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Abstract

Tanzania is one of the most frequent countries conducting Labour-Based Technology (LBT) under several initiatives of international donors such as JICA, ILO, etc. Appropriate Technology Training Institute (ATTI) provides the capacity building program for the sake of educating LBT engineers. Nevertheless, economic impact of LBT has not clearly been estimated. Thus, this paper i presents two key analyses: (a) the estimation of economic impact and employment creation of LBT implementation in Tanzania by using Input-Output Table (I-O Table) and (b) the cost comparison between LBT and Equipment-Based Technology (EBT) to show the cost advantage of LBT by using several data from Tanzania and Uganda as well as Asian experience, Cambodia. In the analysis of economic impact of LBT, we used input value which amount is equivalent to 29% of road fund of 2007/08 fiscal year. It was treated as new demand and also considered as direct effect in Input-Output Analysis (I-O Analysis). Subsequently, economic effect was calculated up to secondary stage on the basis of which new production of each industrial sector would expectedly be induced in order to satisfy the new demand in accordance with the increase of household income (which directly links to the increase of household consumption) by the implementation of LBT. Finally, total economic impact of LBT was calculated by summing up economic effect of each stage. Besides, the size of newly created employment was estimated from I-O Table and Social Accounting Matrix (SAM) in the year of 2000. Cost comparison between LBT and EBT was done by using cost data of each road construction. The data were collected mainly by interview and literature based survey. Cost comparison shows obvious superiority of LBT over EBT particularly in terms of employment creation. Furthermore, unit cost of road construction of LBT was also superior to that of EBT.

1. Introduction

Labour-Based Technology (LBT) is one of the well-known employment-intensive approaches to unpaved feeder road construction in developing countries, particularly African nations. According to ILO (2009), LBT has been applied world wide to a total of 52 countries and regions which are split into 14 from Asia and central Asia, 27 from Middle East and Africa and 11 from Latin America. In addition, the method of LBT is published as an engineering manual by International Labour Organization (ILO) and World Road Association (PIARC) (Tembo and Blokhuis, 2004). Some countries are well prepared with the engineering standard and training material for training purpose (ATU and MOW, 1997). One of the primary advantages of LBT is obviously its employment creation which contributes to the activation of local economy. Nevertheless, economic impact of LBT has not been clearly estimated.

Under this background, this paper carried out two analyses (a) estimation of economic impact and employment creation by LBT implementation in Tanzania by using Input-Output Table (I-O Table) and (b) the cost comparison between LBT and Equipment-Based Technology (EBT) to show the cost advantage of LBT by using several data from Tanzania and Uganda as well as Asian experience, Cambodia. In chapter 2, economic impact and its logic are described. Subsequently, the comparison of cost structure between LBT and EBT is mentioned from several aspects in chapter 3. In the final chapter, summary and conclusion is stipulated.

2. Economic Impact of LBT Using Input-Output Analysis

Tanzania is one of the countries which noted as frequently applying LBT on feeder road construction under initiatives of several international donors such as ILO, Japan International Cooperation Agency (JICA) etc. Appropriate Technology Training Institute (ATTI) provides capacity building program for educating LBT engineers. University of Dar es Salaam (UDSM) offers course works for learning a wide range of technologies of LBT in terms of design and construction method. In rural areas, there are a lot of roads constructed by LBT that indeed contribute to the activation of local economy since LBT creates more employment than that by EBT. Once people earn money, it is very likely that consumption of local goods and services rises up. Nevertheless, this economic impact has not been clearly revealed. Some donors and the Government have not known to what extent LBT affects economic activation and employment creation. Besides, they sometimes hesitate to adopt LBT due to the reason that LBT is a "primitive" approach. Therefore in order to promote further LBT application, it is significant to estimate its economic impact.

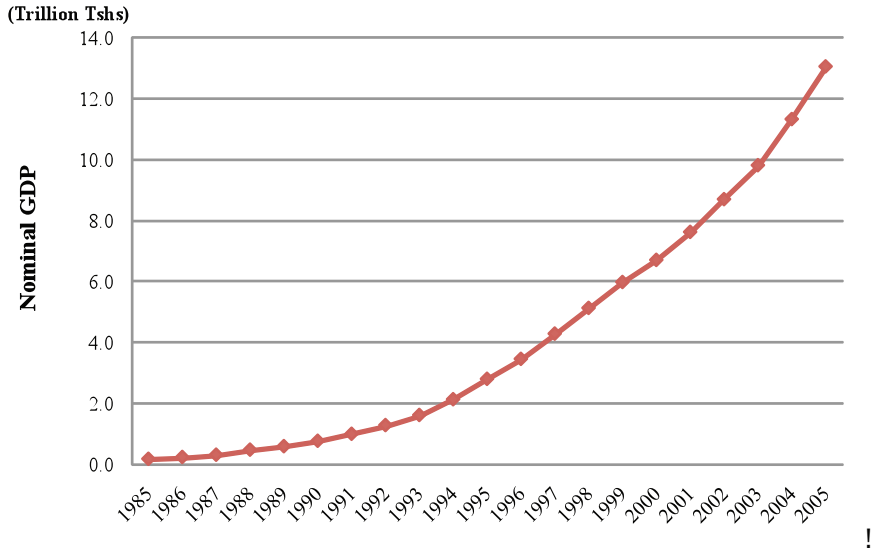
2.1 Input-Output Table in 1992 and Change in GDP in Tanzania

Tanzanian I-O Table consists of 79*79 sectors. Unfortunately, there is no sector for LBT although Tanzania has been operating LBT since 1992 to date. This analysis therefore assumes that LBT is included in the construction sector even if the estimation of economic impact cannot be done by conducting "pure" LBT instead of covering the whole construction sector.. Thus, this analysis does not totally ignore LBT application in ETB and other work methods.

A key assumption is that final demand of construction sector would be increased by the Government of Tanzania increasing investment in the sector through the Road Fund. Input-Output Table (I-O Table) is a matrix representation of a nation's or a region's economy to predict the effect of changes in one sector on others including consumers, government and foreign suppliers. I-O Table was used to estimate economic impact on domestic economy of Tanzania by local road construction. We used 1992 I-O Table for the estimation. Actually, 1998 I-O Table exists, but it was not possible to be availed a copy. . As shown in Table 1 and Figure 1, Tanzanian nominal GDP in 2005 is over 10 times larger than in 1992. Even though it is not real GSP, it indicates rapid economic growth of Tanzania which may dramatically change its economic structure. Thus, it should be noticed that this analysis would not be an accurate estimation of current economic impact of local road construction of Tanzania.

Table 1 Trend of Nominal GDP in Tanzania (1985-2005)

Year	Nominal GDP (Million Tshs)	Year	Nominal GDP (Million Tshs)
1985	167,768	1995	2,796,640
1986	227,310	1996	3,452,590
1987	302,063	1997	4,281,600
1988	468,098	1998	5,126,177
1989	582,163	1999	5,977,699
1990	760,006	2000	6,705,134
1991	989,593	2001	7,624,616
1992	1,275,976	2002	8,699,887
1993	1,607,762	2003	9,816,319
1994	2,125,325	2004	11,331,638
		2005	13,063,317



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Source: Board of External Trade (2008) and OECD (1999)

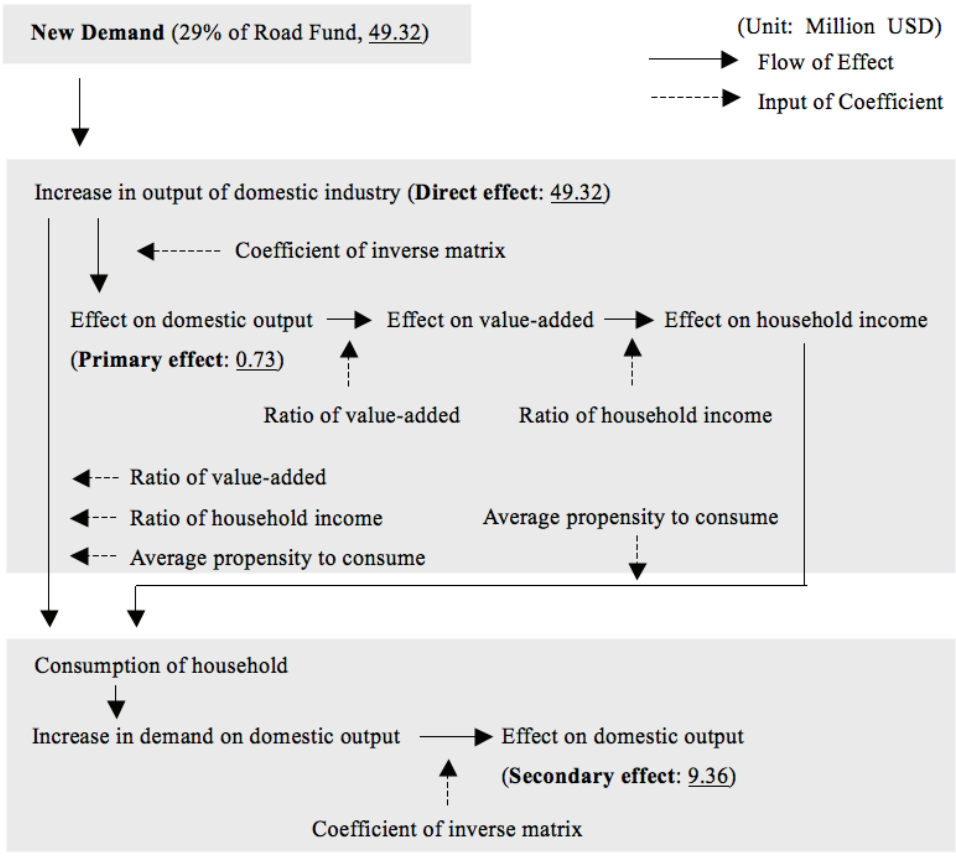
Figure 1 Trend of Nominal GDP in Tanzania (1985-2005)

2.2 Flow of Economic Effects

In order to estimate economic impact of investing Tanzania road fund into construction sector (including LBT application), several numerical values such as input coefficient (input needed for unit output) and coefficient of inverse matrix are required for the calculation process. Procedure and flow of economic impact are depicted in the Figure 2. Firstly, 49.32 Million USD (29% of road fund as investment for LBT, 2007/08 fiscal year) has been allocated for the construction sector. This would be estimated as new demand and considered as direct effect. Posterior to inputting new investment (demand), new production of each sector would expectedly be induced in order to satisfy the new demand. This is the first effect of the economic impact of local road construction, and summation of new investment is regarded as primary effect.

As production of each sector is increased, household income of each sector would also be increased accordingly. Consequently, household consumption will be increased. In order to estimate these effects, several numerical values such as the rate of value-added and household income are calculated by I-O Table. Increase in household consumption can be calculated by using average propensity to consume, which is a coefficient of how much income per person is spent for his/her consumption.

Final output would be the increase of household consumption induced by direct effect and primary effect. Whole domestic consumption is stimulated by household consumption and intermediate goods. As a result, final output on each sector would be increased. This is the concept of secondary effect, or sometimes called the multiplier effect. Finally, summation of direct effect, primary effect and secondary effect are obtained. This is the economic impact of construction sector. Economic effect may continue like the effect of tertiary, quaternary, etc., however, this paper analyzes till secondary effect. In general I-O analysis, third or fourth effect is not estimated due to several reasons, for example, unknown period of economic effect (Fujikawa, 2005).

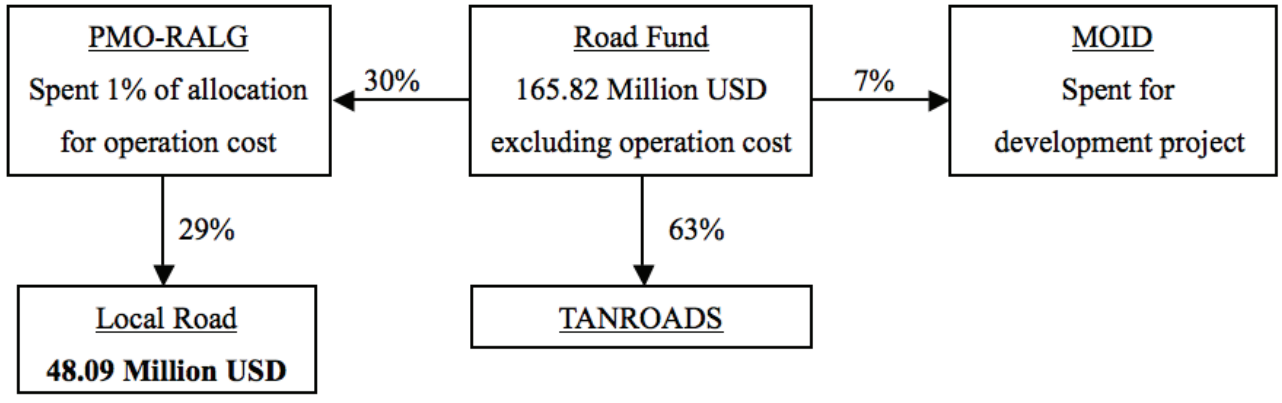


Note: 1 Tanzania Shilling=0.000759USD, 1 USD=1,317.5 Tanzania Shilling (October, 2009).

Figure 2 Flow of Economic Effect

2.3 Direct Effect

In this paper, direct effect is exactly the same value as investment of road fund since final demand is increased by initial investment in construction sector. Investment in construction sector is determined based on the budget allocation system in the fiscal year of 2007/08. 30% (i.e. 49.75Milion USD) of road fund (165.82 Million USD) is firstly allocated to Prime Minister's Office Regional Administration and Local Government (PMO-RALG). After PMO-RALG spends 1% of the transferred portion of the road fund for their overhead cost, the remaining 29% (49.32 Million USD) has been allocated to the local road construction (including the application of LBT), rehabilitation and maintenance. Direct impact therefore would be 49.32 Million USD which is appropriate for construction sector as final demand.



MOID: Ministry of Infrastructure Development

TANROADS: Tanzania National Roads Agency

Source: JICA (2008)

Figure 3 Allocation of Road Fund in Tanzania (2007/08)

2.4 Primary and Secondary Effect

In general, economic effect resulted from estimating I-O Table is the estimation of outputs of a given sector which are produced for meeting the final demand of each sector (demand-oriented analysis). In this analysis, change in the final demand is the initial investment being 49.32 Million USD in construction sector. Primary effect is the effect on each sector when final demand of construction sector increases. As final demand on construction sector increases, output of each sector would be induced and finally changed. Moreover, as demand in domestic production expands, quantity of import also expands. In case demand increases in domestic economy, import also increases in some sectors. To estimate correct GDP as the economic effect, we need to internalize import in I-O analysis.

The primary effect was estimated to be 0.73 Million USD by following procedure depicted in Figure 2. Assuming import is regarded as an exogenous variable, 69.04 Million USD is obtained as primary effect. The gap between with and without internalizing import is 68.31 Million USD which is even larger than direct effect. This result implies that the economic structure of Tanzania is similar to a typical Least Developed Country (LDC), which highly relies on import in the domestic economic activities. However, in actual LBT project, most activities such as employment, material procurement and household consumption can normally be done in the local area. Therefore, import effect would be somewhat lower than estimated value.

Secondary effect can be obtained by internalizing household consumption. As final output is increased, household income would be increased proportionally, moreover, increase in household consumption would be induced by increase in household income. Following the procedure of Figure 2, 9.36 Million USD in the whole sectors has been estimated as secondary effect.

2.5 Summary of Economic Effect

From all above estimation, 59.41 (= 49.32+0.73+9.36) Million USD has been estimated as total economic impact of local road construction. In general, construction sector is the most expected sector in terms of economic impact per unit input; however, total multiplier effect remains only 10.09 (= 0.73+9.36) Million USD whereas investment is 49.32 Million USD. This result seems to be somewhat lower but further discussion is not possible since there is no comparable case. However, Tanzanian economic structure in 1992 was excess in import. This might be one of the reasons to support this result.

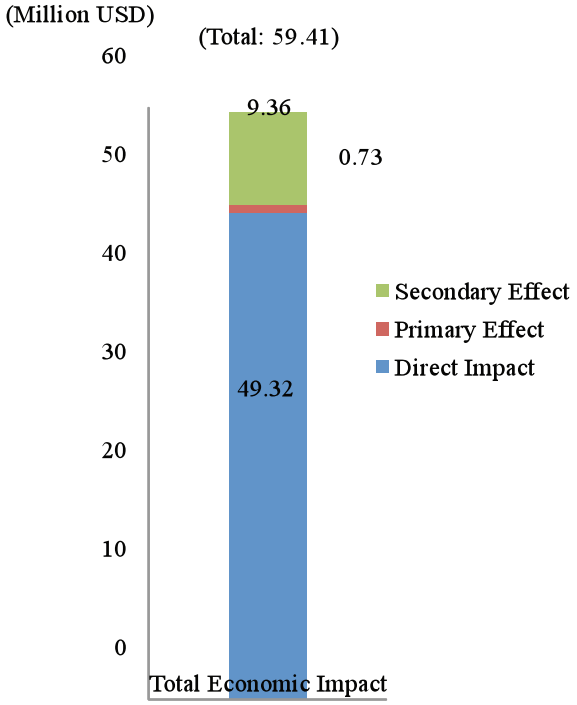


Figure 4 Total Economic Impact by Local Road Construction

2.6 Effect on Employment Creation

In this section, number of employment newly created by increase in output of each sector is estimated as the effect of employment creation by local road construction including LBT. Although there is a variety of labour such as skilled and unskilled labour, this analysis assumed them as the same attributes for the estimation purpose. The relationship between number of employment and output is not always linear; however, this analysis assumes that this relation is linear as general I-O analysis does (Fujikawa, 2005). The number of employment is estimated from Social Accounting Matrix (SAM) in 2000, which is comprised of 43*43 sectors. In SAM used for this analysis, labour are divided into 9 groups as shown in Table 2.

1992 I-O Table structured of 43*43 sectors is used for employment creation analysis in order to correspond to SAM that is also consisting of 43*43 sectors. Estimation for employment creation needs Labour Input Coefficient (LIC). The definition of LIC is input labour per unit output. Employment creation induced by increase in output can be estimated by multiplying LIC with increase in output by economic effect estimated in the section 2.5. According to the result of estimation, 52,687 labours are newly created in the whole sectors in Tanzania and 34,328 labours in the construction sector. The breakdown of employment creation subdivided by the labour attributes in the construction sector is as follows;

Table 2 Employment Creation by Conducting LBT

o Progress on site which included the contractor's ability to take instructions, continuous improvement compared to the previous assessment and time spent on site.

The panel graded each contractor according to poor, fair, good and excellent. The panel agreed that a candidate would scores say ¾ (3 being scored as poor, fair, good, excellent in three categories out of 4 categories, then the candidate is poor, good, fair, excellent). Any scores in between would be extrapolated and the panel would agree on the nearest score.

(a) A standard reporting template that was issued in terms of Eastern Cape Treasury Notice 38 of 2004 was adhered to in the monthly monitoring of the projects. Monitoring included two site meetings per month and a monitoring meeting on a monthly basis. The Consultants reported as per the template on progress regarding budget/expenditure, Time, Quality and socio-economic aspects including employment regarding both the gender/youth, training on HIV/AIDS and Occupational Health issues, progress on EPWP contractors, and placement of FET College and University students on a monthly basis. The prescribed templates were such that both the Consultants and Contractors had their own reports with the Contractors submitting names of people employed and trained including wage rate per day, age, gender and disabled. The Consultants reported on numbers employed, trained and placed students in addition to Time, cost and quality. These reports were monitored, evaluated and acted upon by the panel.

1 RESULTS OF THE METHODOLOGY ADOPTED IN THE PAPER

1.1 Placement of FET College Students and Professionals

After a period of about three years, the results of DPW placed students are shown in Table 3 as follows:-

Labours	Number of Labours Created
Child Labour Age 10 to 14	98
Female Labour with Non Formal Education	31
Female Labour Non Finished Primary School	0
Female Labour Non Finished Secondary School	166
Female Labour Secondary or Higher Education	349
Male Labour with Non Formal Education	682
Male Labour Non Finished Primary School	3,726
Male Labour Non Finished Secondary School	23,442
Male Labour Secondary or Higher Education	5,834
Total	34,328

The employment creation according to Ministry of Works (MOW) (2003) in 1988 estimation, which is currently widely used as an indicator of LBT employment creation in Tanzania, is shown in Table 3 as a comparison. In fact, following table is somewhat overestimated since trunk road is also included in the estimation of employment creation. A target road of LBT is normally feeder road, not trunk road.

Table 3 Employment Creation Estimated by MOW

	Type of Road			Total
	Trunk & Rural	District	Unclassified	
Routine Maintenance	9,500	9,700	12,800	32,000
Periodic Maintenance	4,700	5,500	6,800	17,000
Rehabilitation	5,200	9,300	11,600	26,100
Total	19,400	24,000	31,200	75,100

Source: MOW (2003)

It should be noticed that LIC of LBT is normally higher than general road construction (e.g. EBT). In this case, if employment creation is estimated only in LBT sector (which sector does not exist); number of employment creation would be much higher than estimated value.

2.7 Labour-base or Labour-intensive

According to the report of ILO (1999b), terminology of "Labour-base" and "Labour-intensive" are differently defined as follows;
(a) Labour-base: Optimum use of labour
Flexible and optimum use is made of labour as the predominant resource where cost-effective and quality aspects are ensured.
(b) Labour-intensive: Maximum use of labour
Labour is the dominant resource, preferred to be efficient where income generation and job creations are principal.

LIC should be decreased for the efficient use of our valuable resources, which are not only labour but also capital and equipments. In this case, number of employment may also decrease. Maximizing use of labour is not a final goal. It must also achieve economical efficiency. Therefore, it is highly required to estimate an optimum use of labour under the conditions of project duration, scale of roads, traffic volume, topographical conditions, etc.

3. Cost Comparison between LBT and EBT

3.1 Cost Comparison

Cost comparison between LBT and EBT was attempted by using five project data. Among each data, there are plenty of differences such as construction period, year, season, location and so on. Cost of road construction is normally determined by several factors such as condition of construction site and easiness of haulage for material, regardless of LBT or EBT. Hence, this analysis cannot be a universal cost comparison between LBT and EBT. According to ILO (1999a), in the LBT, geographic condition affects cost of road construction the most.

(1) Survey data (Tanzania)

Cost data of Tanzania (survey-based data) had been collected by author's interview survey on several LBT projects in Tanzania in the year of 2008. Each value in Table 4 takes average of several projects. The type of construction is full road rehabilitation. "Full" requires the work of Hauling of gravel; on the other hand, "spot" does not. Spot rehabilitation is applied for relatively small part of road mainly at swampy and steep slope area. Full rehabilitation means whole section of road. Unit cost structure of LBT and EBT is shown in Table 4. All data is collected by Tanzania Shilling. However, for the purpose of comparing with other cases (Uganda and Cambodia), they are shown in United States Dollar (USD) using exchange rate as of October, 2008 in Tanzania case (survey data).

Table 4 Unit Road Construction Cost of LBT and EBT (USD/ km)

	LBT					EBT					
	Equip-ment	Fuel	Unskilled Labour	Material, Others	Subtotal	Equip-ment	Fuel	Labour		Material, Others	Subtotal
								Skilled	Unskilled		
Setting out	-	-	32.68	-	32.68	-	-	-	32.68	-	32.68
Bush clearing	-	-	215.00	-	215.00	404.20	359.48	25.80	32.68	-	822.16
Striping & grubbing	-	-	244.24	-	244.24	202.10	179.74	25.80	6.60	-	414.24
Stump removal	-	-	165.12	-	165.12	202.10	179.74	25.80	6.60	-	414.24
Ditching	-	-	924.50	-	924.50	193.50	147.06	25.80	-	-	366.36
Spreading	-	-	135.02	-	135.02	193.50	147.06	25.80	6.60	-	372.96
1st Compaction	94.60	98.04	32.68	-	225.32	180.60	182.32	25.80	-	-	388.72
Inner slope	-	-	924.50	-	924.50	193.50	147.06	25.80	-	-	366.36
Back slope	-	-	386.14	-	386.14	193.50	147.06	25.80	-	-	366.36
Camber formation	-	-	132.44	-	132.44	193.50	147.06	25.80	6.60	-	372.96
2nd Compaction	94.60	98.04	32.68	-	225.32	180.60	182.32	25.80	-	-	388.72
Mitre Drain	-	-	32.68	-	32.68	193.50	147.06	25.80	-	-	366.36
Culvert laying	-	-	66.22	-	66.22	-	-	-	66.05	-	66.05
Excavation of gravel	-	-	1,595.30	-	1,595.30	323.36	287.24	25.80	3.27	-	639.67
Loading of gravel	825.60	1,176.48	1,033.72	-	3,035.80	1,118.00	1,895.44	283.80	3.27	-	3,300.51
Hauling of gravel (Dump truck)	-	-	-	-	-	-	-	-	3.27	-	3.27
Spreading of gravel	-	-	135.02	-	135.02	193.50	147.06	25.80	3.27	-	369.63
Watering	326.80	392.16	-	-	718.96	172.00	261.44	51.60	-	-	485.04
Compaction	94.60	98.04	52.46	-	245.10	516.00	522.88	51.60	-	-	1,090.48
Subtotal	1,436.20 (13.5%)	1,862.76 (17.5%)	6,140.40 (57.5%)	1,228.08 (11.5%)		4,653.46 (38.3%)	5,080.02 (41.8%)	722.40 (5.9%)	170.89 (1.4%)	1,535.96 (12.6%)	
Total	10,667.44					12,162.73					

1 Tanzania Shilling=0.000860USD, 1 USD=1,162.79 Tanzania Shilling. (2008)

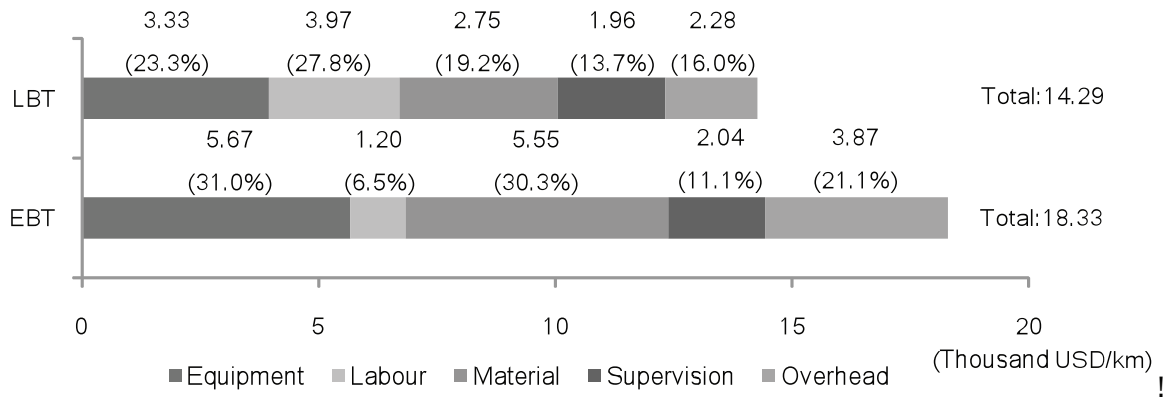
In EBT construction, labour cost is classified into two; skilled labour and unskilled labour. Skilled labour has skill to operate specific equipment (generally, large-size equipment). Skilled labour that is in charge of operation of specific equipment is given daily allowance in addition to normal salary. In Table 4, salary of unskilled labour is approximately 3 USD/km while skilled labour is 26 USD/km which is summation of normal salary and allowance. Although LBT requires equipment for each construction process; they are all handy equipments that are operable even by unskilled labour.

The labour cost of LBT is only for unskilled labour which amount is 6,140 USD/km (58% of all construction cost). This accounts for more than half of total construction cost. On the other hand, in EBT, 893.29 USD/km is paid for unskilled labour cost; this accounts for only 7% of total construction cost. As for equipment cost including fuel cost, LBT is 31% and EBT is 80% of total cost. The unit cost of LBT is 1,495 USD/km lower comparing that of EBT. In summary, it is revealed that LBT is 14% comparatively low in cost.

Loading of gravel is the most costly process for both LBT and EBT. Since 10 skilled labours for dump truck operation are needed for EBT, loading gravel alone accounts for 10 times the cost of the rest of each of the processes of EBT which needs 1 skilled labour in most cases. On the other hand, in LBT construction, excavation of gravel requires 483 labour that is highest in the whole process. Loading of gravel and work for slope also needs no few labour. In the entire working process, LBT requires 1,860 and EBT 80 (skilled and unskilled) labour. Considering all above facts, the obvious effect on employment creation can be observed.

(2) Literature Data (Tanzania, Uganda and Cambodia)

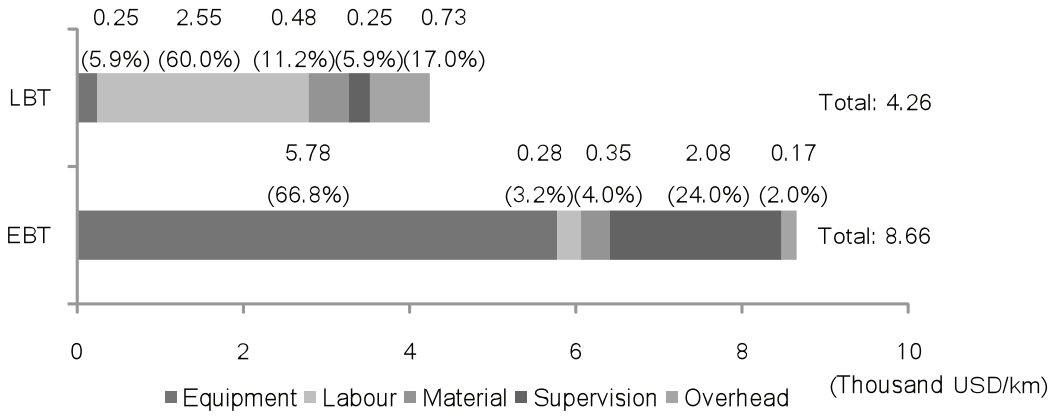
Here in the literature data, unit road construction cost of LBT and EBT is compared by using four cases from Tanzania, Uganda (spot and full) and Cambodia. Figure 5 shows cost structure of Tanzanian case (MOW, 2003). Target roads are 10 for LBT and 3 for EBT, respectively. The construction year is mostly from 2002 till 2003. Thus the exchange rate for conversion to USD is used year 2002. The form of construction is rehabilitation, with full construction in eight cases for LBT and spot in two cases. As for EBT, all three cases are full construction project. The unit cost of LBT and EBT is 14.29 thousand USD/km and 18.33 thousand USD/km, respectively. The total cost of LBT is 4 thousand USD lower than that of EBT. In EBT, equipment cost occupies 31 % (5.67 thousand USD/km) of total cost, on the other hand, that of LBT is 23% (3.33 thousand USD/km). Regarding labour cost, LBT is 2.77 thousand (=3.97-1.20) USD/km higher than EBT. The unit labour cost is unknown as number of labour is unknown. In addition, it was not possible to distinguish between unskilled and skilled labour.

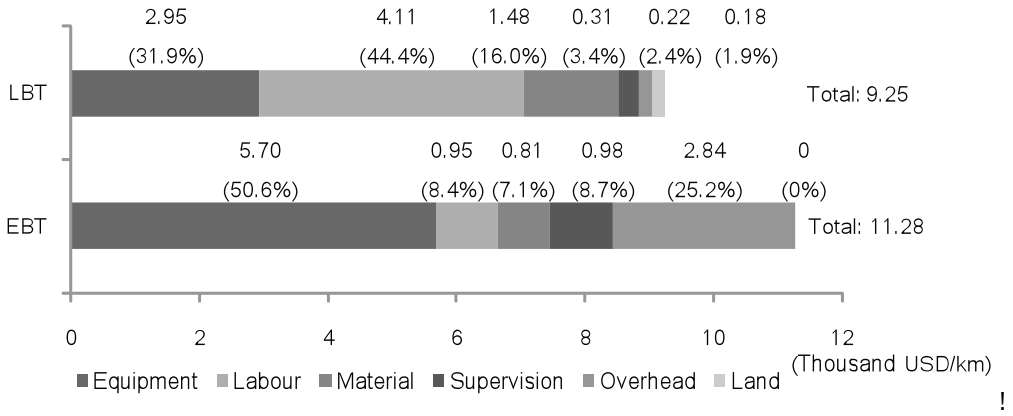


1 Tanzania Shilling=0.001343USD, 1USD=744.76 Tanzania Shilling. (2000)

Figure 5 Cost Structure of LBT and EBT in Tanzania

The cost structures of Uganda case for both full and spot construction are shown in Figure 6 (ILO, 1999a). The form of construction is rehabilitation. In the case of EBT, there is slight difference between LBT and EBT in terms of total cost, however, in the LBT case, total cost of spot rehabilitation is approximately half the amount of EBT. Target area of spot rehabilitation is swampy and steep slope area. This gives advantage for LBT in term of cost. As for labour cost, spot construction of LBT is 60.0%, EBT is 3.2%, full construction of LBT is 44.4%, EBT is 8.4%. For equipment cost, spot construction of LBT is 5.9%, EBT is 66.8%, full construction of LBT is 31.9%, EBT is 50.6%. LBT cost of spot rehabilitation is prominently low. According to ILO (1999a), the number of labour for EBT construction is 459 per one km, whereas LBT requires 1,374-2,027 labour for one km road construction.





1 Uganda Shilling=0.0008889USD, 1USD=1,125.00 Uganda Shilling. (1997)

FIGURE 6 COST STRUCTURE OF LBT AND EBT IN UGANDA (ABOVE: SPOT, BELOW: FULL)

Lastly, the cost structure of Cambodian case is shown in Figure 7 (Munters, 2003). In this report, all costs are indicated in USD, conversion to USD using exchange rate was not done. LBT was conducted by Asian Development Bank (ADB) (in 6 regions) and ILO (in 2 regions). Equipment cost of EBT exceeds 70% which is quite high. On the other hand, the labour cost of LBT accounts for 49% (summation of unskilled and skilled labour). Unskilled labour is required at approximately 5,000 labour/km for LBT and 200 labour/km for EBT. Total cost of LBT (14.07 thousand USD/km) is approximately 3.3 thousand USD/km less that of EBT (17.34 thousand USD/km).

Figure 7 Cost Structure of LBT and EBT in Cambodia

3.2 Summary of Cost Comparison

In this section, cost comparison between LBT and EBT was attempted by summarizing labour and equipment cost of five cases; (i) Survey data of Tanzania, (ii) literature data of Tanzania, (iii) spot rehabilitation in Uganda, (iv) full rehabilitation in Uganda and (v) Cambodian case.

From Figure 8, it can be observed that the percentage of labour cost of total cost is 3-9% for EBT cases whereas LBT accounts for 28-60%, which is much higher than EBT. In the case of Tanzanian literature data, two spot constructions are included in LBT data. In the case of Uganda, equipment cost of spot construction is much lower compared with full construction. Considering all above cost comparison, there is clear cost advantage of LBT over the EBT.

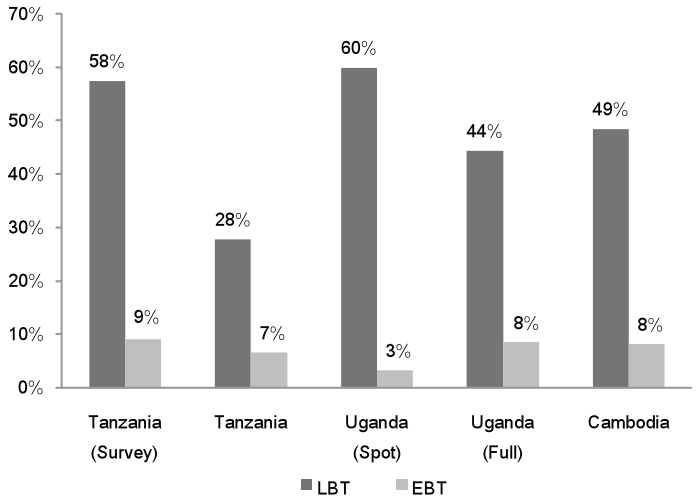


Figure 8 Comparison of Percentage for Labour Cost between LBT and EBT

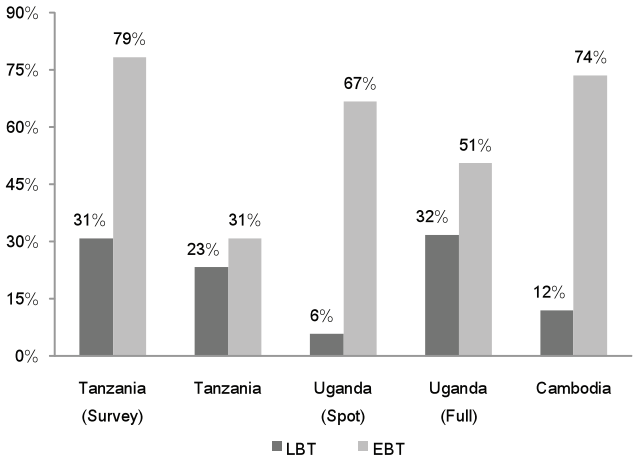


Figure 9 Comparison of Percentage for Equipment Cost between LBT and EBT

4. Conclusion

This paper has discussed the advantages of LBT from two aspects; one is its economic impact to Tanzanian economy and the other is cost superiority over the EBT construction. Even though economic impact is estimated for the whole construction sector due to the limitation of I-O Table, the result can be one of the important references for observing economic impact of LBT. Additionally, employment creation by LBT implementation was calculated by using SAM. Normally, LBT is applicable for relatively "small" roads like feeder road. Cost comparison was done using five cases from three countries. It is revealed that unit construction cost of LBT is approximately 3-4 thousand USD/km lower than that of EBT.

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