ENGINEERING-ERGONOMICS VERSUS SOCIO-ECONOMICS: A CASE STUDY OF THE TOLL ROAD BALI MANDARA INDONESIA

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ABSTRACT: This study was conducted to determine why ergonomics is very difficult to implement in developing countries like Indonesia. Achieving a better life is a central goal of ergonomics. With this in mind, ergonomics has been well implemented in developed countries. Unfortunately the same is not necessarily true in developing countries such as Indonesia. Referring to Maslow's Hierarchy of Needs, most people find themselves still in the section on physiological needs of human survival. Security and comfort are often ignored in order to meet the basic needs. Such conditions can be encountered on Jalan Bypass Ngurah Rai, Bali - Indonesia. This research showed that the majority of people prefer to go through congestion streets in order to ensure their basic needs can be satisfied, although there is a Toll Road Bali Mandara (TRBM) designed which considers engineering ergonomic and provides a security, comfort, and productive trip. According to population growth and an increase in the number of vehicles, traffic congestion levels are also higher. As a result, the number of accidents has also increased. Previous research showed that the highest accident rates in Denpasar occurred at Jalan Bypass Ngurah Rai. The highest type of vehicles involved in the accidents was a motorcycle. This proves that an ergonomic toll road design, which provides safe and convenient traffic and infrastructure, has not been able to attract people to use it because of socio-economic (monetary) constraints.

Keywords: Engineering-ergonomics, Socio-economics, Toll road Bali Mandara.

1. INTRODUCTION

Achieving a better life is a central goal of ergonomics; with this in mind, ergonomics has been well implemented in developed countries. Unfortunately the same is not necessarily true in developing countries such as Indonesia. Referring to Maslow's Hierarchy of Needs [1], most people find themselves still in the physiological needs of human survival. Security and comfort are often ignored in order to meet basic needs. This condition is in accordance with the economic level of the majority of the population in Indonesia. The World Bank [2] reported that approximately 68 million people in Indonesia remain vulnerable to falling into poverty. Their income is only slightly higher than the poor families. Furthermore, poverty reduction in Indonesia continued to slow, the rate of decline is only 0.7 percent for the years 2012 to 2013 - the smallest rate of decline in the last decade. Inequality has also increased in recent years, potentially disrupting social cohesion and hence jeopardizing the gains from solid economic growth, which has helped to reduce the poverty rate to 11.3% in 2014, compared to 24% in 1999. This makes the poor even more difficult to get out of poverty. Of course, this condition becomes an obstacle for purposes of applying ergonomics to create a better life. Moreover, the government's effort in improving the welfare of society is still very weak. One indicator that can be seen is the lack of public transport system, included in Bali Province, the most well known Tourism Island. The lack of availability of a safe and comfortable public transportation makes people to have their own vehicle, at least a motorcycle.

Bali provincial statistics bureau [3] reported that the total population in the province of Bali in 2013 was 4,056,300 people, while the total number of vehicles was 3,003,688 (74.05%). The number of vehicles was dominated by the motorcycles, which achieved about 2,586,715 motorcycles, or about 86.12% of total vehicles. Based on the mode of transport in the province of Bali, the pattern of movement of people concentrated in strategic areas Sarbagita (Denpasar, Badung, Gianyar and Tabanan), and the highest density of transportation is in Denpasar regency. It is showed by the number of vehicles in Denpasar regency which is achieved the number of 1,260,286 vehicles or about 41.96% of total vehicles in Bali. It followed by Badung regency for 381,122 or about 12.69%, Gianyar

regency was 314,527 or about 10.47%, and Tabanan regency was 305,838 or about 10.18%, and the rest (24.70%) spreading in 5 other regencies (Buleleng, Karangasem, Jembrana, Bangli, and Klungkung). In contrast, the total length of roads in the city of Denpasar is only 656.52 km or 8.37% of the total length of roads in the province of Bali, which is 7843.98 km. Therefore, the highest vehicle density is in Denpasar and the traffic congestion becomes an everyday sight in Denpasar. As a result, the number of traffic accidents is also high. In proportion to the type of vehicles that pass through this road, the highest type of vehicles involved in the accidents was a motorcycle. Wedasana [4] reported that the highest accident rates in Denpasar occurred at Jalan Bypass Ngurah Rai. The length of Jalan Bypass Ngurah Rai is 16,466 Km and the black spot was at stationing 7-8 km (Between Tohpati and Pesanggaran). Jalan Bypass Ngurah Rai is a road that connects some tourist areas located in Denpasar and Badung. In line with the growth of the tourism industry in the region, the level of traffic congestion along Jalan Bypass Ngurah Rai also increased dramatically so that the stagnation of traffic going on throughout the day, especially at peak hours, ie in the morning (07:00 to 10:00 am) and afternoon (4:00 to 7:00 pm).

Based on those data, the Indonesian government has built Toll Road Bali Mandara (TRBM). The road is a shortcut that connects several strategic areas in Denpasar with a strategic region in Badung regencies. This TRBM is the only Toll road in Indonesia that comprised motorcycle lanes. The main goal of this TRBM project was to reduce the traffic jam along Jalan Bypass Ngurah Rai, especially between Pesanggaran and Nusa Dua. It designed based on engineering ergonomics, which provides the security, comfort, and productive trip. Unfortunately, the President Director of TRBM reported that the TRBM management could not achieve the goals of its business plan as well as the targets it had set during the first year operation (achievement was ± 7% below the target). TRBM has been operating since October 2013. Until March 2014, the number of vehicles passing through the toll road has reached 6.2 million vehicles, but only around 93% of the target. On the other hand, investments of the TRBM expected to unravel congestion along the road by pass Ngurah Rai. But after 10 months of operation, still appear to have a relatively high congestion, especially on roads between intersections Pesanggaran up to the intersection of Udayana University. From these indicators, it appears that the achievement of development targets Toll Road Bali Mandara is not optimal. This proves that most people consider physical needs remains a priority than the safety

and comfort. Of course, there are important reasons why this happens. This research was conducted to identify the socio-economic problems in the implementation of ergonomics in the TRBM project.

2. MATERIAL AND METHOD

It is a case study at Toll Road Bali Mandara (TRBM) Bali – Indonesia that conducted through the Quantitative Descriptive analysis [5]. The engineering analysis was conducted to evaluate the geometrics, traffics counting, Original Destination, Trip Duration and speed, and V/C ratio; the Ergonomics analyses were conducted on traffics sign and pavement marking; and the socio-economics analysis was conducted through questionnaire with 595 respondents, focused on the proportion of salary and transportation budget.

The respondents were the roads user who works in the three zones around TRBM transportation system as shown in Fig. 1.
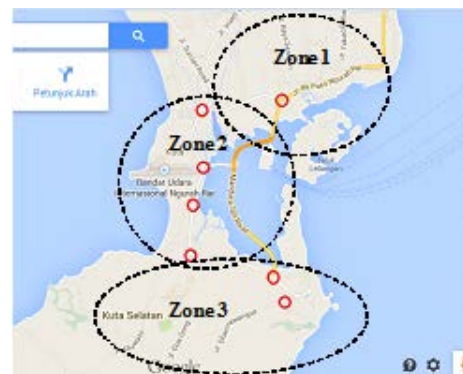

Fig. 1. Three Zones of respondents

Zone 1: Pesanggaran-Dewa Ruci
Zone 2: Dewa Ruci-Ngurah Rai Airport
Zone 3: Ngurah Rai Airport-Nusa Dua

The number of respondents is set with reference to the Sekaran [6]. The respondents were divided into three zones, between the Pesanggaran-Dewa Ruci as zone 1 (around Benoa gate TRBM), Dewa Ruci-Ngurah Rai Airport as zone 2 (around gate Ngurah Rai TRBM) and Ngurah Rai Airport-Nusa Dua as zone 3 (around gate Nusa Dua TRBM). The proportion of respondents in each zone were set based on the result of traffic counting which has conducted in 7 points that influence on TRBM road system as shown in Fig. 2.

The questionnaire consisted of several groups question, the profile of respondents, characteristic of respondent travel, TRBM user perception on motivation, smoothness, security, safety, and satisfaction.
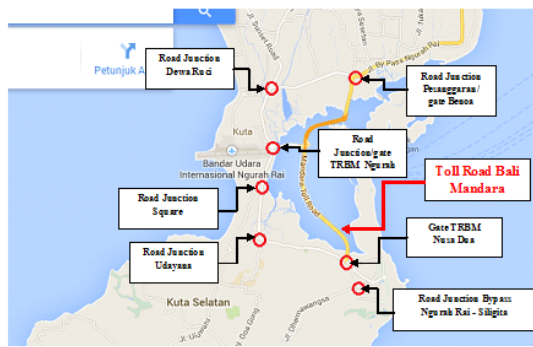
Fig. 2. The Location of Traffic Counting

3. RESULT

3.1 Toll Road Bali Mandara (TRBM)

TRBM is the first toll road in Bali. It is the only highway that is built on the sea and provides special lanes for motorcycles. It relatively short construction period of 14 months. The toll road has started its commercial operation on October 1, 2013. It connects the golden triangle area of Bali tourism, Benoa Harbor, Ngurah Rai Airport, and Nusa Dua, with a total length of roads is 12.7 km (including access roads) as shown in Fig. 3.

Fig. 3. The Map of Bali Mandara Toll Road

Total investment costs are about 2.4 trillion with the main goal is to reduce the high levels of congestion along the Bypass Ngurah Rai and surrounding areas, so that the safety and comfort of road users, especially for tourists and people who work day-to-day activities in the region can be assured.

3.2 Traffic Counting Analysis

Traffics counting analysis showed the variation of traffic from 07.00 am to 07.00 pm (12 hours) for each road in TRBM system. It also showed that the highest traffic volume is Ngurah Rai Bypass road segment from the intersection Dewa Ruci - Ngurah Rai Airport with traffic volume about 109,690 Passenger Car Unit (PCU)/day, while the volume of traffic intersections Ngurah Rai Airport - Dewa Ruci 86,433 PCU/day. In addition, the

peak hour volume (PHV) in all TRBM gate generally happened at about 07.30 – 09.30 am (morning PHV), 01.45 – 02.00 pm, and 04.00 – 06.45 pm (afternoon PHV). The compositions of the traffic flows were dominated by motorcycles (64%), and then followed by cars, taxies, pick-up, microbus, and bus (35%), and the rest were heavy vehicles (1%) as shown in Fig. 4 and Fig. 5.
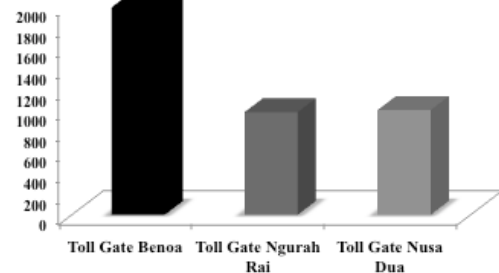

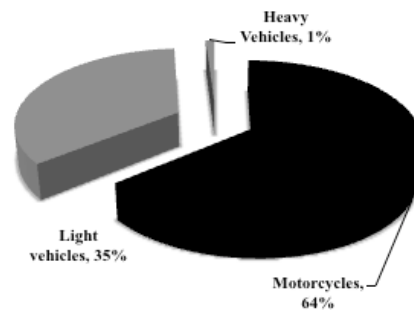Fig. 4. The Peak Hour Volume at Toll Gate

Fig. 5. The composition of the Traffic Flow

The PHV volume was between 1,047.45-8,621.6 PCU/hour. The travel speed on existing road Jalan Ngurah Rai - Nusa Dua between 30-40 km/hour with a travel time range between 10-30 minutes, while travel speed toll roads Bali Mandara between 70-80 km/hour with a travel time ranges from 5 - 9 minutes. The general level of service on roads Ngurah Rai - Nusa Dua is in the section between category C and F while the road section between Ngurah Rai Airport - Dewa Ruci is at the service level F with the Volume to Capacity (V/C) were in a very bad category (>1). Conversely, the V/C ratio of the TRBM was in a very good category (<0.6). This indicates that the existing traffic load has exceeded the capacity of roads, causes high delay, traffic congestion, the inconvenience of travel and finally lead to the decreasing of the productivity. The existence of new toll roads Bali Mandara expected to increase existing service roads due to the partial flow of traffic through the toll road.

3.3 Ergonomics Analysis

Ergonomics analysis on the Bali Mandara Toll

Road was focused on the road signs and pavement marks. Data showed that road signs and pavement marks referred to Federal Highway Administration Standards which considers ergonomic aspects as shown in Fig. 6-7.
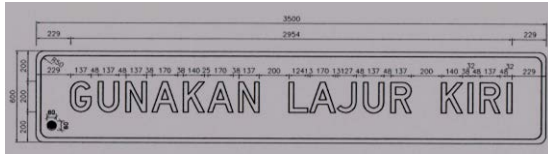

Fig. 6 Dimension of one line Road Sign due to FHWA 1977
Resource: TRBM Management

Fig. 7 Dimension of two line Road Sign due to FHWA 1977
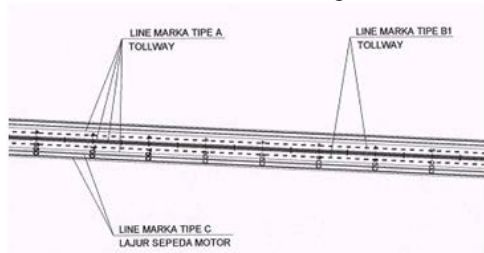Resource: TRBM Management

Fig. 8 Pavements Marking due to FHWA 1977
Resource: TRBM Management

Ergonomics analyses showed that the shapes, colors, dimensions, and placements of all road sign and pavement markings were designed ergonomically. The white letters or symbols of road signs with the green color of background make a contrast but not glare. It is easy to read from the distance of about 30 m clearly, as well as the pavement markings.

3.4. Socio-economics Analysis

The assessment of socio-economics aspect was conducted by distributing the questionnaire to the 595 of the subject in the three angle of the area that influences the TRBM transport system.

3.4.1. Respondents Characteristic

Respondent's characteristic was described as shown in Table 1.
Table 1. Shows that the participants consisted of 366 male (61.52%) and 229 female (38.48%). The majority of participants work at private sectors

(60.17%), students (22.52%), state employees (5.38%), and others (11.93%). The percentage of respondents who have a salary of more than 7.5 million IDR was 8.67%; between 2.5 and 7.5 million IDR was 29.92%; and less than 2.5 million IDR was 62.02%.

Table 1. Respondent's characteristic

		Zone 1	Zone 2	Zone 3	Total
Number of Respondents	Male	130	122	114	595
	Female	88	87	54	
Ages (years old)	≤ 25	106	94	88	595
	≤ 35	48	56	35	
	> 35	64	59	45	
Occupational	SE	18	9	5	595
	PE	129	122	107	
	Students	52	45	37	
	Others	19	33	19	
Salary/ Month (IDR)	< 2,500,000	137	128	104	595
	< 7,500,000	69	68	41	
	≥ 7,500,000	12	13	23	

3.4.2. Original Destination (OD) Survey

Majority of respondents leaves at Badung Regency (337 respondents or about 56.64%), 222 (37.31%) at Denpasar regency, 29 (4.87%) at Gianyar, and 1.17% at Tabanan Regency. Most of the respondents from SARBAGITA go to Nusa Dua (37.31%), Udayana University (24.70%), Kuta/Tuban (13.27%), Benoa (6.55%), Dewa Ruci junction (2.18%), and others (15.97%).

3.4.3. Transportation budget allocation

Table 2 shows that the highest frequency of travel was more than 3 times a week (54.78%), followed by 1 to 3 times a week (35.65%), and the rest was once a week only. Most of the respondents went to this triangle of the region were for tourism (38.78%), working (36.98%), and business (12.57%). Between Pesanggaran (gate Benoa TRBM) and Nusa Dua. It was in accordance with the characteristic of the area, which is mostly for tourism industries. Furthermore, there are three higher educations (Bali State Polytechnic, Udayana University, and Institute Of Tourism). Therefore, some of the respondents went through this region for studying. In line with the monthly incomes, table 2 also

shows that only 8.5% of respondents allocated transportation budget more than 500,000 IDR/month that is in line with the respondents who have a salary of more than 7.5 million IDR (8.67%-table 1). The majority of respondents allocated the transportation budget less than 200,000 IDR/month (58.41%), and others were between 200,000-500,000 IDR/month (33.09%). As the consequences, only 34.55% of respondents could meet the TRBM fee with the salary more than 2,5 million/month (38.59%).

Table 2 Trip Characteristics

	Zone 1	Zone 2	Zone 3	Proportion (%)
Frequency of travel				
> 3 times/ week	93	80	79	54.78
2 - 3 times/ week	46	76	42	35.65
≤ 1 time/ week	19	24	1	9.57
Intent trip				
Studying	31	22	12	11.67
Working	77	75	54	36.98
Business	24	21	25	12.57
Social/ tourism	75	76	65	38.78
Transport budget IDR/month				
≤ 200,000	124	124	75	58.41
200,000-500,000	61	65	57	33.09
> 500,000	20	18	9	8.50
Routine use TRBM				
≥ 3 times /week	48	35	115	34.55
1-3 times /week	38	31	40	19.02
Sometimes	122	127	11	45.38
Never	3	3	0	1.05

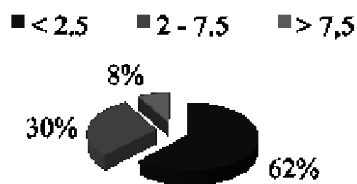The salaries, transportation budget, and the use of TRBM are shown in Fig. 8-10.

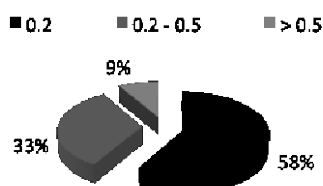Fig. 8 Salary (million IDR/month)

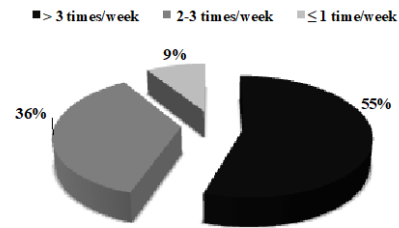Fig. 9. Transportation Budget (million IDR/month)

Fig. 10 Frequency of respondent pass-through TRBM

4. DISCUSSION

Ergonomics is the science, technology and art that seek to harmonize tools, methods and working environment on the capacity, capabilities and limitations of human beings so as to create conditions and working environment that is safe, healthy, comfortable and efficient in order to achieve the highest productivity [8]. Sudiajeng [9]–[10] reported that ergonomics workstation minimized unsafe action, decreases the health impairment and electrical energy usage at the woodworking workshop. Some ergonomics research also found that ergonomics improvements were required due to limited budget and financial constrain [11]-[12]. Furthermore, Washington State Department of Labor and Industries [13] reported some examples of costs and benefits of ergonomics. It summarized many ergonomics interventions that bring benefit to industries. One of the researches showed that participatory ergonomics intervention on the furniture changes lead to the decreasing of absenteeism from 4% down to 1% (75%); Error rates 25% down to 11% (56%); Time on task 60% up to 86% (40% increase in active work time), and reduced discomfort. Refers to the definition and the reports of ergonomics researches, it can be defined that achieving a better life is a central goal of ergonomics. With this in mind, everyone should implement ergonomics happily. But, the reality is often different, especially in the low-level economics country.

The result of this study showed that the Toll Road Bali Mandara (TRBM) has been technical-ergonomically designed which is emphasized by the result of the questionnaire analysis. 89% of 595 subjects agreed that the road singed and pavement markings are clear and easy to read from a distance. The conditions are safe, smooth, comfortable and productive. In contrast, none of the subjects pass through the TRBM regularly. 55% of subjects pass the toll road more than three times a week, 36% 2 to 3 times a week, and the rest was just once a week. Most of the subjects preferred to pass the By Pass Ngurah Rai road with a very high volume of

passenger car unit, even high traffic congestion. The travel speed was between 30 to 40 km/hour with travel time range was 10 to 30 minutes from Pesanggaran to Nusa Dua. According to the traffic regulations set by the transportation minister of Indonesia as well as the report of National Cooperative Highway Research Program [14], the level of service (LOS) in By Pass Ngurah Rai road is in the F level (speed of travel < 50 km/hour), which means forced or breakdown flow. Every vehicle moves in lockstep with the vehicle in front of it, with frequent slowing required. Travel time cannot be predicted, with generally more demand than capacity. Facing this condition, normally the subject will switch automatically pass through the TRBM with a higher travel speed of 70 to 80 km per hour and 5 to 9 minutes of travel time (about 214% faster), but the fact was in the opposite.

Traffic congestion problems generally occur in urban areas where the industry is growing rapidly, especially in developing countries such as India and Pakistan [15]-[16]. Furthermore, this is usually also closely related to economic problems. In any country, a good economic situation can be efficient in transportation and also the maintenance of transportation systems. Hence, to reach the ideal situation in infrastructure it's needed to come up with the lack of budget.

Analysis showed that the percentage of respondents who have a salary of more than 7.5 million IDR was 8.67%; between 2.5 and 7.5 million IDR was 29.92%, and less than 2.5 million IDR was 62.02%. Based upon wages earned, the budget of transport capable allocated is less than 200.000 IDR/month (58.41%), and others were between 200.000-500.000 IDR/month (33.09%). As the consequences, only 34.55% of respondents could meet the TRBM fee with the salary more than 2,5 million/month (38.59%). A single TRBM trip costs 4,000 IDR or about 240,000 IDR per month, while for cars; it is 10,000 IDR/trip or about 600,000 IDR per month. This means that usage of TRBM was very costly for most respondents. It made the majority of people prefer to go through congestion streets in order to ensure their basic needs can be satisfied. This condition is met to the Maslow's hierarchy of needs [1]. Most people find themselves still in the physiological needs of human survival.

Congestion road is very hazardous. The transport noise and pollution increase the accidents, health impairment both physically and psychologically, that finally leads to the decreasing of productivity [17].

Head of Traffic Corps of the Indonesian National Police (Kakorlantas RI) Irjen Royke Lumowa exposes shocking data. Each year, the death rate from accidents in Indonesia is highest in the world. The number reaches 28-38 thousand per

year lives floating in the country due to traffic accidents [18]. Inline with this data, Sanjay [19] reported that fatalities and injuries resulting from road traffic accidents are a major and growing public health problem in India. Every week nearly 2,650 people get killed and 9,000 get injured due to traffic accidents. The results of encouraging research came from China. In China, the number of fatal accidents per motor vehicle is diminishing, as is common in countries with a growing car ownership. The discipline of Chinese road users and especially drivers show opportunities for improvement. Disobedience significantly contributes to the number of fatal accidents (3% of the road fatalities are due to alcohol abuse, 14% to speeding, 12% to ignorance of priority rules).

Unlike the case with developed countries where infra structure and transportation facilities have been very adequate, the traffic accidents are generally caused by the negligence of the driver, and nothing to do with economic conditions. Thomas et al [21] reported that based on the work of Hollnagel the model considers a collision to be a consequence of a breakdown in the interaction between road users, vehicles and the organization of the traffic environment, 54% of road users experienced interpretation errors while 44% made observation errors and 37% planning errors. In contrast to other studies only 11% of drivers were identified as distracted and 8% inattentive. There was remarkably little variation in these errors between the main road user types. However, the regional office of Europe for World Health Organization reported that road traffic injuries in the WHO European Region represent a major public health problem. About 127 thousand people are killed and about 2.4 million injured every year. The cost of road traffic injuries to society is an estimated 2% of a country's gross domestic product. About one-third of the victims are aged 15–29 years.

From traffic accident data in both developing and developed countries is mainly due to the behavior of road users, but with different background issues. In developing countries, traffic accidents are generally closely related to economic conditions. In solving the problems, the strategies exist and need to be applied is through the Macroergonomics SHIP approach, which means Systemic, Holistic, Interdisciplinary, and Participatory approach. Macroergonomics has been around long enough for its benefits to be assessed. The preventive or curative action were designed by considering all sub-systems as a whole (holistically), studied from various related disciplines, and involving all elements. Hendrick in Anderson [22] reported that successful macroergonomics programs tend to get a 10-25 percent improvement, whether it is in productivity

or accident reduction. But with the macroergonomic level in there and it is a true macrorgonomic intervention, it normally 50-90 percent improvement. Associated benefits include better productivity and quality, and improved job satisfaction and employee commitment. This report is inline with the perception of RTBM user. 89% of 595 subjects agreed that the road singed and pavement markings are clear and easy to read from a distance. The conditions are safe, smooth, comfortable and productive. However, they prefer to use the uncomfortable and unsafe road in order to ensure their basic needs can be satisfied. In the long term, such conditions can reduce the level of community welfare. Of course, it needs awareness among the general public and enhances commitment among policy-makers to take immediate action for the welfare of society.

5. CONCLUSION

This study was conducted to determine why ergonomics is very difficult to implement in developing countries like Indonesia. Through this case study, it showed that the main problem is because of socio-economic constrain. Although there is a toll road, which provides a security, comfort, and productive trip, the majority of people prefer to go through congestion streets in order to ensure their basic needs can be satisfied. Based upon wages earned, the allocated budget of transport was not meet the TRBM contribution fee. Refers to the Maslow's hierarchy, means that the majority of the community is still in the physiological needs of human survival. Therefore, they prefer to ignore about security and comfort. In conclusion, an ergonomic toll road design, which provides safe and convenient traffic and infrastructure, has not been able to attract people to use it because of socio-economic constraints. As a recommendation, this paper posits that a better public transportation service should be considered by the government in order to provide safe, convenient and productive traffics that lead to achieve a better life.

6. ACKNOWLEDGEMENTS

7. REFERENCES

[1] Jerome N. Application of the Maslow's hierarchy of need theory; impacts and implications on organizational culture, human resource and employee's performance. International Journal of Business and Management Invention, Vol. 2. March. 2013, pp. 39-45.

[2] The World Bank. The rate of Poverty Reduction in 2013 the Smallest Decline in Decades. Available online at www.worldbank.org /.../poverty-reduction-slows-inequality-i, December 14, 2017.

[3] Bali provincial statistics bureau. Bali in Number (translated). Available online at www.baliprov.go.id. December 14, 2017.

[4] Wedasana A S. *Analisis daerah rawan kecelakaan dan penyusunan data base berbasis system informasi geografis: study kasus Kota Denpasar* (analysis of accident-prone areas and preparation of data base based geographic information system: a case study of Denpasar). Thesis, Magister Study Program, Civil Engineering, Udayana University-Denpasar, 2011.

[5] Stone H, Sidel J, Oliver S, Woolsey A, and Singleton R C. Sensory evaluation by quantitative descriptive analysis. Food Technol, Vol. 28, issue 11, 1974. Pp. 24-34.

[6] Sekaran U. Research Methods For Bussines, A Skill Building Approach, Second Edition. Singapore: John Wiley & Sons, Inc. 1992.

[7] Goyal T and Kataria D. Traffic Congestion on Roads. SSRG International Journal of Civil Engineering (SSRG-IJCE), Vol 2 Issue 5, May 2015, pp 12-15.

[8] Manuaba, A. A Total Approach in Ergonomics is a Must to Attain Humane, Competitive and Sustainable Work System and Product. Journal of Human Ergol., Vol. 36, 2007, pp. 23-30.

[9] Sudiajeng L, Adiputra N, Leibbrandt R. Ergonomics Work Station Decreases the Health Impairment and Saves Electrical Energy at the Woodworking Workshop in Bali, Indonesia. Journal of Human Ergology, Vol. 41, No. 1,2, 2012. pp. 41-54.

[10] Sudiajeng L, Sutapa N, Wahyu I G, Sanjaya N, Adiatmika I P G, For chapter in a book. Ergonomics Redesign minimized unsafe action in a woodworking workshop. *Ergonomics In Asia: Development, Opportunities, and Challenges*. CRC Press/Balkema, Taylor & Francis Group, 2012, pp. 289-293.

[11] O'Neill, D H. Ergonomics in Industrially Developing Countries: Does its application differ from that in industrially advance countries? Applied Ergonomics Journal. Vol. 31, 2000, pp. 631-640.

[12] Soo L H and Richardson S. Ergonomics in industrially developing countries: a literature review. Journal of Human Ergology, Vol. 41, No. 1,2, 2012, pp 1-16.

[13] Washington State Department of Labor and Industries. Examples of costs and benefits of ergonomics, 2015. Available online at http://www.pshfes.org/Resources/Documents /Ergonomics_cost_benefit_ case_study_ collection.pdf. August 22, 2015. 11.05 pm.

[14] Dowling, Richard. NCHRP Report 616: Multimodal Level of Service Analysis for Urban Street, Transportation Research Board. Retrieved 15 January 2012. Available at https://nacto.org/docs/usdg/nchrp_rpt_616_d owling.pdf.

[15] Muhammad Tahir Masood, Ph.D., P.E.; Azhar K, Hasnain A, Naqvi. Transportation Problems in Developing Countries Pakistan: A Case-in-Point. International Journal of Business and Management, Vol. 6, No. 11, November 2011, pp. 256-266.

[16] Ashkan T, Gholamreza K, Ali Y and Milad R. Investigation Transportation Infrastructure in Developing Countries. International Journal of Chemical, Environmental & Biological Sciences (IJCEBS), Vol.1(1), 2013, pp.31-35.

[17] Dora C and Phillips M. Transport, Environment and Health. WHO Regional Publications, European Series, 2000, No. 89.

[18] Divianta D (2017). *Angka Kematian Akibat Kecelakaan, Indonesia Tertinggi di Dunia* (Accidental Death Rate, Indonesia Highest in the World). Available online at news.liputan6.com › News › Peristiwa.

[19] Sanjay K S. Road Traffic Accidents in India: Issues and Challenges. Transportation Research Procedia Vol. 25, 2017, pp 4708–4719. Available online at www.sciencedirect.com.

[20] Jie L and Zuylen H J. Road Traffic in China. Procedia - Social and Behavioral Sciences Vol. 111, 2014, pp. 107 – 116. Available online at www.sciencedirect.com.

[21] Thomas P, Morris A, Talbot R, and Fagerlind H. Identifying the causes of road crashes in Europe. Ann Adv Automot Med, September 2013, Vol. 57, pp 13–22. Available online at https://www.ncbi.nlm.nih.gov/pmc/articles/P MC3861814

[22] Jennifer Anderson. Macroergonomics is Better Economics, 2006. Available online at https://ergoweb.com/macroergonomics-is-better-economics.