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Comparative Analysis of Road Financing at Operational Level in Tanzania

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Abstract

This article reports on the utilization of budget split model in distributing fund to implementing agency at operation level. Budget split module is an experimental and engineering mathematical model developed to bring about fair distribution of funds to all regions. This article reports the comparative analysis of using budget split model versus empirical approach. The objective of this study is to compare the budget allocation based on empirical method against Budget Spilt Module developed into RMMS system. The finding indicates that when the budget split model is used, no region gets surplus budget. The budget is distributed such a way that all regions received reasonable amount. The Model balance the fund so that the amount available is shared based of the needs and justification of the road length. Finally, it is concluded that using Budget split model developed into system for fund distribution at operational level will create balanced economic development between regions.

Keywords: ***Budget split model; Road fund distribution empirical approach; Fund distribution; Road expenditure.***

1. Introduction

Budget allocation for road maintenance is the most challenging task in many road agencies [1-3]. For many years, most developing countries, particularly Tanzania, have been suffering from poor road condition due to insufficient funds for road maintenance. Among other factors associated with poor road condition maintenance is improper allocation of funds [4]. Despite many countries having developed road fund agencies which are responsible for fund distribution at National level, the operation level for fund distribution suffer from empirical or political influence. This assertion is also noted by [2] that much debated topic nowadays in the roads sector centers on "How much money needs to be allocated to roads?" and "How should the necessary funds be generated?" As a motivation for an increase in funds allocated to

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roads, many perhaps misguided people propagate that all funds rose from taxation of road users should in their entirety be devoted to the roads sector.

Yet, roads in all countries represent an important national asset. For example, the asset value of the road network in the emerging countries of Central and Eastern Europe is estimated to be in excess of US$550 billion. For many countries, the asset value will be comparable with that of some of the world's largest companies. Despite the importance of managing road networks in a business-like manner, many countries find this to be a difficult challenge. A number of reasons are responsible for this, including insufficient funds, shortage of qualified staff, absence of machines and spare parts as well as deficient institutional arrangements and management capability [3].

Globally, road infrastructure has a remarkable economic and social impact on society. This is why road financing has always drawn the attention of policymakers, especially when resources available for government spending become scarce. Nations exhibit differing approaches to dealing with road transportation financing [5]. Most suggestion is to raise fuel taxes or user cost so as to keep pace with inflation [6]. Others recommend vehicle-miles-travelled system charges to compensate the funding [7]. Inevitably road pricing and financing attracted more research because it has potential not only to manage travelled demand as a signal to guide efficient investment decision but also to increase tax collection for travel demand as well as resource for revenues to fund roads and public transport [8].

More over many studies have focused on how to compute road fund from national budget while neglecting the technical distribution at operational level. A Review of Road Sector Reforms in Tanzania reports how maintenance fund is estimated with assumption that only maintenance and periodic work is required on roads. At that time, rough estimates of road maintenance needs suggest a total annual requirement of US$90.8 million [9]. The empirical approach was developed by Ministry of Works in the absence of well-established inventory and lack of proper data collection which currently is not a problem in Tanzania. The availability of inventory and condition survey raised the concern for improving fund disbursement. The application of empirical approach have causes a huge backlog of maintenance amounting to about US$600 million, as estimated under the Urgent Rehabilitation of Road Program. The funding gap is not only for underdeveloped country; it occurs everywhere even to developed ones [10].

In the absence of well-established inventory, the condition surveys were carried out by visual inspection or from the regional engineer's knowledge of the road without any scientific evidence in the form of roughness measurements, bearing capacity, etc. The results are therefore dependent on a subjective view and vary from region to region. In this situation, the only solution was to use empirical approach in fund distribution [9].

The value engineering-VE methodology for cost distribution discussed in [11] aim at developing a tool for optimizing funds allocation after getting the optimum value for each activity to meet network goals. The decision variable in VE taken in kilometres of road class for each district assumed that the study has activities, (H) for road class and (R) for district roads for any implementing agency and therefore decision variable can be represented by combining both activities. The cost of the activities is a function of the activities type, road class and location and it assumes that

variation will not significantly vary within road class in the district and therefore the best value will depend on VE. Some studies recommend different ways including road user fees charges, mileage fees, gas tax etc [12].

In this article we developed and integrated budget split model into road maintenance management system to solve this problem. Budget split module is an experimental and engineering mathematical model developed to bring about fair distribution of funds to all regions. This article reports the comparative analysis of using budget split model versa empirical approach. Objective of study was to compare the budget allocation from an empirical method allocation versus programmed system on Budget Spilt Model.

1.1 Empirical approach of road fund distribution for maintenance

Most governments including Tanzania use an empirical approach of distributing fund. The empirical approach is when you use evidence and experience to analyze something rather than reason which is used in rational approach [13]. The idea behind empirical approach is to use personal beliefs and by observation out of the equation from actual experiments. This implies that manager may not draw conclusions based on empirical data rather by using personal feeling [14].

The approach mostly based on the experience of engineers in understanding the implementing agency or in connection with political influence. Really consideration of economic factors and equal distribution of Tax payers is considered. In this approach, the knowledge based on experiences of successful managers is normally applied by other managers in solving problems in future and in making decisions. As a result, many new managers use the term apply maintenance fund distribution as per previous year. When this is repeated, three times or more, and those implementing agency by mistake were not foreseen in the first distribution, which keep suffering the same consequence as per last three years. Empirical analysis, therefore, is an evidence-based approach to the study and interpretation of information. The empirical approach relies on real-world data, metrics and results rather than theories and concepts.

Even though empirical approach involves analyzing some data set and drawing conclusions directly from that data typically, data can be interrelated by equations of best fit which approximates the overall findings and trends of the data, and can be used as a good predictor of values which are hard to measure experimentally. We dispute that this approach rarely fit optimization of fund for road maintenance for faire economic development between regions and therefore using programmed model for fund distribution may be of optimum for road financing.

Tanzania National Roads Agency (TANROADS) is the agency responsible for development and maintenance of trunk and regional roads in Tanzania. Apart from receiving fewer funds, the agency has been distributing funds using empirical approach to all 26 regions. This approach of funds distribution has attracted complaints from several regions for all years since the agency was formed. The recent development of RMMS integrated more sophisticated model that properly considers network length, actual needs or unconstrained needs and multi criteria (MCA) parameters. With more than five years testing of the model it has come to a point where the model can be directly applied by RMMS to harmonized fund distribution among the region.

1.2 Related works on road funding approaches

Literature review on road funding approach was much done in early 1990's and they mostly focus on how to compute road finance from the national budget [9,12,15,16]. The recommendation mostly relays on road user fees, vehicle-miles-travelled system or gas tax. In the next subsection, we discuss different approaches applied in different countries.

Several possible policies on road financing direction are to increase the role of direct road user charges. Some include a mileage-based user charge which normally is found to have considerable potential both as a financing mechanism and as a means for implementing road pricing [17]. Forkenbroke further argues that among the policies that can be supported are congestion pricing, privately operated toll ways, use of environmentally friendly vehicles, and improved travel demand analyses. Above all, more of the financing burden for local roads can be shifted from those paying property and sales taxes to actual users of roads within a community. Furthermore, estimation of road capacity is significant because it's an important indicator of road performance and can point road managers in the right road maintenance and traffic management direction [18]. Many studies discuss how to make road financing from national income leaving aside how to distribute the fund among competing needs of the implementing agency. Such approach is summarized in the Table below (Table 1).

Table1: Summary of the Basic Methods for Road Financing.

Appraisal Method	Application	Source	Strengths	Weaknesses	Countries Applied
Cost Benefit Analysis (CBA)	- It assesses economic worth of a road	-Jules Dupuit 1848	-Objectivity -Transparency -Extensively Used.	-Suited to road with high traffic volumes -Excludes a wide range of benefits	International Application
Consumer Surplus Approach	-It is by the calculation of VOC savings, time savings and vehicle cost savings	-Van Der Tak and Ray (1971)	- Objectivity -Transparency	-It is not equity based	International Application
Producer Surplus Approach	-It calculates the economic return on the value added of increased agric. Production and transport cost savings	-Camemark et al (1976) -Beenhakker and Lago (1983)	- Objectivity -Transparency	-It is applied on rural roads -It does not consider other benefits	Developing countries
Cost Effective Method	-It compares alternate costs of different options. -Decision is based on a cost Index	-Fabrycky and Thugesen (1980)	-It uses quantifiable indicators -It is objective	-It excludes benefits -It is acceptable so far as an index is obtained.	Developing countries

Source [19]

1.2.1 Road financing in the United States

Most resources for funding highways in the United States come from fees paid by those who use the road network in the form of fuel taxes, tolls, vehicle excise taxes, tire taxes, truck and trailer sates taxes, and heavy vehicle use taxes [5]. Consequently, the U.S. model is characterized by a strong connection between road revenues and expenditures [6].

The suitability of limiting highway revenues to road purposes has been widely discussed, with opinions that are both in favor of and against the measure of improving road economy [15]. State and local governments do collect revenue from a variety of charges not only specifically targeted ones, but also the general taxes on the population (income, sales, property) unrelated to motor vehicle use [20]. The increased use of general taxes to fund transportation programs at the state and local levels breaks the links associated with the traditional "user pays" concept [16].

1.2.2 Road Funding in European Countries

European countries have adopted a different approach to road funding. Unlike the United States, gas tax revenues are rarely dedicated to the funding of road economy. They are, rather, considered as part of the general revenues and allocated to the general budget, so their final application is ultimately decided by the Parliament. The UK government, for instance, is in favor of implementing high, but non-road-allocated, gas taxes as a means for the government to collect revenues for use in dealing with public policy priorities, and that includes some that are clearly transportation-related, such as reducing air pollution and traffic congestion [21]. As happens in the United States, fuel taxes in Europe represent one of the most important road user charges. However, European countries face serious budgetary constraints as a result of economic recession. In some cases, it has caused severe changes in road management. Portugal, for instance, some of the former shadow toll road sections shifted toward real toll schemes because of governmental revenue needs [22]. In the past years, budgetary limitations have led European governments to explore new mechanisms to fund road expenditures.

The implementation of distance-based tolls in Europe is usually associated with the private operation of roads through concession contracts. Countries such as France, Spain, and Italy have an extensive toll road network of more than 20% of total trunk highways, and run mostly by private concessionaires [5]. The involved private investment to public services has both advantage and disadvantage. However, such investments usually entail not only significant risk but also have the potential for substantial upside [23]. Naturally, these tolls are allocated to finance road expenses. Other European countries, however, have implemented time-based flat fees known as *vignettes,* which allow users to drive during a specified period of time that a day, a week, a month, or a year. Some countries, such as Belgium, the Netherlands, and Sweden, apply vignettes to heavy vehicles. Other nations, such as Switzerland, Austria, and the Czech Republic apply vignettes to light vehicles. Vignettes are usually collected by public road agencies and are often allocated to fund road infrastructure needs.

Ever since the approval of the road charging directive (EUROPEO, 1999), the European Commission had promoted the implementation of a harmonized approach of distance-based tolls on heavy goods vehicles or heavy-vehicle fees - HVF in specified sections of the no privatized network. This approach belongs to a wider transport policy strategy intended to achieve both a more sustainable transport system by promoting cleaner vehicles and a more stable mechanism for funding roads as distance-based charges on heavy vehicles are usually allocated to road purposes. Following the timing first envisioned by the European Union several nations like Austria and Germany, among others, sometimes ago established distance-based tolls on heavy vehicles, mainly in the whole trunk highway network or specific sections of it, while other nations like Poland and Slovakia have more recently adopted the France model of privatizing high-

capacity network. In addition, European countries apply some charges to road users including vehicle purchase, vehicle ownership, plate fees, and the resulting revenue are very rarely allocated to road purposes.

Table 2: Road Funding Gap in Some Selected Countries.

Country	Govt. Grant	Donors	Total Need	Actual	Shortfall	Percentage of Total Need
Argentina	293	40	68	61	7	89
Chile	421	0	760	308	452	41
Ghana	20	121	135	73	62	54
Hungary	97	46	240	127	113	53
Jordan	58	16	31	9	22	29
Kazahstan	81	0	176	101	75	57
Korea	175	0	970	655	314	67
Pakistan	320	75	40	27	13	68

Road Expenditures versus planned programmes [19]

From Table 2 above, the funding gap varies across different countries. An average financing gap of about 57.25% is experienced in many countries. In the same line, since 2012/2013 to 2016/2017, Tanzanian is experiencing financing gap between 32% to 41% respectively which is almost the same as Chile. Imperatively, this is an indication to the need to have a scientific approach of fund distribution at operational level.

1.2.3 Road financing and trend in Tanzania

The report of [25] reveals various useful information on road financing in Tanzania. Fig. 1 shows planed budget, approved and actual released in USD. The result indicates that national roads approved development budget was generally not been increased with the exception of FY 2013/14. Actual released budget for FY 2012/13 and 2015/16 is more than approved budget because of settlement arrears. But the approved budget was quite far from the actual needs. Fig. 3 shows allocated budget against needs. The approved total budget (national and local roads) has always been below Maintenance needs. When examining the paten of needs and those allocated budget it implies that annual maintenance needs are growing faster than the annual budget allocation. This reveals the increased backlog maintenance. For the country road networks condition to optimally stabilize, financing should aim at reversing the divergence trend into convergence trend so that the rate of growth of budget is higher than growth of maintenance needs. Many countries experience road financing gap. Fig. 2 indicates that financing gap in national roads increase from 16% in FY 2012/13 to 65% in FY 2015/16. The same experience is also noted in local roads with an increase of 55% to 73% respectively. This implies building up of maintenance backlog each year. The increased maintenance backlog is reflected into deteriorating road conditions as shown in Fig. 4.

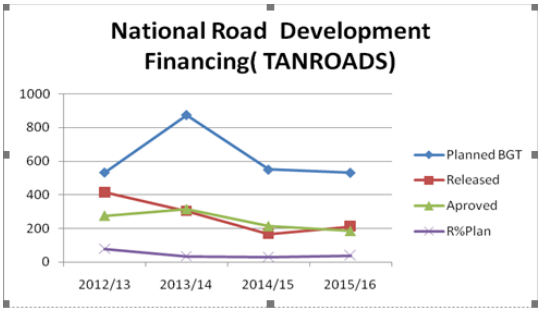

Fig. 1. National road development financing trends.

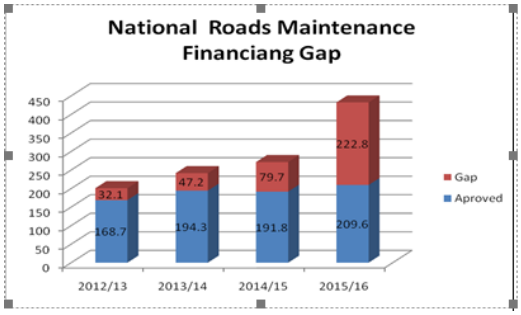

Fig. 2. National roads maintenance financing gap.

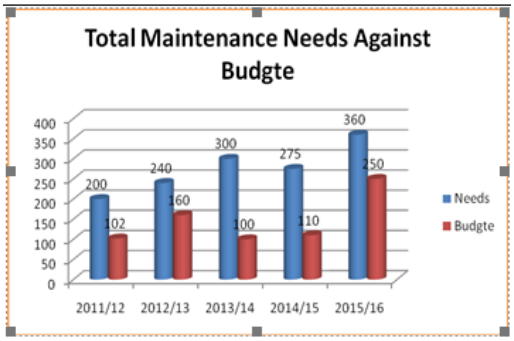

Fig. 3. Total maintenance vs budget.

2. Study Approach

This study uses RMMS database library which store historical data for lasts ten years. The data were collected using both visual and technology-based system. Most data were collected using lesser beam of ROMDAS. The typical data collected includes Traffic, EIRI, economic determination factors such as road classification type, tourism, social services and population [26].

In order to develop budget split model, a narrative approach was applied in developing the mathematic model. Engineering parameters, road length, and climate, ere key parameter applied and used to build the mathematical modal. Three major equations were built and finally percentage distribution of each result was computed to come out with rational model. The mathematical modelling is beyond this article.

The RMMS data base library was the source of major information. The data set used was from 20017 to 2019. Even though the first release of model was in year 2013 but it was not used until 2017. In the past two years every time of budget analysis the comparison was presented to road engineers to build the discussion of area from government. The seal empirical budget was obtained from TANROADS. The RMMS system was fed by current data approved from the workshop and result was examined.

3. Results and Discussion

3.1 National road condition trends

As can be noted from Fig. 4, national roads in good condition fall gradually from 43.5% in FY 2011/12 to 28.5 in year 21013/14. It almost keeps steady from 2014/15 to 2017/18 before it falls in 2018/19 to 2019/20. Nevertheless, fair condition increased from 38.6 in FY 2015/16 to 53.6 in FY 2019/20. At the same time, poor condition remains with harmonic fluctuation between the years. The overall percent of Good and Fair condition was 83.5% in FY 2016/17 and remain almost the same in FY 2019/20. This has not reached the target of 86% as proposed by JTSR). The implication is that despite the rehabilitation backlog increase gradually.

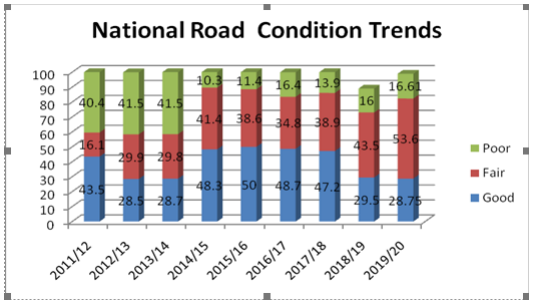

Fig. 4. National road condition for past nine years the budget split distribution model.

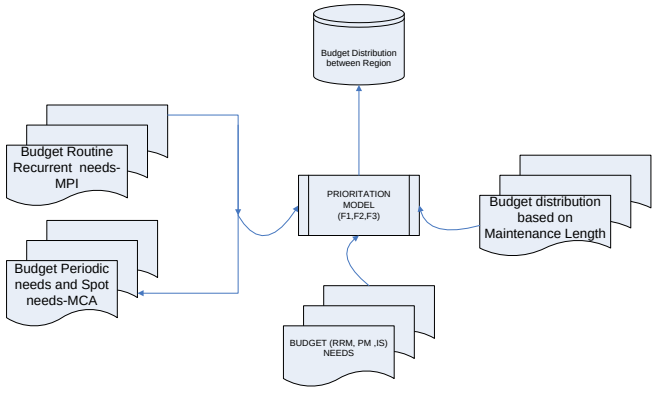

Fig. 5. Budget split model.

The budget split distribution model is in Fig. 5, based on modelling of different aspect of the budget needs. These include Routine recurrent need scomputed based of Multiple Priority Index. Periodic maintenance needs and sport needs based of Multiple Criteria Analysis, Budget need that combined RRM, Sport and PM and finally Budget need based on regional total network's needs.

3.2. Case 1: Budget distribution comparison when surface type is not considered

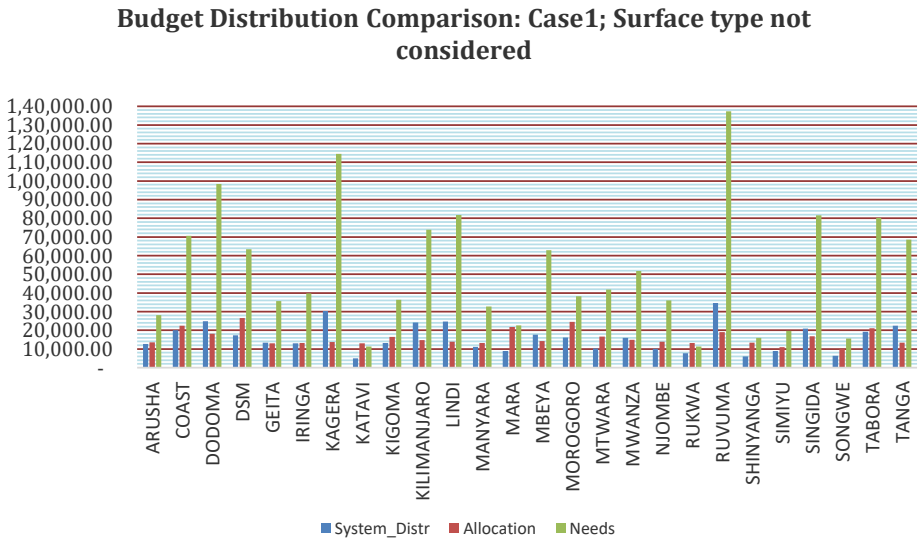

Fig. 6. Budget distribution case 1.

Table 5: Summary of Finding in Case 1.

	Budget split model	Empirical Model	Needs
Total (Ml)	415,361.4	416,539.0	1,370,589.8
Max.	34,648.8	26,618.7	137,254.5
Min.	4,960.1	10,051.4	11,305.5
Average	15,975.4	16,020.7	52,715.0
St.Dev	7,707.9	4,202.8	32,995.7

From Fig. 6 above, and following an empirical distribution, it can be observed that Morogoro, Mara, Coast which has less network size compared to Kagera and Ruvuma received large budget. Some regions like Rukwa and Katavi received higher budget than the actual needs. But the result based on the system distribution indicates that all regions received budget proportionally depending on the available fund and actual needs. There is no region that received fund higher than the actual needs. This implies equal development of society and economic of the regions.

The summary of the finding in Table 5 indicates total needs of Tsh.1370589.8 Mil. As per system allocation the maximum value of 34,648.8 is observed in Ruvuma which was allocated 19,105.24 using empirical approach. Likewise, minimum value of 4,960.10 is experienced in Katavi which was allocated 13,097.10. The average for system allocation is 15,975.4 with standard deviation of 7.707.9 and when empirical approach was used it read 16,020.7 with standard deviation of 4202.80. Budget allocation Distribution Case 2: Surface Type Inclusive.

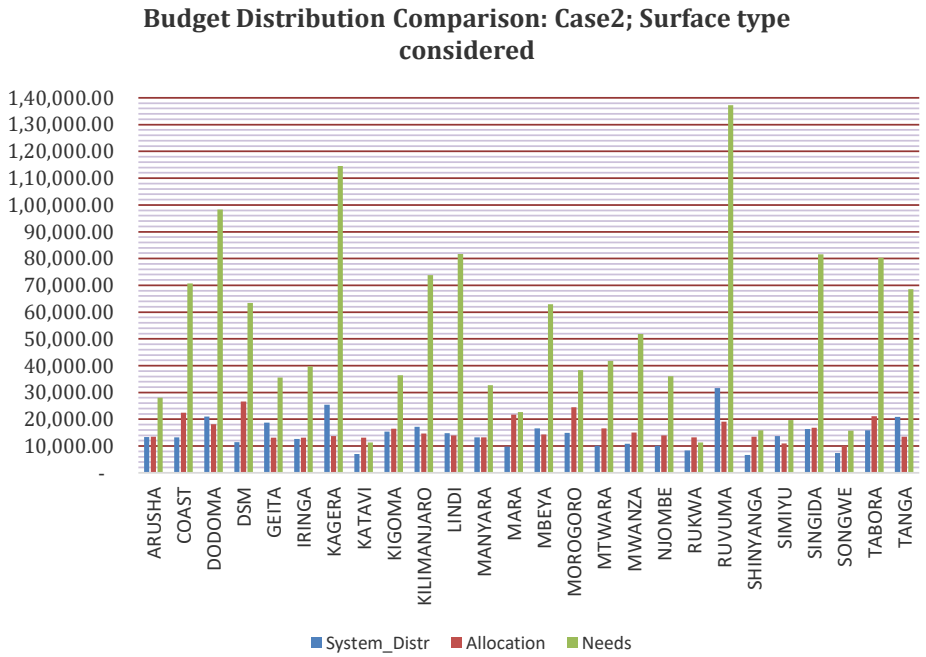

Fig. 7. Budget distribution case 2.

Table 6: Summary of the Finding Case 2.

	Budget split model	Empirical Modal	Needs
Total (Ml)	377,079.4	416,539.0	1,370,589.8
Max.	31,593.0	26,618.7	137,254.5
Min.	6,666.6	10,051.4	11,305.5
Average	14,503.1	16,020.7	52,715.0
St.Dev	5,754.0	4,202.8	32,995.7

Fig. 6 presents the second scenario with the same budget as first scenario. The result from empirical approach indicates that Morogoro, Mara and Coast which has less network size compared to Kagera and Ruvuma received large budget. Region like Rukwa and Katavi received surplus budget above the actual needs. However, when system is used to distribute the fund, all region received budget proportionally depending on the available fund and actual needs. No any region received surplus budget than actual need.

From Figs. 5 and 6 above, it can be observed that, without considering surface type, 99.7% of total fund released was utilized, and when surface type was considered, 90.5% of the total fund release was utilized. This means budget allocated to roads network is affected by surface types.

The summary of the findings in Table 2 indicate a total need of Tsh1, 370,589.8 Mil. When empirical approach was applied, the maximum value of 26,618.7 was observed in Dar es Saalm which, according to the system, is allocated 11,444.00. Likewise, when using empirical approach, a minimum value of 10,051.4 was experienced in Songwe, which

was allocated 7,333 using system. The average for system allocation is 15,975.4 with standard deviation of 7.707.9 and when empirical approach was used, it read 16,020.7 with standard deviation of 4202.80.

3.3 Road funding gap between empirical vs. System allocations

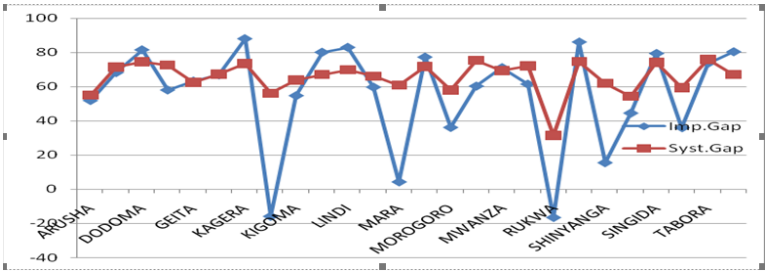

Fig. 8. Funding gap in case 1.

The Fig. 8 above indicates the funding gap when using empirical approach and when budget split model from the system is used. The results indicate that the funding gap is reduced to a minimum of 31.34 ml realized in Rukwa, and to a maximum of 76.05 ml, realized in Tabora. The system ensures that there is no region with surplus of budget. This approach plays faire distribution. Dar Es Salaam region is considered in empirical situation with some reasons. It is a fact that when using system, all engineering factor must be collected realizably. Fault in data collection would definitely cause effect in budget analysis.

On the other hand, when empirical approach was used, Katavi had extra budget of about 15 ml. Rukwa had surplus of around 16 ml. while Kagara was experiencing a shortage of 87.99%. This is reduced by 14.51% when system is used. A surplus experienced in Katavi 15.85 ml. And in Rukwa (16.53 ml.) was then utilized to compensate other regions as a result those regions share the budget shortage.

4. Discussion

With exception of Dar es Salaam region which most of its roads are dual carriage way, Ruvuma is considered to have higher road network size followed by Tabora, Morogoro and Kagera. On the other hand, Simiyu has lowest road network size followed by Geita and Songwe. Similarly, based on system distribution, Ruvuma needs to have higher budget followed by Kagera in both cases. However, empirical distribution did not consider the difference between the two cases. With the use of system allocation, the shorted budget is shared among all regions. Finally, it is ascertained that using system distribution will create balanced economic development between regions.

In the last two decades, Tanzania put many efforts to provide substantially higher funding for road maintenance through road fund board as compared to 19th century. However, the available funds are insufficient to properly maintain the road network attracting more backlogs. As a result, most of the roads network requires a substantial amounting of rehabilitation works carried out before they can be in a maintainable condition. Effort to improve the poor state of the road networks would require that maintenance funding is used for reconstruction part of the network and therefore any estimated resource required for maintenance must be programmed beyond human intervention. Scientific approach of fund distribution may reduce backlog level in region. Even though social-economic value of a

region matters in transportation, the funding gap needs to be experienced by all regions in proportion to economic contribution.

5. Conclusion and Recommendation

Based on the analysis of results, observations, and discussion above, it can be concluded that distribution of budget by using system is more realistic and economical compared to empirical approach. The major fault in empirical budget allocation is that if a budget is not changing in subsequent year than those with surplus will keep having surplus yearly and those with higher shortage will keep the same. In the Empirical approach the distribution of areas will not consider those with higher shortage.

The analysis includes two different approach of budget analysis. The analysis that include major surface type and those that does not include surface type. In the results Ruvuma region presents an example of an extensive higher capacity network length, but when using empirical approach of fund distribution, it is always getting fewer funds. When looking at economic contribution of Ruvuma and its population there is no justification of why it gets less budget. In the 2019/2020 budget, analysis conducted in Kigoma rectifies the approach and recommends to the government that any area should therefore consider the system allocation rather than empirical approach.

It is therefore recommended that the mode should be adopted with more improvement and flexibility in allowing user intervention. This model my not only be applied in National road financing but also in local road financing too.

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