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Land Use Change and Traffic Impact Analysis in Planned Urban Areas in Tanzania: The Case of Dar es Salaam City

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Abstract

This paper is based on the review of the statutory requirements for land use change development projects in Urban Planned areas. In spite of Environmental and Social Economic Impact Analysis reports considered as basic requirements for the approval of development plans in Tanzania, the depth of traffic impact measurements and Traffic Impact Analysis (TIA) has not been adequately considered in urban plans. More concern is on approval process of development proposals that makes a case for the preparation of TIA as a separate and distinct study for proposed projects. We argue in this paper that while TIA is more germane in areas where land use change proposals are taking place very rapidly, most projects still do not asses or analyse the traffic impacts from the proposed developments on the existing transport networks. Thus, in Tanzania, TIA is the most concealed component in urban planning laws and regulations and its approach, level of execution and functional standards are neither exposed nor put into urban planning operations. The paper observes that, traffic impact analysis is an important component to be subsumed as potential study among generalized studies during land use change practices in urban planned areas. Furthermore, TIA is overviewed for big investments in urban developments, but current studies have revealed the need of TIA in small and spot developments which collectively has shown a great traffic impacts in cities with rapid land use change practices. The paper recommends the inclusion of traffic impact analysis report as a statutory document in the portfolios which are basically required to be submitted for approval of urban development proposals. The paper advocates the need for the urgent enactment of necessary legislation to make this requirement an obligation in land use change process.

Keywords

Development Projects, Environmental and Social Economic Impact Analysis, Land Use Change, Planned Urban Areas, Traffic Impact Analysis, Transport Networks

1. Introduction

Land use change in urban planned area is legally accepted and formally operationalized in Tanzania. However, Traffic Impact Analysis (TIA) is hitherto not included in the documents required to be submitted during application and approval for land use change. Normally the process for the proposed development project that changes of land use requires submission of development plans alongside with Environmental Impacts Assessment (EIA) and Social Economic Impacts Assessment (SEIA) reports (United Republic of Tanzania (URT) Urban Planning Guidelines (2007b)); but TIA report is not mandatory for the submission. The reports only spell out the environmental characteristics and conditions of the proposed project in physical, social, cultural, economic and aesthetic dimensions. It measures the potential environmental and social economic impacts on the proposed changes, and suggests the mitigations on the impacts on available technology and legislative limitations in order to eliminate or reduce the potentially significant environmental consequences as a way of achieving the objectives of environmental protection and social sustainability (URT, 2008). The question is, how social and environmental sustainability can be achieved in isolation of TIA?

The effects of land use change and the extent of the increased traffic volume in transport networks are not included in EIA and SEIA reports. Generally, change of land uses cause generation of extra traffic from the proposed developments which raise traffic on existing transport infrastructure. The oversights in deliberating traffic impacts on land use change proposals result into enormous urban transport problems such as traffic congestions, accidents, pollutions and crime. These problems constitute major challenges in a rapidly growing metropolitan City like Dar es Salaam (Gordian et al., 2013).

Traffic impact study is a concealed component for the development project or change of use developments in Tanzania. Specifically for Dar es Salaam City, the master plan of 1979 requires TIA to be performed for manufacturing and processing industries, container and bus terminals, warehouses, housing estates, spot grounds and commercial centres, but there are few development projects which have performed TIA. It is only 24 projects which have conducted traffic impact studies out of 704, which is about 3 percent. For land use change projects, this study revealed that, land use changes normally take place at individual plot or building which disqualify these projects from TIA requirement standards and therefore no land use change project has conducted TIA. But these changes have great impacts in terms of over increase travel demand and change of travel behaviour which resulted to traffic congestions and accidents (Gordian et al., 2013). So far, TIA is not requested as a part of the portfolio that a developer must submit to planning authorities requesting consent for development, or in seeking approval for a changed development project.

Following from the above, thus, this paper examines the need of traffic impact studies for new projects or for change of use development for larger projects in urban areas in Tanzania. Section two provides a condensed review of literature pertaining to the Urban Planning Guidelines, the Urban Planning Act and the National Policy on Transportation that stipulate the need of traffic impact studies for new projects or for change of use development for larger projects. This is supplemented by current debates on public interest for the issues concerned with TIA, EIA and SEIA on environmental protection and sustainability which have, in recent years, become notable. Section three presents Dar es Salaam City as the largest City and section four provides discussion on the methods of the study. Section five details results and discussion on the subject and the case study while the last (section six) provides conclusions and recommendations. The paper advocates the need for the preparation of TIA as basic and separate attachment for the new or land use change development projects.

2. Literature Review

Public interest for the issues concerned with TIA, EIA and SEIA on environmental protection and sustainability has in recent years become notable. This has come in conjunction with a number of legislations, national and international regulations which have raised concerns on use of natural resources and protection of the environment. An often quoted definition of EIA and TIA defined by Taofiki (2014) refers to "the need to identify and predict the impacts of traffic and other developments to the environment and on man's health and wellbeing". The most cited issues encompass the legislative proposals, policies, programmes, projects and operational procedures which need to interpret and communicate information about TIA and EIA impacts on any definite urban development. Taofiki (2014) discusses the need of working together between EIA and TIA and submit as one document to relevant authorities during project approval stages.

Taofiki and Nnko (2010) itemized the main components of TIA to be contained in EIA studies. First, the definition of the proposed project which is about description of the existing site characteristics in terms of infrastructures, land use, water bodies, social, cultural and heritage information. Second, is about assessment of public perception of the proposed development through public consultation. Third, is about identification of policies, legislation and regulations relevant to the proposed project and description of other alternatives for development. Fourth, description of possible short, medium and long term impacts, indirect and cumulative impacts, any mitigation action to be taken to minimize predicted adverse impacts, where applicable and practical with associated costs. Lastly, is concerned with development of Traffic Impact and Environmental Monitoring Plan (TEMP) to ensure that Traffic Impact Mitigation Measures (TIMM) has been adopted during project implementation.

On the other hand, Regidor, 2014 and Regidor & Teodoro (2008) introduced stakeholder participation in the process of TIA preparation. Potential stakeholders within the study area are used to obtain qualitative and quantitative baseline information characterized by traffic conditions, development status and environmental issues and collective mitigation measures. In addition, stakeholders need to provide cost effective recommendations and mitigation plans for elimination of negative impacts and develop collective actions in controlling traffic and environmental impacts in proposed developments. Teodoro and Regidor (2015) identified the objective of conducting TIA. The major TIA objective includes identification of negative and positive impacts that are likely to happen after implementation of proposed developments and determine the mitigation options that reduce or eliminate the negative impacts. The aim is to ensure management of traffic problems such as pollution, accidents, crime and congestion.

The Dar es Salaam Master Plan of 1979 mandates TIA for urban development in order to protect and improve traffic conditions, safe guard traffic infrastructures, air and water quality, and land uses. According to the master plan, TIA were required to be conducted for the development of manufacturing and processing industries, warehouses, container and bus terminals, freight yards, housing estates which accommodate not less than thirty dwelling units, commercial centres, shopping and business centres. **Table 1** portrays the data presented in Strategic Urban Land Use and Transport Plan for Dar es Salaam City in 2012 (URT, 2012). The data shows that, TIA was performed on 24 development projects out of 704 projects, which is about 3 percent of all development projects that qualify TIA. The levels of conducting TIA are very low simply because traffic study is not essential for the submissions required by the urban planning authorities for approvals of development proposals.

Meanwhile, the Urban Planning Guideline of 2007, the Urban Planning Act No. 8 of 2007 (URT, 2007a) and the National Transportation Policy of 2003

Table 1. The TIA projects in Dar es Salam, 1979-2012.

Years (from-to)	Projects with TIA	Projects without TIA	Types of projects
1979-1990	17	186	Manufacturing industries, ware house, container terminal and freight yard
	1	33	Housing estates & commercial centres
1991-2000	5	192	Manufacturing industries, ware house, container terminal and freight yard
	1	29	Housing estates & commercial centres
2001-2010	none	159	Manufacturing industries, ware house, container terminal and freight yard
	none	26	Housing estates & commercial centres
2011-2012	none	68	Manufacturing industries, ware house, container terminal and freight yard
	none	11	Housing estates & commercial centres
Total	24 (3%)	704	

Source: Dar es Salam City Five Years Strategic Plan (2010-2015).

(URT, 2003) stipulate the need of traffic impact studies for new projects or for change of use development for larger projects. Projects that require TIA include mixed-use development which covers 4500 square meters ground area, multi-storey buildings with height not less than nine storeys, residential estate not less than thirty dwelling units and all types of manufacturing and processing industries. However, experience shows that, there are few development projects on which traffic impact studies have been carried out. **Table 1** shows projects implemented between ten and twenty years after the development of Dar es Salaam master plan, but no TIA was conducted after development of Urban Planning Guidelines of 2007. At the same time, there is no TIA conducted for the land use change project. The main reason is that land use changes take place piecemeal in spots and small areas that exempt them from TIA requirement standards. However, these changes have created great traffic impacts in quickly urbanizing cities including Dar es Salaam city (Gordian et al., 2013).

The Urban Planning Guidelines (2008) provide the criteria that necessitate traffic impact analysis of the proposed new developments. The criteria are categorized into residential and non-residential developments. For residential developments, a TIA study have to be conducted when the proposed project generates more than 100 peak hour vehicles or the site generates more than 200 vehicles per day or it doubles the existing traffic volume. For non-residential areas the site has to generate 250 vehicles in the peak hour, or more than 2500 per day.

The existing administrative and legal framework in Tanzania has ensured that the project pre-construction evaluation is done before a go ahead is given. Enforcement is only for environmental and social economic impact studies, but a traffic impact analysis report is not a mandatory for project approval. The gap for the TIA requirement and implementation in cities of developing countries has resulted into urban transport problems such as traffic congestion, accidents, pollution and crime. However, necessities of implementing TIA in urban transport planning and management have raised a great concern among policy makers, urban planners and other stakeholders Teodoro and Regidor (2015). But the process of effecting traffic impact studies for big and small projects in Tanzania is not in place.

According to Nachmias (2010), Traffic Impact Analysis (TIA) is a study carried out to predict the magnitude and effects of the additional traffic from proposed new development or change of use of the planned or existing transport network. TIA is an important document which helps planning authorities to make decisions on land and its use (Tilsdor, 2012). It is also used to evaluate whether the proposed developmental project is appropriate and what type of transportation facility improvements would be necessary. Traffic impacts could be direct or cumulative. A direct impact would result solely from the implementation of the proposed project while cumulative impact is based on list of past, present and probable future projects in the area. This means that a cumulative impact would occur as a result of traffic growth from both the new project and other projects in the area (Takyi, 2014).

Traffic impact studies help to forecast additional traffic associated with new development. It can help determine the necessary improvement to accommodate anticipated traffic and identify potential problems associated with the proposed development. Analysed traffic problems help to ensure safe and reasonable traffic conditions (volume or flow) after project implementation. It also shows weather the existing transportation networks can accommodate the traffic to and from new developments or the way of mitigating the prospected impacts from the proposed development.

A traffic impact is an effect, either positive or negative, on the road segment or road junctions and other transportation infrastructures that may be associated with a proposed project activity. According to ITE Traffic Impact Analysis Manual (2011), the assessment of the proposed project may be based on a synthesis of criteria such as nature of the impact (pollution, accident, crime or congestion); direction of the impacts (either increasing from centre to periphery, or decreasing from centre to periphery or spreading equally between centre and periphery). Major components of TIA include the spatial extent, duration, intensive or magnitude and determination of significance.

Teodoro and Regidor (2015) described spatial extent and scales of determining and analysing the potential traffic impacts. They are categorized in local, regional and national levels. Local scale is where the impacts affect the small extended area adjacent to the site such as a settlement, neighbourhood, town, probably affecting traffic up to 10 km outside the affected areas. Regional is where the impacts could affect traffic in areas which include outlying parts of the city, transportation route, adjoining towns, and national is where the impacts could be as far reaching as national boundaries.

According to Hokao and Mohamed (2009), the duration criterion refers to the expected lifespan of the proposed project's traffic impacts. This can be defined in short term, if the traffic impact will disappear with mitigation or will be reduced in a span shorter than the construction phase (impacts that are predicted to last only for a limited period). Medium term if the traffic impact will last for only the construction phase and thereafter it may completely be terminated. Long term, if the traffic impacts will continue or last for the entire operational period of the project, but will be mitigated by direct engineering or traffic control solution afterwards. Permanent, if the traffic impact is considered non-transitory. That is, mitigation by engineering or human processes will not occur in such a way or time span that the impact can be considered transitory.

Impact intensity or magnitude analysis also was referred by Hokao and Mohamed (2009) as a description of whether or not the intensity or magnitude of the impact would be high, medium (moderate), low or negligible (or no impact). Evaluation of potential traffic impacts on traffic components may be qualitative or quantitative. Botha narrated the factors used to describe intensity or magnitude could be termed as:

1) Low, if the impact will not have significant influence on the adjoining traffic and hence it will not require significant accommodation in the project design

or implementation. The impact may alter the affected transport environment in such a way that traffic processes or functions are not affected in any significant way (i.e., the existing road networks are not overburdened or existing traffic patterns and flows are not altered or affected).

2) Moderate, if the impact could have an adverse influence on the existing level and flow of traffic requiring a modification of the project design or alternative implementation schedules. The affected traffic and transportation environment is altered, but the functions and processes continue, albeit in a modified way.

3) High, if the impact could have significant influence on the traffic environment but cannot be mitigated or accommodated by the project design. It can only undergo the introduction of alternative mitigation measures, such as road re-alignment at a particular stretch, construction of new parking facilities, widening of existing adjoining roadways, etc. Functions or process of the existing traffic environment is distributed to the extent where it may be affected temporarily or permanently.

Determination of significance criteria is another traffic impact indication defined by Teodoro and Regidor (2015) in terms of physical extent, intensity and time scale. It is an indication of the required level of mitigation and is determined through a synthesis of impact characteristics or combination of effects. The various classes of significance are defined as negligible, if the impact is considered to be insignificant and does not require any mitigation efforts. Low, if the impact is of little importance but may require limited mitigation. Moderate, if the impact is of importance and considered to have mitigation. Mitigation is required to reduce the negative impacts to acceptable levels or to maximize positive impacts. High, if the impact is of great importance hence failure to mitigate and reduce impact to acceptable levels could potentially negate development or make entire project unacceptable.

3. Dar es Salaam City: A Case Study Area

Dar es Salaam City is the largest City in Tanzania accommodating over 4.4 million people and average annual population growth rate of 5.6 percent (National Population Census Report, 2012). The city has grown from a mere village of 5000 people at the turn of the 20th century to metropolitan regional area extended to 75 kilometres south, north and west, from the east coast of the Indian Ocean. As presented in **Figure 1**, the city is the commercial and industrial hub of Tanzania which accommodates about 50 percent of the country's total industrial investment, 45 percent of her commercial activities and accounts for approximately 30 percent of the country's manufacturing sector (Nachmias, 2010). Despite of the city extensive spatial developments, but is served by four major arterial roads radiating from the CBD namely Morogoro, Kilwa, Nyerere and Bagamoyo roads. The rapid and extended spatial developments exert great pressure on existing transport systems whereby the transport demand by far exceeds the supply of transport infrastructures. This situation result to traffic jams and

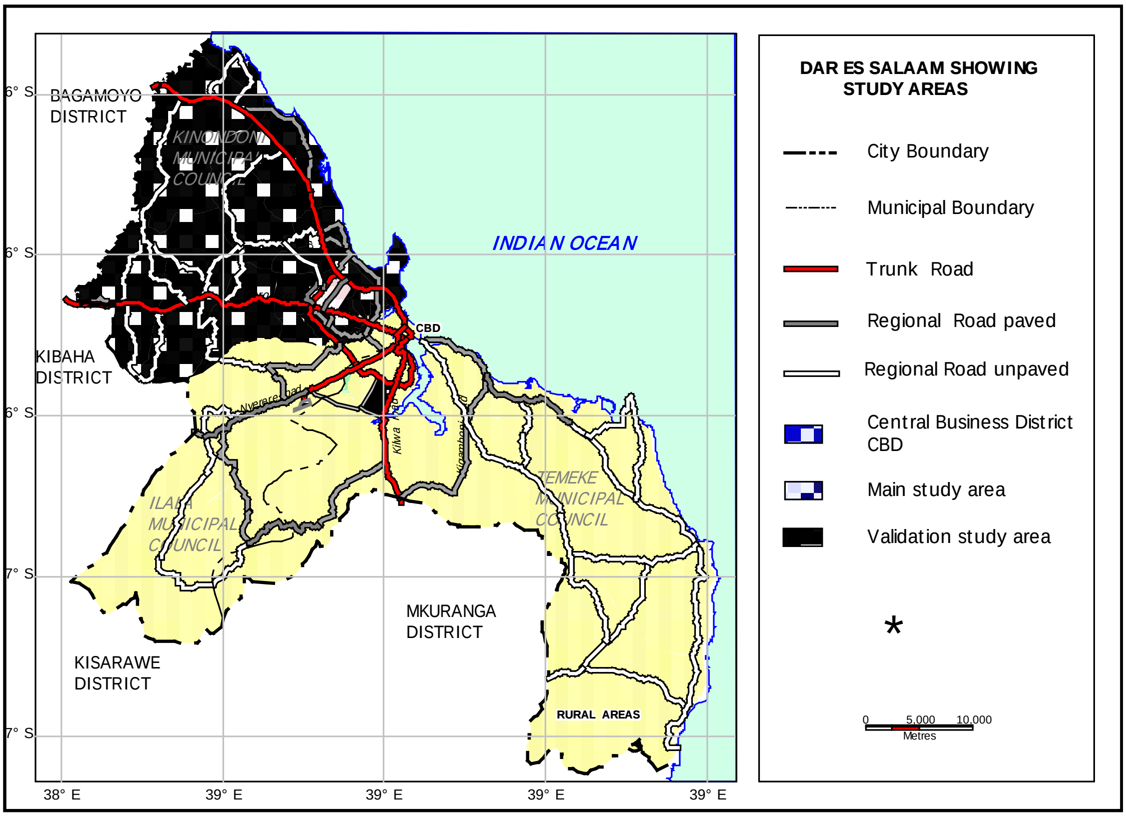


Figure 1. Map of Dar es Salaam City: location of study area. (Source: survey and mapping division, Dar es Salaam, 2016).

congestions, road accidents, limited accessibility and mobility to some of activity locations which led to reduced city's productivity (Nachmias, 2010).

Gordian et al. (2013) asserts that Dar es Salaam is a fast growing city in terms of new projects in CBD, and peri-urban areas. There is a need of understanding the demands placed on the city transportation network in relation to new developments and assessing the travel directions and intensity. However, Whitehill and Phial (2007), insist on spot development and new proposals of building structures should be analysed as a separate traffic generator to assess their impacts on the transportation system. Development in the CBD, commercial, industrial and other land uses tend to generate undetermined traffic in the city that result in traffic congestion, longer travel times, air and noise pollution, accidents and crime. As a road becomes more congested drivers tend to turn to other roads, not necessarily intended for through traffic, which leads to change of driver behaviour and violation of safety rules.

More critical for the Dar es Salaam is that, there are unanticipated traffic generated by new developments or land use change projects that normally necessitate the government to invest a lot on the transportation networks (URT, 2014). Some of government investments include creation of new modes such as commuter train, construction of new roads especially in peri-urban areas, expansion or improvement of existing roads especially in city centre, creation of new routes for public transport, construction of new terminal facilities, authorization of new modes like motor cycles, tricycles and vans, and development of new traffic control mechanisms like use of traffic lights, traffic police, community police and traffic camera (URT, 2014).

Under all circumstances, Tanzanian planners and decision makers have overlooked TIA as a mechanism of controlling the impacts of new developments in existing transportation systems (URT, 2007). Although urban planning policies have defined the need of TIA but its operationalization is not yet effected in urban planning practice. Normally, land use change process does not qualify TIA standard and requirements and therefore TIA study is less or completely neglected in urban land use change development. Although the impacts of land use change are directly observed in the immediate vicinity of the proposed developments, their effects are found direct on the proximity of proposed development or on traffic conditions of the whole city (Whitehill & Phial, 2007).

4. Data Collection

The data collection for this study was categorized into primary and secondary data. Primary data were physically collected in the study area by interviewing owners of the buildings which were changed from one land use to another. Data also included the road side interviews made to drivers and some key informants from different planning authorities. Secondary data were collected from population census reports, urban planning reports, policies and guidelines. The collected data present the number of projects which have applied TIA and those that didn't apply, number of land use change projects, population changes in the study area and number of accidents before and after implementation of land use changes. Traffic volume and speed on five counting stations along Shekilango such as Bamaga, Africa Sana, Mwika and Kijiweni and Shekilango were collected (**Figure 2**). Manual traffic counting methods were applied. Counting traffic flow were performed from 6.00 am up to 7.00 pm for seven days, and counting traffic speed were performed in one day from 5.00 am up to 8.00 pm for one day. The Average Daily Traffic (ADT) was obtained by multiplying the total counts with the Night Factor (NF = 1.5) provided by the National Urban Transport Planning Standards.

Traffic speed data were also collected in four counting stations established in between junctions (**Figure 2**). First section is between Bamaga and Africa Sana, Second section between Africa Sana and Mwika, third section between Mwika and Kijiweni and fourth section between Kijiweni and Shekilango. As indicated in **Figure 3**, counting sections are about 50 meters long and were located far from major junctions in order to avoid queue effects. Random sample of 100 vehicles were counted in each section for morning peak hours (5.0 am - 8.0 am), evening peak hours (4.0 pm - 8.0 pm) and non peak hours (8.1 am - 3.59 pm). Counting traffic speed for non-peak hours helped to determine the free-flow speed on the road sections.

Road side interviews were performed on entry or exit of Shekilango, Makanya, Makaburini and Africa Sana roads. Random sample of 1200 car drivers was

Figure 2. Traffic counting stations in the study area. (Source: survey and mapping division, Dar es Salaam, modified by the authors, 2016).

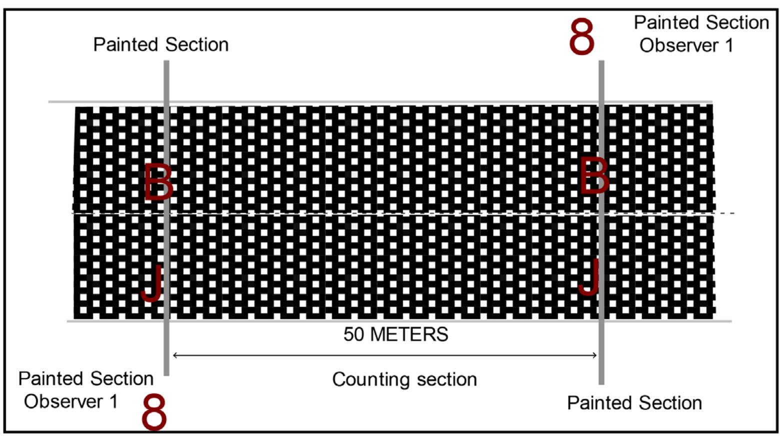


Figure 3. Traffic speed counting section (2 lane - 2 way) road. (Source: field work and authors construct, 2016).

interviewed on Friday and Saturday (Friday representing working days and Saturday representing non-working days). The data collected include types of vehicles, number of passengers in the car, time used in the road, entry and exit junctions, and reasons of crossing the study area.

Accident data were obtained from the National Traffic and Accident Database. The collected data include type of accidents, times of accident events which were categorized into peak and non-peak hours, and locations where accidents mainly occurred especially for major intersections. The second category is the data collected in order to assess the applicability of TIA in urban planning process. Different opinions on the disparity between land use and transport policies especially were discussed, together with the suggestions for effective execution of TIA for small, medium and big developments. Data was mainly collected from the key informants in Dar es Salaam City Planning Authorities, Local Government Authorities, Planning Division at Ministry of Lands and Human Settlements Developments, Ministry of Work, Ministry of Transportation, and Tanzania Road Agency (TANROADS). The tool applied was questionnaires with open questions performed on face to face interviews between researchers and interviewers. Many concerns and challenges were raised, and different opinions were suggested on practical implementation of land use change in urban planned areas.

5. Results and Discussion

1) TIA on Planned Land Use Developments

The findings in the study area give out planned land uses that meet the requirements of TIA to be performed during implementation of development plans. As indicated in Table 2, TIA was performed on 3 developments out of 167 that qualify TIA process. Also, it was observed that there were no land use change developments that have applied TIA from year 1993 up to 2012. At the same time, TIA practice is very low about 1.4 percent, while the changed properties have increased two times from 167 in year 1992 up to 446 in year 2016.

The study area covers 7,572,718 square meters of different land use categories such as residential, commercial, institutions and industries. The area were planned to accommodate 36,633 people, household size at 5 people per household and each dwelling unit was planned to accommodate one household. The area was planned to generate about 69,050 vehicle trips per day. But as indicated in Table 3, planned land uses have increased by 13 percent from year 1992-2016. The additional area is obtained by incorporating the ground areas of changed land uses, and the floor areas of changed single storey to multi-storeys buildings. On the other hand, the planned population has increased about four times (258 percent) characterized by the household sizes changed from 5 persons per household up to 6.3 person per household, and number of household per dwelling unit changed from 1 household per dwelling up to an average of 2.9 household per dwelling unit. The effects of changes are implicated in additional vehicle trips generated by different planned land uses which have increased by 242 percent; about four times of the planned and forecasted vehicle trips.

2) Land Use Change Effects on Level of Service (LOS) for Road Transport

The vast increase for the number of vehicle trips generated in the study area

Table 2. TIA practice in the study area development projects.

Item	Planned and implemented on 1992		Change from 1993-2016	
	Implemented without TIA	Implemented with TIA	Changed without TIA	Changed with TIA
Commercial				
Bank	1	0	4	0
Hotel	2	2	112	0
Local market	7	0	7	0
Bar and restaurant	11	0	60	0
Service station	3	0	8	0
Shopping centre	1	1	1	0
Car sale yard	0	0	4	0
Institution				
Bus terminal	1	1	3	0
Collage	1	0	5	0
Hospital	0	0	1	0
Health centre	1	0	3	0
Dispensary	3	0	5	0
Office	3	0	40	0
School	24	0	41	0
Hall	1	0	12	0
Religious	16	0	42	0
Open space				
Park	1	0	1	0
Play field	33	0	16	0
Service industry				
Garage	1	0	19	0
Service industry	16	0	12	0
Transit goods yard	0	0	2	0
Residential				
Apartment (Blocks)	41	0	48	0
Total	**167**	**3**	**446**	**0**
Percentage TIA performance	-	**1.4%**	-	**0%**

Source: Field Survey, 2016.

Table 3. Land use change attributes on the study area.

Item	Planned on 1992 (before land use change)	Observed on 2012 (change after land use)	Difference percentages
Area (Sq. Meter) of planned Land uses	7,572,718	8,550,606	13(%)
Population	36,633	124,278	258(%)
Average household size	4.5	6.3	40(%)
Average number of household per dwelling unit	1	2.9	1.9(%)
Vehicle trips	69,050	236,134	242(%)

Source: Field Survey, 2016.

necessitated the essence of measuring the level of services for the major collector roads in the study area. Traffic counting data was also used to determine the Level of Service (LOS) for road sections and junctions in the study area. The LOS used by Tanzania National Roads Agency (TANROADS) for Geometric Design of Highways and Streets are ranked from A through F; A being the best level service and F being the worst level of service.

As presented in (URT) Urban Land use and Transportation Planning Manual (2008), LOS at "A" indicates free flow speed for peak and non peak hours at average speed 80 km/h. The average spacing between vehicles is about 150 metres and is applied on trunk roads at intersection speed ≤10 seconds. LOS at "B" is reasonably free flow speed at average speed 60 - 80 km/h. The average spacing between vehicles is about 100 metres and is applied in regional roads at intersection speed is between 10 - 15 second. LOS at "C" is stable flow at flow speed at average speed 40 - 60 km/h. The average spacing between vehicles is about 50 metres and is applied in district and collector roads. Ability to manoeuvre at this LOS is noticeably restricted and lane changes require more driver awareness. LOS at "D" is approaching unstable flow at average speed 20 - 40 km/h. The average spacing between vehicles is about 25 metres and is applied in minor collector roads. Freedom to manoeuvre within the traffic stream is much more limited and driver comfort levels decrease. LOS at "E" is unstable flow at average speed 10 - 20 km/h. Designed to be applied on disruption to traffic flow, such as crossing traffic lights, roundabouts and or lane changes. Any incident will create serious delays where some roadway congestion is inevitable, and the intersection speed is between 35 - 50 seconds. LOS at "F" is approaching forced or breakdown flow at average speed 0 - 10 km/h. Every vehicle moves in lockstep with the vehicle in front of it, with frequent slowing. Travel time cannot be predicted, with generally more demand than road capacity. A road in a constant traffic jam is at this LOS and the intersection speed is ≥50 seconds.

The results for the LOS in the study area indicated the great impact of land use change. As presented in Table 4 and Table 5, there are big differences between planned LOS obtained in planning manuals and existing or observed LOS

Table 4. Level of services for road sections.

	Time	Before land use change (planned)		After land use change (observed)	
		Speed (km/h)	LOS	Speed (km/h)	LOS
Shekilango	Peak hours	40 - 50	C	17.5	E
	None peak hours	50 - 60	C	33.3	D
Makanya	Peak hours	20 - 30	D	11.7	E
	None peak hours	30 - 40	D	26.1	E
Africa Sana	Peak hours	20 - 30	D	21.5	D
	None peak hours	30 - 40	D	31.5	D
Mwika	Peak hours	20 - 30	D	12.5	E
	None peak hours	30 - 40	D	36.0	D

Source: Field Survey, 2016.

Table 5. Level of services for intersections.

	Time	Before land use change (planned)		After land use change (observed)	
		Crossing time (Seconds)	LOS	Crossing time (Seconds)	LOS
Bamaga	Peak hours	20 - 25	C	62.5	F
	None peak hours	15 - 20	C	26.1	D
Kijiweni	Peak hours	25 - 30	D	51.7	F
	None peak hours	30 - 35	D	33.5	E
Mwika	Peak hours	25 - 30	D	51.7	F
	None peak hours	30 - 35	D	33.5	E
Africa Sana	Peak hours	25 - 30	D	49.6	F
	None peak hours	30 - 35	D	41.5	E

Source: Field Survey, 2016.

obtained in the study area. The comparisons are presenting the LOS before and after land use change for both peak and non peak hours.

The change for the LOS indicate that, during peak hours, the average speed for the major collector road (Shekilango Road) is 17.5 km/h which is changing from level C to level E. This indicates that, the major collector road is very congested during peak hours and may cause serious delay. Other minor collector roads such as Makanya, Africa Sana and Mwika road are also changing from level D to E indicating that they are congested. For off-peak hours, all roads are changing from the designed level of service to the lower level indicating that they are saturated with much traffic and congestion.

The major junction along Shekilango road such as Bamaga, which is connecting Shekilango road to the arterial road, is very congested during peak hours from C to F, indicating that this junction is not passable during peak hours. Average crossing time is one minute and 5 second. Also other intersections along Shekilango road such as Kijiweni, Mwika and Africa Sana are changed from D to F during peak hours and D to E for non peak hours indicating that, they are too much congested during peak hours. But also their level of service is very low even for none peak hours.

Generally, the existing LOS for road links and junctions are actually low compared to the planned LOS. This situation ultimately makes the existing roads to be unable to accommodate the traffic generated especially in peak hours. As the result, the roads are very much affected with traffic congestion.

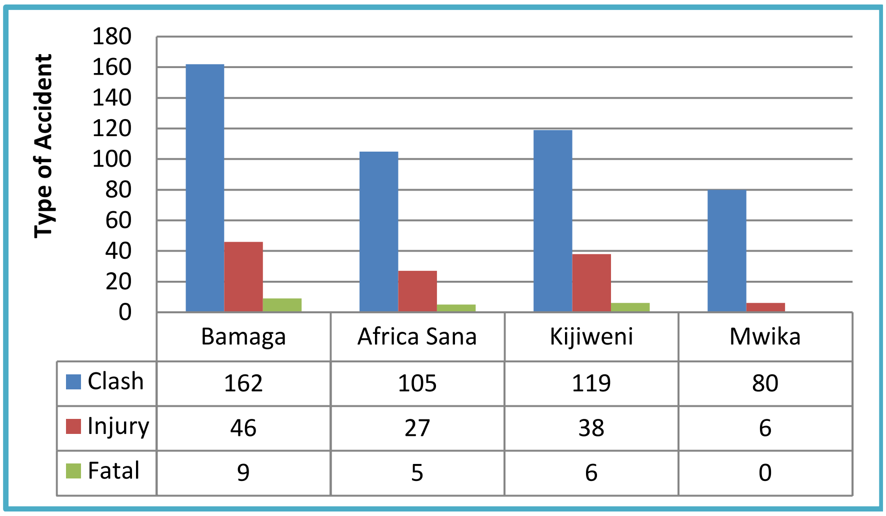
3) Effect of Land Use Change on Traffic Accidents

The accident data for the major intersections such as Bamaga, Africa Sana, Mwika and Kijiweni were obtained from Road Safety Section at the Ministry of Home Affairs. As presented in Figure 4, accident rates are very low in non-peak hours but extremely high in peak hours. More accidents were found in Bamaga and Kijiweni junctions simply because Bamaga is the intersection of major collector and trunk road, and Kijiweni is the intersection two major collector roads such as Makanya and Shekilango roads. Mwika and Africa Sana are intersections of minor collector roads and therefore have low rates of traffic accidents.

Figure 5 shows that the large number of accidents caused clashes or collisions between vehicles which normally damages vehicles. There are very few accidents causing injury or deaths. This situation is mainly caused by traffic congestion and jams on road intersections whereby most of drivers try to manoeuvre and cause accidents.

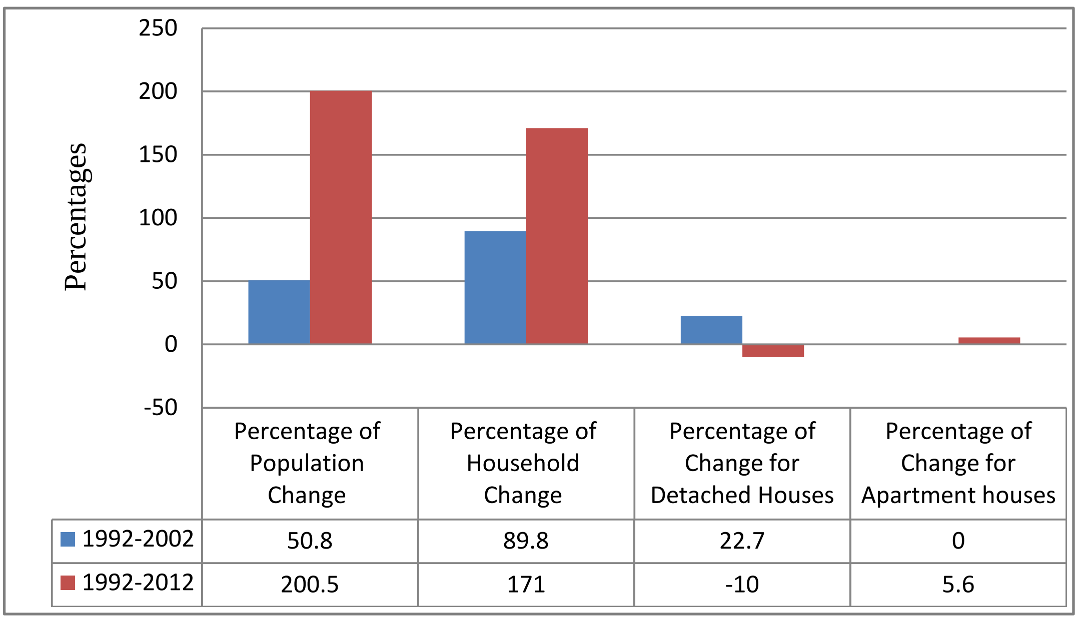
4) Effect of Population Changes on Traffic

Population change was determined by increase of people and number of households in relation to provision of residential houses in the study area. It is observed that, due to residential buildings being transformed to other land uses, the number of people accommodated in the planning area is three times higher



	Bamaga	Africa Sana	Kijiweni	Mwika
Clash	162	105	119	80
Injury	46	27	38	6
Fatal	9	5	6	0

Figure 4. Accident distribution on road intersections. (Source: road safety section the ministry of home affairs, Dar es Salaam, 2016).



	Percentage of Population Change	Percentage of Household Change	Percentage of Change for Detached Houses	Percentage of Change for Apartment houses
1992-2002	50.8	89.8	22.7	0
1992-2012	200.5	171	-10	5.6

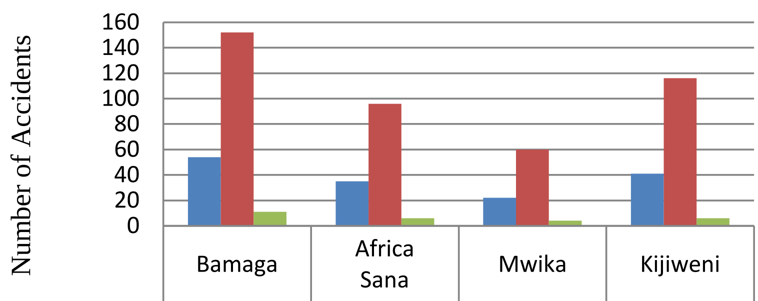
Figure 5. Relationship between change of population, households and housing units. (Source: field survey, 2016).

than the planned population. The planned population in year 1992 was 41,139 people with 7481 number of households, 6709 detached houses and 772 apartment dwellings, and the household size was 5 people per household (Gordian et al., 2014). Figure 6 shows that, in 2002, the population has increased by 50.8 percent, the number of household increased up to 89.8 percent while the houses rose in 22.7 percent. In 2012 the population was raised up to 200.5 percent and number of household rose up to 171 percent and number detached houses decreases by 10 percent while apartments increased by 5.6 percent.

The increased rates of population and household have shown great effects on travel demand. The effects were observed on the number of vehicle trips generated by the household per day. As presented in Appendix 1, the planned and forecasted trips were 9.5 vehicle trips per day for detached dwelling and 6.46 vehicle trips per day for apartment dwelling unit, and the total planned vehicle trips were 68,714 vehicle trips per day, but by using the same rates on existing population, the study area will produce about 212,609 vehicle trips per day. The increased population and number of households generate about 190,323 extra vehicle trips per day.

5) Effect of Land Use Change on Traffic Flows

The results of traffic volume and road side surveys were used to assess the impact of land use change in the study area. The data shows that, during morning peak hours from 6.0 am up to 8.30 am, 85 percent of traffic generated in the study area is going out of the study area to different destinations, and 15 percent ends in the study area. During non-peak hours, 72 percent of traffic is coming from outside the study area and a large part of vehicle trips are for business, services and official activities. At evening peak hours from 5.0 pm up to 7.0 pm, 60 percent of traffic coming from different areas is ended in the study area as home destinations but 40% are traffic passing through the study area to different destinations. At evening peak hours, links and junctions of collector roads are exceedingly concentrated with traffic than morning peak hours. The main reason is that, at evening peak hours, the traffic for work based movements are mixed



	Bamaga	Africa Sana	Mwika	Kijiweni
AM-Peak Hours	54	35	22	41
PM-Peak hours	152	96	60	116
None-Peak hours	11	6	4	6

Figure 6. Accident on road sections in peak and non peak hours. (Source: road safety section the ministry of home affairs, Dar es Salaam, 2016).

with traffic for business and service movements in the study area which result to uncontrollable traffic jam in links and junctions.

6. Conclusion and Recommendations

Results of the study shed light on the consequences of changing land use without taking into considerations the effect of those changes on existing transport. Land use changes have revealed impacts on rapid increase in population, household size and building patterns that result into generation of vehicle trips beyond the estimated transport demand. The extra demand of transport has resulted to some of existing roads losing capacity to accommodate traffic that resulted into traffic congestion, jam and severe accidents. Thus, the documented incidents in the study area justify the importance of Traffic Impact Analysis (TIA) for the land use change processes in the City.

The real practice of TIA in Tanzania is at very lower level despite of its importance as revealed in this paper. As described in Urban Planning Guidelines of 2007, while TIA should be performed for the big development projects it has hitherto disregarded the medium and small scale developments which create great traffic impacts in urban planned areas. On the other hand, the study found that the urban planning policies and guidelines have excluded TIA execution in land use change processes. Subsequently, this exclusion has revealed the practice gap between land use change operations and its effects on existing transport networks. Land use change is the main cause of planned land use to generate additional trips on existing transport infrastructure beyond the planned and forecasted trips which result in traffic jams, delay, congestion and accidents. As land use change developments become larger and more complex with multi-storey building and mixed-use, their effects on traffic conditions become even more pronounced and severe.

Based on the foregoing results and observations, this paper is recommending three major areas of intervention: the first is effective implementation of TIA at all levels of developments including large, medium and small scale projects. However, the overall impacts of small new projects or land use change projects may be more important in the long run than the relatively few large developments. The real practice of TIA for land use change projects will reduce the production of undetermined trips and mitigate their effects on existing transport networks.

Second, is the necessity of inclusion of traffic impact analysis reports as statutory attachments in the portfolio submitted to relevant authorities for development consent requisitions and approvals. These strategies will greatly enforce TIA to be included for the new or changed developments.

Finally, the paper advocates the need for the urgent enactment of necessary legislation to make this requirement an obligation and spell out the procedure and guidelines for TIA preparation in Tanzania. First is to prepare Traffic Impact Statement (TIS) for small land use change proposals which are expected to generate extra vehicle trips beyond the planned and forecasted trips. Second, is to prepare Site Specific Traffic Impact Assessment (SSTIA) for the medium land use change development proposals, and lastly, to prepare Full Traffic Impact Assessment (FTIA) for new or changed development proposal which expect to generate more traffic and create great land use impact in the planned settlements in the City.

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Appendix 1: Changed Land Use: Residential Plots and Additional Vehicle Trips in the Study Area (Refer to Figure 2)

Use	Changed residential plots			Planned 1992		Observed 2016			
	Single storey single uses	Multi-storey single uses	Multi-storey mixed uses	No. of plots	Planned vehicle trips	Area m^2 FA, GA	Trip rates per m^2	Observed Vehicle trips	Difference
Hotels, bars, restaurants, halls	80	36	5	121	1150	91,350	0.96	87,670	86,546
Banks, shops, business complexes	6	1	4	10	95	8550	0.7	5985	5890
Fuel station, bus terminals	2	-	-	2	19	922	1.5	1383	1364
Offices, public buildings	10	2	13	25	238	11,250	0.12	1350	1112
Colleges, schools	31	-	1	32	304	14400	0.11	1584	1280
Churches, mosques	13	2	2	17	162	7650	0.32	2448	2286
Hospitals, health centres and dispensaries	5	-	-	5	42	2250	0.34	720	678
Vehicle yards, garages and warehouses	13	-	-	13	124	5870	0.06	351	227
Villa and Flats	5	4	-	9	86	4050	9.5-villa, 6.4-flats	48 307	269
Total	164	45	25	234	2220			101,846	99,652

GA: Ground areas; FA: Floor area calculated by taking ground area multiplying with number of floors. Source: Field Survey, 2016.