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Efficiency and effectiveness of road infrastructure

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Abstract

This study was to analyse the efficiency and effectiveness of provincial road infrastructure performance Yogyakarta Province. The indicators of the efficiency measurement are congestion level, road maintenance, rehabilitation and improvement and the cost. Using the data envelopment analysis method, there was an only one out of fourteen road segment that is fully efficient. On average the efficiency level was quite low that is 34.9 percent due to equally treated system by local government regardless its utilization level. Whereas the effectiveness of road performance is measured by the satisfaction level using indicator of value for time and money, comfort and convenience, safety aspect, travel amenities and road signs. The satisfaction level of road user toward performance of the most efficient road segment is relatively high that is 73.73%.

Abstrak

Penelitian ini bertujuan untuk menganalisis efisiensi dan efektivitas kinerja prasarana jalan provinsi di Provinsi Daerah Istimewa Yogyakarta. Indikator pengukuran efisiensi adalah tingkat kemacetan, pemeliharaan jalan, rehabilitasi dan perbaikan, dan biaya. Dengan menggunakan metode Data Envelopment Analysis, hanya terdapat satu dari empat ruas jalan yang paling efisien. Rata-rata tingkat efisiensinya cukup rendah yaitu 34.9 persen disebabkan pemerintah memberikan perlakuan sama terhadap semua ruas jalan terlepas dari tingkat utilisasi ruas jalan. Sedangkan efektivitas kinerja jalan diukur dengan tingkat kepuasan menggunakan indikator nilai uang dan waktu, kenyamanan, keamanan, kemudahan dan fasilitas jalan. Tingkat kepuasan pengguna jalan terhadap kinerja ruas jalan yang paling efisien relatif tinggi yakni 73.73%.

Introduction

Infrastructure development is one of the measurements for local economic development. The efficiency and effectiveness infrastructure development by local government should be measured. It is important for local government to have several considerations to make decision about the input or output that should be chosen to gain improvement for economic welfare.

Over years, the services sector has been showing more steady growth rather than agriculture. The growth of services, finance, transport, communication and construction was steady, around 8% annually (Zain, 2010), which is larger than the overall GDP growth. Thus, it is not surprising if developing countries such Indonesia would likely to raise the productivity in service sector. Therefore, better infrastructure to support the growing of service sector is vital. With service sector contributing 54% of Indonesia GDP and absorbing 50% of workforce (Drake-Brockman, 2014), it is expected that the number of employment absorption would grow higher.

Service sector, therefore, would play an important role of Indonesian economy in the upcoming years. Nevertheless, it does not mean that service sector in Indonesia will bring Indonesia to the take-off stage of economic growth, from under-development to development. According to Rostow's stage-of-growth model of development, there are some stage should be faced and proceed by developing countries in the transition from underdevelopment to development. Higher share of saving and investment in GDP would not guarantee an economic growth as it is not the sole sufficed-condition. There should be sufficient condition such as well-integrated commodity and money markets, highly developed transport facili-

ties, a well-trained and educated workforce, the motivation to succeed, and lastly an efficient government bureaucracy (Todaro & Smith, 2006).

It goes the same to the service sector. Just by having numbers of manufacturing and industries work in service sector would be not enough to upgrade Indonesia economy. Sufficient conditions, such infrastructure development and skilled labours are highly important. In this condition, countless problems such uncertain regulatory framework and lack of infrastructure are likely to hamper the growth of service sector. Here, the government plays an important role as the provider of facilities needed for higher levels of output in service sector. Infrastructure development is an absolute qualification for higher economic growth enhancement and more equally income distribution (Calderón Luis, 2004), poverty reduction and living standard improvement (Ali & Pernia, 2003).

Based on Global Competitiveness Index (GCI), Indonesia has higher competitiveness level (4.52) compared to the last five years ago (Schwab, 2015). This index represents the macroeconomic environment, the state of a country's public institutions, and the level of technological readiness. The questionable thing is whether this index is fully explaining Indonesia currently or not. Since the crisis back then Indonesia government had lacked attention on the development of infrastructure across the provinces.

The development of infrastructure was not satisfying, but government did put its priority for the development of infrastructure, whether building a new infrastructure or refining the existed infrastructure. The unsatisfactory of infrastructure development in Indonesia generally caused combination of budget constraints and lack of state-owned companies that specifically address the issue of financing the infrastructure (Ministry of Finance Republic of Indonesia, 2015), and poor quality of physical infrastructure particularly transport infrastructure (Elias & Noone, 2011).

The poor condition of infrastructure is not only faced by national government but it is also happening in local government. Yogyakarta Province still has also a problem of infrastructure underdevelopment. Known as one of the best tourism city in Indonesia, it attracts a lot potential businesses and visitors from foreign. The saddening fact that is some important infrastructure in Yogyakarta Province is not well-built and doesn't perform its function fully such as poor river infrastructure and crowded Adi Sucipto International Airport. According to government rules on Integrated Design and Building (DB), infrastructure such as building, road, railways, bridges, airport, etc should be built quickly with high technological support to create a sustainability infrastructure. This rule is unlikely represents the actualization of the infrastructure development in this region.

In improving and developing economy especially the service sector in the region, the most essential infrastructure that must be considered is road networks. According to Karlaftis & Kepaptsoglou (2012) the social prosperity and economic development are directly related to mobility and accessibility of communities and are, therefore, highly dependent upon the existence of high quality road networks. Thus, the essence of road existence is too important as it is the dominant mode of transport.

Regarding the background of the importance of road infrastructure and the poor infrastructure condition in Yogyakarta, this research is likely to answer some questions like what are the indicators of roads performance measurement. Through this measurement the researcher expects to evaluate the efficiency and effectiveness of road infrastructure. Generally, performance analysis is used to measure the efficiency and effectiveness of inputs utilization to produce output in banking or industrial sector. Apparently, the scope of efficiency analysis has become wider. Not only it measures the performance of private sector but also it has been used to assess the performance of public sector in the level of city.

The Services Performance Technical Working Group established by Local Government Australia developed service performance indicators as principles to guide the performance measurement (Department of Planning and Community, 2013). The services framework would likely represent the performances of Local Government of Yogyakarta as this framework would measure the objectives of the services in terms of its effectiveness and efficiency. The effectiveness indicators measure the outcomes of a service and the efficiency indicators measure the goodness of the use of inputs in producing the outputs.

To measure the performances of the services, the effectiveness and efficiency of the services is measured by three dimensions that would result on service effectiveness indicators. Each dimension would indicate how well the services meet users' need. The effectiveness of the services is indicated by the appropriateness and quality of the services whereas the efficiency is indicated by cost (Department of Planning and Community, 2013). The first dimension, appropriateness, defines the ease of road users in accessing the services (access); how well the service meets all users desire (equity); whether users are being over or under serviced (service levels). In appropriateness, the service level definition of the dimension

is used instead of access and equity in measuring local road performance. The second dimension which is quality defines the indicators of output that measure the extent in which a service is delivered based on defined standards. Cost on the other hand defines the efficiency use of input in producing output. Lastly, all dimensions would give the measurement of how appropriate the outcomes meet the aims.

Service that would be measured to represent the Local Government performance is road. Road plays important role for mobilization, flow of goods and services distribution, flow of inputs or factor of production. As some area of Yogyakarta dominantly covered by plantation land, road is very essential to ease the distribution of input and output.

The appropriateness of local road effectiveness is measured by the service level offered by road agency. This indicator measures whether the serviced delivered to road users is over or under serviced. Under serviced refers to low maintenance over infeasible local road which affect the satisfaction of road users. Whereas over serviced refers to high level of services of road agency in maintaining improper local road condition (sensitive to roads that have the highest probability of damage level and act quickly in solving the possible damage). Therefore, the higher the number of road maintenance or renewal, the better the level of service offered by road agency.

The quality of local road networks is measured by the surface condition of road using The Pavement Condition Index (PCI) (Setyawan, Nainggolan, & Budiarto, 2015). PCI is a measure of the superficies of roads with the aims to identify the need of local road maintenance and rehabilitation conducted annually in order to evaluate the changes in road condition. This measurement gives numerical result of local road condition where 0 defines local road worst possible condition and 100 defines local road best condition. The conditions measured by PCI are the type of, extent and severity of pavement superficies distresses (typically cracks and rutting), and the smoothness and ride comfort of the road. With two basic road condition measurements from PCI, the result will be used as reference in making decision. There are five benefits of the used of PCI. The first benefit is the result of PCI could help road agency in identifying the needs of immediate maintenance, renewal, and rehabilitation. The second benefit is PCI helps road agency in monitoring the pavement condition overtime. PCI also used to develop a network preventive maintenance strategy. Beside its benefits on monitoring and maintenance strategy development, PCI is used to estimate budgets need for road maintenance. And lastly, PCI evaluates pavement materials and designs.

Cost on the other hand is used to measure the efficiency of local road performance. Cost is output indicators that measure how efficiently services use their resources (inputs) to produce outputs. The common indicators or measures used in cost efficiency are the average cost per unit (unit cost). Average cost per units originated from the calculation of total inputs/total outputs and total direct cost providing service/total number of units of service delivered.

Here, in terms of measuring road efficiency performance, the indicator used is cost of renewal and maintenance. The measures of this indicator are the ratio of local roads renewal expenditure spent over total kilometers of local roads renewed and also the ratio of maintenance expenditure of local roads over total roads maintained.

Efficiency has become a concern for any organization to foresee whether the cost that has sacrificed was not a waste. The measurement of efficiency is friendly applied in banking sector, but it does use to measure the performance of government as the concept of efficiency itself, which was mostly discussed in economics.

In assessing the level of efficiency, there is common method that mostly used such as regression analysis. But, this method is inadequate as it does not cover multiple output and input. The existence of Data Envelopment Analysis (DEA) has answered all the needs of efficiency measurement.

Data Envelop Analysis (DEA) is the most common method used to measure the efficiency performance. DEA is used by *Decision Making Unit* (DMU) to determine the efficiency of producers by measuring the level of input and output. The result of the measurement will give the efficiency frontier which defines the maximum combinations of outputs that can be produced for a given set of inputs. 'The Pareto-Koopmans' explains the definition of efficiency of a DMU. The Pareto-Koopmans describes that the 100 % rate of efficiency is given to a DMU if particular DMU has evidence that the inputs and outputs of another DMU can get improvement without hurting or destructing other inputs and outputs (Emrouznejad, Banker, Lopes, & de Alme, 2014).

DEA was used in assessing the performance of Class I freight railroads in North American (Malhotra, Malhotra, & Lermack, 2009). He applied DEA to evaluate the financial performance of railroads

industry comparatively to figure out which firm had efficient operation process among firms in railroads industry. The efficiency performance measurement in his study focused particularly on seven firms of North American Class I freight railroads, that was known as the seven largest railway platforms. In measuring the financial performance, they used several financial ratios such as average collection period, cash flow per share, current ratio, quick ratio, inventory turnover ratio, long term debt per share, return on equity, return on assets, interest rate coverage ratio. The results of the computation were there were 5 railroads firms that are financially performed efficiently for 100%, which are Burlington Northern Santa Fe, Canadian National, Canadian Pacific, CSX Corp, and lastly Union Pacific. The remained two companies had 27% and 87% of efficiency score for Kansas City Southern and Norfolk Southern respectively.

Aside from measuring the effectiveness of local roads from road agency view, the service performance from road user view should be measured also. The importance of road user feeling in experiencing the local road network is very helpful in creating maintenance, renewal, and rehabilitation strategy. The indicators used to measure the road service effectiveness are the road user satisfaction and safety. The technique of this survey is adopted from survey done in New Delhi, India (MDRA, 2007).

Research Method

Here, DEA is also used with the same intention. Local Government Yogyakarta efficiency performance in providing infrastructure (road) will be measured based on the indicators of the measurement. DEA on the other hand has its advantage for the purpose of performance assessment comparativeness. With standardized benchmarking, DEA is able to find the value of specified character of inputs in producing outputs, moreover on inputs-outputs that are hard to be valued.

The service performance efficiency measurement of infrastructure in Yogyakarta provided by Local Government Yogyakarta therefore would likely represent Local Government Yogyakarta performance. The framework of measuring the road performance is modified from Service Performance Technical Working Group established by Local Government Victoria (Department of Planning and Community, 2013).

The research location was conducted in 14 road networks in Bantul District, Yogyakarta Province. The data collected includes the length, rehabilitation, improvement, maintenance and cost of roads annually from 2011-2015. The provided data are used to foresee the efficiency performance of road networks using the input-oriented formula:

$$Efficiency = \frac{Output}{Input}$$

Efficiency is ratio of total outputs and inputs that presents how efficient DMU produces an output with several inputs. Output is total outputs that are produced by DMU, and Input is total inputs that are used to produce a set of output.

Besides computing the efficiency score that defines how DMU efficiently produce output with numbers of inputs, DEA will give solution and recommendation on how some inefficient DMUs could be efficient relative with an efficient DMU. By measuring the performance target of DMU it could help inefficient DMUs to perform efficiently (Ramanathan, 2003). One of the computations of performance target is input target, DMUs that are inefficient could find out what techniques and policy should be applied to perform an efficient productivity process with constant or same output. Input slack could also use to support the result of input target.

$$Input\ Target = Actual\ Input \times Relative\ Efficiency\ /\ 100$$

Input target is the number of input that could give inefficient DMU same ratio of output-input relative to efficient DMU. Actual Input is the actual amount of input used, and Relative Efficiency is the percentage of efficiency score.

$$Input\ Slack = Actual\ Input - Input\ target$$

$$Input\ Slack\ Percentage = \frac{Input\ Slack}{Actual\ Input} \times 100$$

Input Slack is the difference between actual input and input target. Input Slack Percentage will indicate how much inputs should be reduced to earn output the same with the most efficient DMU among others.

DEA is used to find the impact of the measures towards the performance of local roads in Yogyakarta. DEA would give numerical result of the ratio of the measures used to measure the indicator of each dimensions (*Appropriateness, Cost, Service Effectiveness*) of local road performance measurement.

In applying DEA, there are several types of model that can be used as the orientation of measurement. Input orientation is used in this research since it is easier for Local Government of Yogyakarta to control the input that aiming for efficiency instead of output. On this model, the inputs are available to be reduced and added. Input target is used to find out how many inputs should be utilized to get the targeted value of output by controlling the amount of input itself (Ramanathan, 2003).

MAXDEA software is used to measure the efficiency score of each DMU (road segments). As DEA have variant type of models, this research used CCR input oriented model since it is easier for road agency (Local Government of Yogyakarta) to control the inputs instead of output. The CCR Model (Charnes, Cooper, and Rhodes) assumes constant return to scale (CRS). The orientation of the model is input orientation which gives the number of inputs should be reduced to be efficient while holding constant output.

In order to measure the road efficiency, the data are collected secondarily. Secondary data is attained from Public Works Department. The data are used to construct the value of variables of measurement. Below are the lists of the variables and the data needed to support them.

1. Congestion level (CG) is the ratio data of numbers of daily traffic in all road segments and the length of each road segments.
2. Maintenance level (MT) is the ratio data of total kilometers roads maintained and the length of each road segments.
3. Rehabilitation Level (RL) is the ration data of total kilometer roads rehabilitated and the length of each road segments.
4. Road Improvement Level (RI) is the ratio data of total kilometer roads improved and the length of each road segments.
5. Ratio of Cost Spent (CS) is the ratio of data total expenditure of each road segments to the length of each road segments.

To measure the efficiency level, the variable of output is the level of congestion (CG) and the input variables are maintenance level (MN), rehabilitation level (RL), road improvement (RI) and ratio of cost spent (CS). Congestion Level is the output of the efficiency measurement. Congestion level earned from the ratio of numbers of daily traffic over total kilometers of local roads. At a certain number of congestion level (earn from daily traffic/total km of roads), higher maintenance, rehabilitation, and cost will lower the efficiency score. This is because when the physical condition of the road is getting better each km; the congestion level stays still which means the utilization of the road is not increased.

Maintenance level is the kilometers of road maintained by local government. High frequency of road maintenance would rather decrease the efficiency score instead of improve it. Each kilometers of local road maintained would likely reduce the efficiency with almost constant congestion level. High frequency of road rehabilitation, road improvement would also rather decrease the efficiency score instead of improve it. Ratio of cost represents how much one kilometer of road is cost when maintained, improved, or rehabbed. High expenditure for road will decrease efficiency score instead of improve it. Each rupiah of local road spent in Bantul would likely reduce the efficiency with almost constant congestion level.

In conducting the efficiency measurement of road performance, researcher used non-probability and typical case sampling technique. With the population of this research is all province roads supported by Local Government of Yogyakarta Province, the sample of this research are road networks in Bantul District. Bantul district was taken as the sample due to the highest daily traffic number it has. Bantul district has 14 road segments which located in southern part of the Special Region of Yogyakarta Province. Each road segment is measured to figure out the efficiency score that will describe whether the government treatment for each road segment is appropriate enough or not. The efficiency score of each road will depict if the road is utilized optimally with certain level of inputs.

According to previous survey in New Delhi, the survey was aimed to all road users, but in this chance the researcher only applies the survey on single road users only. Here the researcher used the same purposive sampling technique due to some reasons. According to the data, the growing number of motorcycle in Yogyakarta showed that the number of road users dominated by motorcyclist, therefore researcher chose 30 motorcyclists as the respondents of the satisfaction survey. From 30 respondents chosen as the object of satisfaction survey, 20 of them were seller (owner of a store) and staff of a store such as convenience store, jewellery shop, and saloon. The respondents are generally commuters and for the rest of the respondents, they are originally lived around the road segment being surveyed as the owner of food stall.

Road service performance measures the satisfaction level of all road users. This measurement is used to find the answer directly from road users. The data are collected through survey questionnaire in order to identify users' satisfaction toward local roads. The questionnaire is constructed in Likert scale type of question. Each question represents whether the road users satisfy or not when they are using the road. There are five variables of satisfaction that will be covered in the questionnaire includes value for time and money, comfort and convenience, safety aspect, travel amenities and road signs.

Likert scale is used to analyse the level of satisfaction level of the road users. The indicators of satisfaction used are the value for time and money, comfort and convenience, safety aspects, travel amenities, and road signs (MDRA, 2007). With 5 aspects used as the variables of the satisfaction measurement, the data of survey are analysed using interval measurement basis. The results are composed into several categories to present the ranking or level of satisfaction. In conducting this research, the respondents are given questions that divided into 5 groups based on the aspects that are measured. The respondents are also given 4 responses for the questions: (1) strongly disagree, (2) disagree, (3) agree, and (4) strongly agree.

Results and Discussion

Efficiency measurement

The efficiency measurement process is conducted during 2011 to 2015 collectively. The results show efficiency score, reference set, and times as a benchmark. Efficiency score presents the efficiency performance of each road segments. The scores earned by measuring variables of input and output. The reference set describes which road segments policy should be adopted by DMU to finally have 100% efficiency score. Times as benchmark defines the frequency of road segments become referee for DMU. Collective year 2011-2015 is used to overcome the limited data that available to avoid homogeneous result of efficiency score. Here, all input and output are sum up in range of five years; therefore, the data become more complete and satisfying.

Table 1: Efficiency score 2011-2015

DMU	Efficiency Score (%)	Times as a benchmark	Reference Set (l)
Yogyakarta-Bakulan (parangtritis)	95.50%	0	dawung-makam imogiri(0.932142)
Yogyakarta-Barongan	65.90%	0	dawung-makam imogiri(0.631986)
Barongan-Bibal	16.70%	0	dawung-makam imogiri(0.149247)
Sedayu-Pandak	4.70%	0	dawung-makam imogiri(0.044508)
Bantul-Srandakan	73.10%	0	dawung-makam imogiri(0.682241)
Palbapang-Samas	15.90%	0	dawung-makam imogiri(0.159189)
Palbapang-Simpang Kweden	35.70%	0	dawung-makam imogiri(0.356758)
Bakulan-Barongan	51.70%	0	dawung-makam imogiri(0.515855)
Dawung-Makam Imogiri	**100.00%**	**13**	**dawung-makam imogiri(1.000000**
Sampakan-Singosaren	8.00%	0	dawung-makam imogiri(0.073071)
Imogiri-Dodogan	7.00%	0	dawung-makam imogiri(0.065229)
Patuk-Terong	4.10%	0	dawung-makam imogiri(0.038138)
Terong-Dlingo	6.90%	0	dawung-makam imogiri(0.065100)
Siluk-Kretek	2.70%	0	dawung-makam imogiri(0.021962)
Average Score	34.90%		

Based on the result in Table 1 above it is only one road showed efficient performance with 100% efficiency score (Dawung – Makam Imogiri road segment). On the other hand the rest of road networks are far from efficient with only one road that is close to be efficient which is Yogyakarta – Bakulan road segment with 95.5% efficiency score. The rest of road networks tend to be inefficient because of the number of input is too much. Each road networks has Dawung – Makam Imogiri as the reference, which means that other road networks should adopt the policy or technique used by Dawung – Makam Imogiri segment to be efficient.

Quite different with the partial year, the collective year shows some inefficient DMUs in the last five years. With average efficiency score is 34.9%, there are 2 DMUs that are efficient and 12 inefficient DMU. The four inefficient DMU has 0 times of reference which depicts the conditional inputs or outputs. However based on the result, the inefficient DMU can learn from its reference set to become efficient. For example Siluk-Kretek segment which has 2.07% efficiency score would be more efficient if it adopts the policies of techniques done by Dawung-Makam Imogiri segment. On the other hand, although there are 2 efficient DMU, these DMUs still take some DMUs as its benchmark. Yogyakarta-Bakulan segment despite of having almost efficient score it has reference set that indicates this DMU to learn from Dawung-Makam Imogiri segment.

As the orientation of this model is input orientation, it means that the number of inputs was reduced while output to reach efficiency was constant. The table below presents the proportional decrease of each input for the improvement of the inputs itself. Negative numbers mean decreasing input and vice versa for positive numbers.

Based on the efficiency score of collective years above, the result of the efficiency measurement of all road networks in Bantul district showed that only one road segment which is Dawung-Makam Imogiri that performed efficiently for 100% in 5 years. This result is unlikely satisfying; therefore, researcher classified the road networks in two categories to find a heterogeneity results. The road segments are classified into the most congested and less congested road networks. The division of these road segments was obtained by computing the average congested level of road networks. Road segments that have level of congestion above average are categorized as the most congested road classification whereas the congestion level of roads that is below average is categorized as less congested road classification.

There are 6 road segments included in the most congested road classification. Here, Dawung-Makam Imogiri is still the most efficient road segment even among the most congested road segments and 5 times become the referee for other road networks (Table 2). This implies that for other road networks such as Yogyakarta-Bakulan (Parangtritis), Yogyakarta-Barongan, Bantul-Srandakan, etc should adopt the policies and techniques used by Dawung-Makam Imogiri to equally perform 100% of efficiency.

Table 2. Efficiency score of most cogested road networks

DMU	Efficiency Score (%)	Reference Set	Time asBenchmark
Yogyakarta-Bakulan (parangtritis)	0.955016	dawung-makam imogiri(0.932142)	0
Yogyakarta-barongan	0.658879	dawung-makam imogiri(0.631986)	0
bantul-srandakan	0.731323	dawung-makam imogiri(0.682241)	0
palbapang-simpang kweden	0.356758	dawung-makam imogiri(0.356758)	0
bakulan-barongan	0.516681	dawung-makam imogiri(0.515855)	0
dawung-makam imogiri	1	dawung-makam imogiri(1.000000)	5

Table 3. Efficiency score of less congested road networks

DMU	Efficiency Score (%)	Reference Set	Time asBenchmark
bibal-barongan	1	bibal-barongan(1.000000)	1
pandak-sedayu	0.295125	samas-palbapang(0.279592)	0
samas-palbapang	1	samas-palbapang(1.000000)	6
singosaren-sampakan	0.496253	bibal-barongan(0.166266); samas-palbapang(0.303138)	0
dodogan-imogiri	0.442322	samas-palbapang(0.409762)	0
terong-patuk	0.256687	samas-palbapang(0.239575)	0
dlingo-terong	0.436211	samas-palbapang(0.408948)	0
kretek-siluk	0.168444	samas-palbapang(0.137964)	0

In less congested road classification, there are two road segments (Bibal-Barongan and Samas-Palbapang) that surprisingly performed efficiently for 100% (Table 3). On the previous measurement these roads did not show a good performance, but after classified into less congested road networks, these roads become the efficient among other less congested road segments. The efficient condition here refers to how efficient the inputs (maintenance, rehabilitation, road improvement, and cost) used to produce output whereas the output is the congestion level of road that represents the utilization level of the road itself.

The reason behind the perfect performance of Bibal-Barongan and Samas-Palbapang is due to both road segments are located in tourism area which make their utilization tend to be higher than other road segments in this classification. On the other hand, Kretek-Siluk as the most inefficient road networks should implement the policies used in Samas-Palbapang in order to perform equally. The probable reason of this inefficient condition on Kretek-Siluk is because this road was just improved into provincial road and required high amount of cost and maintenance. Therefore, with almost constant utilization level (level of congestion) huge treatment applied to Kretek-Siluk will cause unsatisfying result of performance measurement.

Input and target slack

Input target presents the number of input should be reduced or increased for inefficient DMU. From the result of efficiency estimation done above using MAXDEA, it turned out there are 13 DMU that are inefficient during 5 years. Here the input target and input slack manually calculated on collective year result to give recommendation for local government in achieving efficient road performance to improve the service sectors. Below are the results of input target on each input used.

Table 4. Maintenance Targeting & Slack

DMU	Input Target	Input Slack	Slack %
Yogyakarta-Bakulan (parangtritis)	**0.93**	**0.043922156**	**4.50%**
Yogyakarta-Barongan	0.63	0.327081633	34.10%
Barongan-Bibal	0.15	0.74375	83.30%
Sedayu-Pandak	0.04	0.902842105	95.30%
Bantul-Srandakan	0.68	0.250946309	26.90%
Palbapang-Samas	0.16	0.841	84.10%
Palbapang-Simpang Kweden	0.36	0.643	64.30%
Bakulan-Barongan	0.52	0.483	48.30%
Sampakan-Singosaren	0.07	0.8372	92.00%
Imogiri-Dodogan	0.06	0.861541667	93.00%
Patuk-Terong	0.04	0.895066667	95.90%
Terong-Dlingo	0.06	0.8728125	93.10%
Siluk-Kretek	0.02	0.796933333	97.30%

Table 5. Rehabilitation targeting & slack

DMU	Input Target	Input Slack	Slack %
Yogyakarta-Bakulan (parangtritis)	**0.114**	**0.005**	**5%**
Yogyakarta-Barongan	0	0	0%
Barongan-Bibal	0.055	0.276	83%
Sedayu-Pandak	0	0	0%
Bantul-Srandakan	0.123	0.045	27%
Palbapang-Samas	0	0	0%
Palbapang-Simpang Kweden	0	0	0%
Bakulan-Barongan	0	0	0%
Sampakan-Singosaren	0.009	0.102	92%
Imogiri-Dodogan	0.009	0.114	93%
Patuk-Terong	0.014	0.32	96%
Terong-Dlingo	0.022	0.291	93%
Siluk-Kretek	0	0	0%

After manually computed, the 13 inefficient DMUs gave variance results over maintenance as one of the road performance measurement inputs (Table 4). Yogyakarta-Bakulan (Parangtritis) which almost perfectly efficient need to operate 0.93 km of maintenance with output 15.728 congestion level to be efficient. On the other side, percentage of input slack explains that Yogyakarta-Bakulan should reduce maintenance input by 4.5%.

Still discussing Yogyakarta-Bakulan (Parangtritis), the second input which is rehabilitation should also be changed to be efficient in delivering the function of roads. For Yogyakarta-Bakulan to be efficient should do rehabilitation by 0.114 km of road or reducing the conduction of rehabilitation in this road by 5% (Table 5).

Since road improvement is done one in a time and not regularly, therefore without doing any road improvement or do 0 km of road improvement, it will help Yogyakarta-Bakulan to be efficient such as Dawung-Makam Imogiri (Table 6). The slack percentage for Yogyakarta-Bakulan rehabilitation is 0%, it means the rehabilitation should be reduce by 0% or in other words does not need any treatment.

Table 6. Road improvement targeting & slack

DMU	Input Target	Input Slack	Slack %
Yogyakarta-Bakulan (parangtritis)	**0**	**0**	**0%**
Yogyakarta-Barongan	0.134	0.07	34%
Barongan-Bibal	0.034	0.17	83%
Sedayu-Pandak	0.006	0.125	95%
Bantul-Srandakan	0	0	0%
Palbapang-Samas	0	0	0%
Palbapang-Simpang Kweden	0	0	0%
Bakulan-Barongan	0	0	0%
Sampakan-Singosaren	0.009	0.107	92%
Imogiri-Dodogan	0	0	0%
Patuk-Terong	0	0	0%
Terong-Dlingo	0	0	0%
Siluk-Kretek	0.012	0.44	97%

Table 7. Cost Targeting & Slack

DMU	Input Target	Input Slack	Slack %
Yogyakarta-Bakulan (parangtritis)	**42.617**	**2.008**	**5%**
Yogyakarta-Barongan	80.138	41.467	34%
Barongan-Bibal	31.831	158.773	83%
Sedayu-Pandak	7.089	143.741	95%
Bantul-Srandakan	69.948	25.74	27%
Palbapang-Samas	2.586	13.679	84%
Palbapang-Simpang Kweden	5.807	10.459	64%
Bakulan-Barongan	8.396	7.843	48%
Sampakan-Singosaren	16.43	188.943	92%
Imogiri-Dodogan	7.816	103.848	93%
Patuk-Terong	4.616	107.978	96%
Terong-Dlingo	7.999	107.932	93%
Siluk-Kretek	**13.94**	**502.347**	**97%**

In this research, cost is the only input that influences the performance score clearly. The inefficiency of these DMU resulted from the strange expenditure on particular road like Siluk-Kretek. Siluk-Kretek has only 370 unit of vehicle per kilometer or 3891 unit of vehicles in one day, but Siluk-Kretek spent for about 5.421 million rupiah compared to Yogyakarta-Bakulan. Yogyakarta-Bakulan spent around 372 million rupiah on average in 5 years but has 131.330 vehicles used this road. Therefore Yogyakarta-

Bakulan needs to spend 42.617 million rupiah per kilometer and later consider having equal efficiency with Dawung-Makam Imogiri (100%). The slack percentage of cost on the other hand tells that to be as efficient as Dawung-Makam Imogiri, Yogyakarta-Bakulan should decrease the cost spent by 5% (Table 7).

Satisfaction level

Based on the survey of road user's satisfaction level, 73.3% of respondent feel satisfied enough (agree) and 26.7% feel not satisfied (disagree) toward the condition of the road. Below is the percentage of satisfaction level on each aspect:

Table. Percentage Result of Satisfaction Measurement

Satisfaction Aspects	Description			
	Very Unsatisfied (Strongly Disagree)	Not Satisfied (Disagree)	Satisfied Enough (Agree)	Very Satisfied (Strongly Agree)
Value for Money & Time	-	40%	60%	-
Comfort & Convenience	-	60%	40%	-
Travel Amenities	-	20%	70%	10%
Safety Aspects	-	10%	90%	-
Road Signs	-	33.30%	66.70%	-
Overall Satisfaction	-	26.70%	73.30%	-

After conducting the survey in Dawung-Makam Imogiri as it is the most efficient road segment, it turned out that road user in Dawung-Makam Imogiri feel satisfied enough with the physical condition of the road measured by 5 aspects of satisfaction. Users who use this road only for commute do not consider the road damage is very disturbing. It was informed that the road damage did not increase the spending of users related with vehicles complementary such as gasoline, vehicle service spending, tire maintenance, etc. Instead, the users felt 60% satisfied with the value of time and money. The satisfaction level of this aspect (value for time and money) is 20% higher for the commute people than local people who have live for a long time.

The local people tend to feel dissatisfied with the physical condition of the road. Proven by overall satisfaction level of the origin people is 26.70%. The original people mostly felt dissatisfied with the safety level in Dawung-Makam Imogiri. After directly questioned, they confess that there are a lot of crimes happened in Makam Imogiri Avenue. Most of them are robbery, even though Makam Imogiri Avenue is very crowded.

Despite the low satisfaction level showed by origin road users of Makam Imogiri on average, they felt very satisfied on particular aspect which is comfort & convenience. Comfort & convenience describes how convenience the users of road utilizing the road segment itself and how easy road users could access the road networks. Based on direct interview that origin road users do feel better improvement done on Dawung-Makam Imogiri since the accessing from Makam Imogiri Avenue to capital region is easier and not time consuming.

There will be an increasing demand from road users over more amenities and better road properties such as distance signs and warning signs when there is an improvement on road condition. Improvement on road condition will increase the value for time and money and increase comfort and safety levels, therefore road users would expect better facilities (MDRA, 2007).

Conclusions

The efficiency result shows that there is only one road segment among 14 that is efficient during 2011-2015. This road segment is Dawung-Makam Imogiri. This result depicts that the local government did not perform an efficient performance in providing the road infrastructure. The rest of the result described the inefficient performance with only 1 out of 13 road segments which is Yogyakarta-Bakulan that close enough to be as efficient as Dawung-Makam Imogiri. By having references (benchmark) on DEA measurement of road performance, the local government could figure out what policy or technique should be applied on inefficient DMUs. All DMUs have Dawung-Makam Imogiri as the referee. Therefore, the gov-

ernment could adopt the techniques used in it to perform a good road condition for road users. Despite applying the techniques and policy of Dawung-Makam Imogiri, local government is also helped by the numerical result of input-oriented model used in the measurement process. This input-oriented model could support the government on controlling the number of inputs used in order to be efficient.

Road users' point of view is also used to measure the effectiveness of road performance. Measuring the satisfaction level of road users could help local government to improve its road services such as road safety, travel amenities, road signs, comfort and convenience, etc. The result of road users' satisfaction survey in Dawung-Makam Imogiri show that the road user is satisfied enough toward the road condition.

Since the results of this research are quiet unsatisfying due to many road networks performed inefficiently, therefore the local government has to reconsider the inputs used in producing the function of the road based on the input target and slack computation. The results of the computation would help the government in increasing the efficiency performance of road networks and improve the road users' satisfaction level. Many road networks would be better if given less treatment instead of equally treated.

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