = \hat{\gamma}_i y_i + (1 - \hat{\gamma}_i)\hat{m}(x_i)$ with $\hat{\gamma}_i = \frac{\hat{\sigma}_u^2}{\hat{\sigma}_u^2 + 1}$

RESULT DISCUSSION

The estimation of HDI on small area in Demak District using the per capita expenditure approach as the concept of purchasing power. The estimation results of the average per capita expenditure in Demak District in 2013 using SAE method is Rp 225.510,00. Based on the standard deviation of 0,5591 indicates that the estimates value of

per capita expenditure at sub-district level in Demak Districtwas very diverse.Estimates value of the smallest per capita expenditure is Rp 188.110,00 and estimate value of the largest per capita expenditure is Rp 250.680,00. Sub-districts that have estimate value of the smalest per capita expenditure is Kebonagung Sub-district and sub-districts that have estimate value of the largest per capita expenditure is Demak Sub-district.

Table 2 Summary Value of Statistics Per capita Expenditure

Statistict	Per Capita Expenditure
Mean	225.510,00
Standard Deviation	0,5591
Minimum	188.110,00
Maximum	250.680,00

In Figure 1, we can see that the pattern of per capita expenditure in each sub-district in Demak District is almost equal between the width of the top and the width of the bottom. This shows that the distribution of per capita expenditure in each sub-district in Demak District which is above the average of per capita expenditure and under the average of per capita expenditure is impartial.Thus, almost half of the total sub-districts in Demak District was under the average of per capita expenditure, this indicates that the public welfare is not evenly distributed in Demak District. There are some sub-districts that have a high outlier per capita expenditure, namelyDemak and Mranggen Sub-Districtthat the location is closely to the city center where the Sub-District of Demak has the highest population density in Demak District. Some of the major factors that lead to high per capita expenditure, among others are population density, level of education, occupation, health, infrastructure, as well as the purchasing power then per capita expenditure is used to the approachto measure HDI. HDI value in a small area in Demak District can describe the level of public welfare so that the high and low of HDI value reflected in the amount ofper capita expenditures in each sub-district.

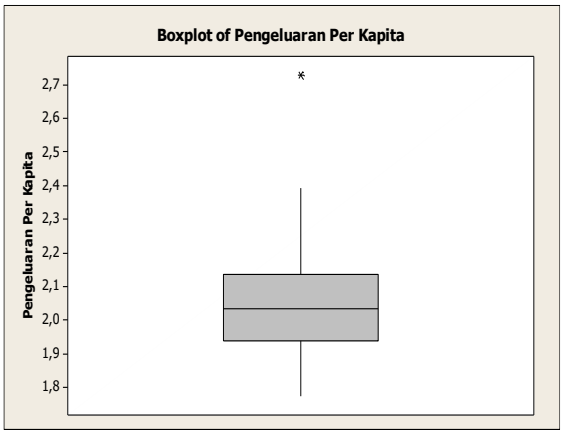

Figure 1 Boxplot per Capita Expenditure

Figure 2 shows that there is a striking difference in the value of the HDI. From the value of per capita expenditure at the sub-district level in Demak District can be drawn the conclusions that the sub-districts that have the smallest per capita expenditure is a sub-district that has the lowest HDI value, otherwisethe one that has the largest per capita expenditure has the highest HDI value. Sub-districts that have the smallest per capita expenditure is Kebonagung, it is indicating that the sub-district had the lowest HDI value that is far from the quality of the development, while the one that has the largest per capita expenditure is Demak Sub-district which is indicating that the sub-district had the highest HDI value.HDI prediction results on the sub-district level is expected to be a very valuable input for local governments to prioritize and give serious attention to the sub-district who had a low HDI category. The information on a small area will be the reference for local governments in drafting, planning, and creating the information-based regional development policy. Regional development based on information is expected right on target in the areas that need to avoid imbalance in development so that the public welfare in Demak District can be evenlydistributed.

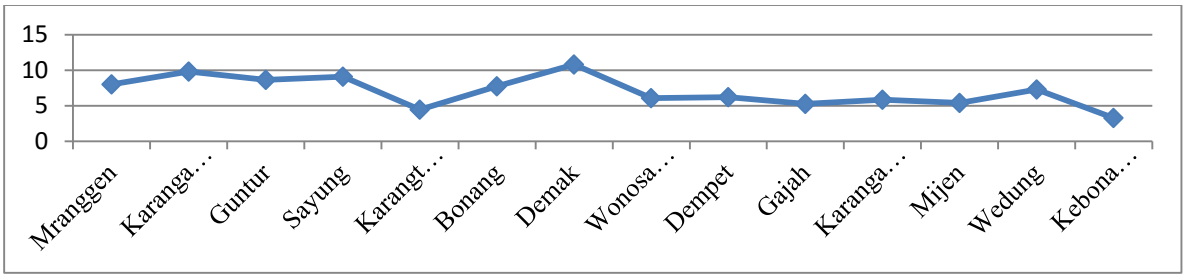

Figure 2 Distribution Graph of HDI area in Demak District

CONCLUSION

The results of the estimation with SAE methods in Demak District indicates that the largest per capita expenditure in the Sub-district of Demak was Rp 250.680,00 and the smallest per capita expenditures in the Sub-district of Kebonagung was Rp 188.110,00 with a diversity of inter-subdistrict per capita expenditure is very large with a standard deviation of 0,559. Demak Sub-district has the largest per capita expenditure that can be said have the highest HDI value while Kebonagung Sub-district has the smallest per capita expenditure that can be said have the lowest HDI value.

Selection of the concomitant variables in the SAE model is very important to obtain the best estimate so that the concomitant variables chosen to be complex. SAE subsequent research is encouraged to try to use the other of nonparametric approaches and can be done by comparing the SAE model with the parametric approach to build a model of comprehensive Small Area Estimation.

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