A Framework of Space Standards for Roads Widening in Upgrading Informal Settlements for Improvement of Traffic Mobility and Accessibility: The Case of Dar Es Salaam City

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Abstract

Improvement of transport network in upgrading informal settlements involves roads widening according to the approved space standards for roads improvement. However, the existing approved space standards are not realistic in informal settlements as they are associated with massive demolition of houses in roads improvement that results into high compensation costs. Under budget constraints there are lack of funds for compensation and that roads are not widened according to the approved space standards. Instead the existing spaces on the ground are used for roads improvement while there is no limit that has been established to provide cut-off point of the minimum space standards for transportation improvement. Consequently the improved roads in highly developed informal settlements do not improve transport network and thus intensifies the problem of traffic mobility and accessibility. This study has therefore, developed a framework of space standards with a lower limit for roads widening that improves transport network. These space standards have been developed to achieve roads widening requirements, roads functional performance requirements and roads design requirements for the purpose of improvement of transport network in upgrading informal settlements.

Keywords*:* Accessibility, Informal settlement, Mobility, Road widening, Space standard

1.Introduction

Improvement of roads network in upgrading informal settlements is currently carried-out by each upgrading program and/or informal settlement upgrading project to develop its own space standards according to the existing space on the ground (CIUP, 2002a; Magigi and Majani, 2005) so-as-to minimize compensation costs. This is due to the fact that the approved space standards for roads network are very high and thus they are associated with massive demolition of houses when applied in informal settlements (Nnkya, 2002). For instance, the Community Infrastructure Upgrading Program (CIUP) that was implemented from 2002 to 2012 in Dar es Salaam City to upgrade 32 informal settlements developed 10.0-12.0m Right-of-Way (RoW) and 5.0m Carriageway (CW) for Local Distributor Roads (CIUP, 2002a;b). The Community Infrastructure Program (CIP) that was implemented from late 1990s in Dar es Salaam City to upgrade Hanna Nassif, Kijitonyama and Tabata informal settlements developed 6.0m CW for Local Distributor Roads (Kyessi, 2002; Mchome, 2004). Also the Ubungo Darajani Informal Settlement Upgrading Project that was implemented in Dar es Salaam City from 2003 to 2004 to upgrade Ubungo Darajani informal settlement developed 12.0m RoW for Local Distributor Roads (Magigi and Majani, 2005). Assessment of these space standards by Mchome (2004; 2016) according to the functional performance objectives of each type of road was that they does not provide accessibility within the settlements for emergency vehicles such as fire engines and ambulance; service vehicles such as cesspit emptying trucks and garbage collection trucks; public transport such as commuter bus/minibus and does not link with planned areas/settlements in terms of the existing road network within the city fabric and for the public transport network.

Furthermore, they does not permit safe movement for pedestrians and cyclists along the roads; they does not provide sufficient space for bus stops and parking bays for private cars and commercial vehicles; they does not provide accessibility for motorized traffic (private cars) to all parts of the community and/or the settlements; they does not provide sufficient space for provision of service infrastructures such as roadside storm water drains. Water distribution network, sewerage network, electricity and street lights; and they do not provide sufficient space for roads construction machines (rollers) to compact roadways without destruction to the nearby houses. Due to these deficiencies, this study has developed a framework of space standards for widening different types of roads in informal settlements so-as-to achieve their performance requirements.

2. Performance requirement of roads space standards

There are three performance requirements of roads space standards for improvement of transport network. They are roads widening (right-of-way) requirements, roads functional requirements, and roads design requirements.

2.1 Roads Widening (Right-of-Way) Requirements

According the UK Transport Research Laboratory (1988) through Overseas Road Note-6 that is mostly used in developing countries, including Tanzania; right-of-way is required to be provided in each type of road as reserved land for future upgrading (expansion) of the roadway. It is further explained by TRL (1988) that right-of-way space should be determined by extending the roadway on both sides and be used for provision of specified facilities for non-motorized road users such as pedestrian footpaths and bicycle lanes. It was also explained by URT (2000) that right-of-way space should be made available in all types of roads for contractors as their working space during roadway constructions. Nevertheless, it was explained by the UK Ministry of Overseas Development (1978) that right-of-way should also be provided for installation of service infrastructures such as storm water drains, electricity, water, and telephone.

Table 1: Approved planning and design space standards for roads network

Road Hierarchy	Type of Road	Right-of-Way (Metre)	Carriageway (Metre)
1	Trunk roads	100.0	12.0-15.0
2	Primary distributor roads	80.0	7.0-10.0
3	Secondary distributor roads	60.0	7.0-10.0
4	Local distributor roads	30.0	5.0-7.5
5	Access roads in industrial/shopping areas	20.0	7.0-10.0
6	Access roads in residential areas	10.0-15.0	5.0-7.0
7	Pedestrian footpaths	2.0-3.0	2.0

Source: URT, 2011

Therefore, the URT (2011) established right-of-way space standards for different types of roads (see Table 1) that are used in urban and regional planning in Tanzania. However, these space standards are too high to be applied in upgrading informal settlements and once they are applied they are associated with massive demolition of houses along the roads and thus high compensation costs.

2.2 Roads Functional Requirements

The function of a road is defined as the purpose from which the road was planned to provide. Road planners adopt road hierarchy and functional classification for the purpose of minimizing nuisance between different functions on the same road and to maximize efficiency (the use of a road) and safety of traffic movement (De Langen and Tembele, 2001). The type of roads that are mostly found in informal settlements and thus being covered in this study are local distributor roads, access roads and pedestrian footpaths. According to De Chiara and Koppelman (1984), the functional performance of local distributor roads in residential areas is to provide access to the housing clusters; abutting properties; and public facilities. It also provides access to the economic activities along the road, such as shops, small business and workshops; provide link between access roads and district distributor roads; and permits on-street parking (De Chiara and Koppelman, 1984; De Langen and Tembele, 2001; Kildebogaard, 1985).

Furthermore, De Langen and Tembele (2001) explain that local distributor roads may serve as bus routes for public transport in case where the distance to the nearest district distributor road is more than 2 kilometre. The functional performance of access roads (access roads in shopping areas and access roads in residential areas), as explained by De Chiara and Koppelman (1984), is to provide access to buildings and plots within housing clusters and link local distributor roads to the residential housing clusters.

According to this functional use, Kildebogaard (1985) in application of the Radburn concept (Birch, 1980) that is commonly used all over the world in the planning of urban residential areas suggest that free length of access roads should be limited to prohibit through traffic by the use of culs-de-sac and loops. It is also recommended that access roads in residential areas should mostly accommodate non-motorized traffic and provide good residential living environment for children. The functional performance of pedestrian footpaths is to provide direct access to buildings and plots within housing clusters and link the residential housing clusters to community facilities (Kildebogaard, 1985; TRL, 2005). They also form shopping streets with commercial activities on both sides of the paths. TRL (2005) clarify that pedestrian footpaths can include roadside footways, footpaths or special pathways designated for use by pedestrians and cyclists.

2.3 Roads Design Requirements

The road, which is also called the roadway, refers to the road space that consists of carriageway and shoulders (URT, 2000). Depending on the road function elements as determined by road hierarchy, functional classification and right-of-way; road engineers design roadways for different types of roads so-as-to realize their intended functions (De Langen and Tembele, 2001). Roadway design space standards for local distributor roads are depicted from the UK Transport Research Laboratory, which is mostly used in developing countries, including Tanzania. It is recommended by TRL (1991) that Average Daily Traffic (ADT) on local distributor roads should be 100-400 motorized vehicles per day. Therefore, carriageway width for the road is recommended to be 5.0 metre with a shoulder of not less than 1.0 metre wide on both sides. This makes a total of 7.0 metre roadway space for local distributor roads. Roadway design space standards for access roads are to permit ADT between 20-100 motorized vehicles per day (TRL, 1991). Therefore, the minimum carriageway for access roads is recommended to be 3.0 metre (one way traffic) with a shoulder of not less than 1.5 metre wide on both sides of the road. Therefore, 6.0 metre roadway space is recommended for one-way access roads. Shoulders are recommended to protect damage of the edge of carriageway as well as for movement of non-motorized traffic. However, in-case where ADT is less than 20 motorized vehicles per day, both motorized and non-motorized traffic is recommended to share the same carriageway. Design space standards for pedestrian footpaths are required to reduce road-use nuisance between motorized and non-motorized traffic. TRL (1988) therefore, recommends provision of 3.0 metre on both sides from the edge of local distributor roads and access roads for non-motorized traffic. However, physical separations such as bollards are insisted to be provided to segregate pedestrians from motorized traffic for safety reasons (TRL, 1988; 1991).

3. Development of a framework of space standards for roads widening in informal settlements

A framework of space standards for roads widening is focused to develop planning and design space standards in-terms of right-of-way and carriageway for upgrading informal settlements. These space standards are developed to achieve roads widening (right-of-way) requirements, roads functional requirements, and roads design requirements for the purpose of improvement of transport network in informal settlements in-terms of traffic mobility and accessibility.

3.1 Widening of Local Distributor Roads

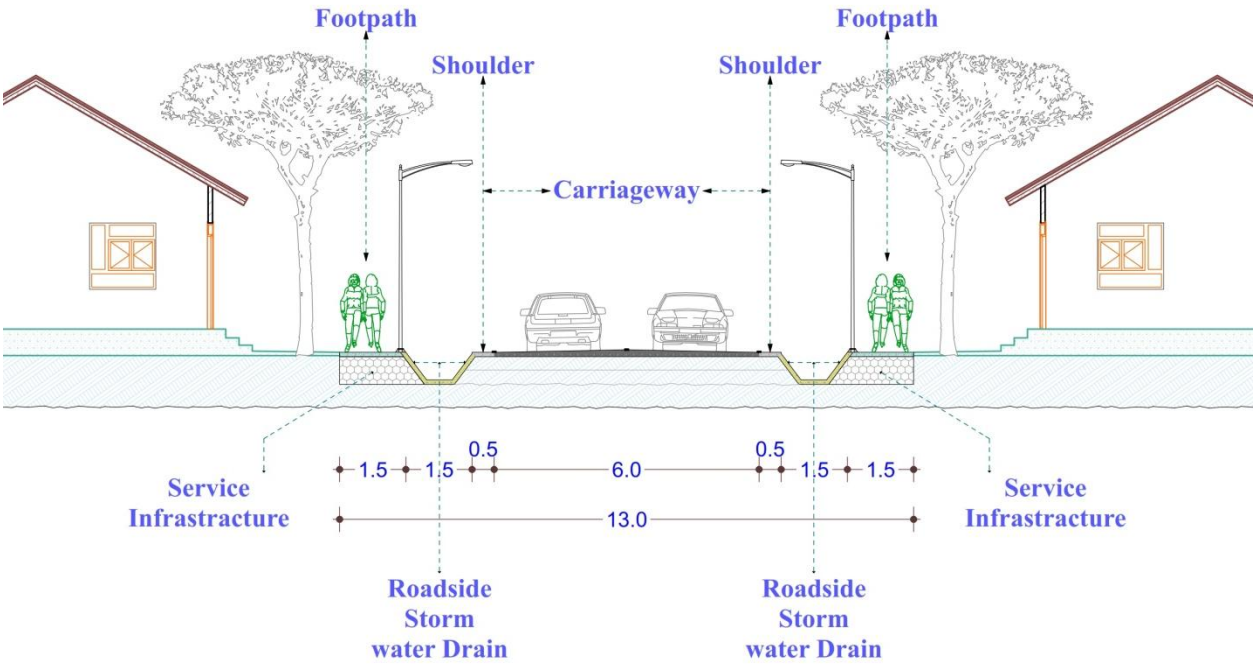
Traffic that traverse within local distributor roads in informal settlements are fire engines, cesspit emptying trucks, garbage collection trucks, 2-axles trucks, commuter minibus, commercial vans, private car, bajaj, motorcycle and pedestrians. Furthermore, traffic volumes in local distributor roads in informal settlements are very high. For instance, Mnyamani road in Buguruni ward accommodates the average of 1,000 motorized traffic per day with the peak hour of 800 vehicles and high concentration of non-motorized traffic, which is about 30,000 pedestrians per day (Mchome, 2016) and roadside commercial activities. Figure 1 shows high traffic volumes, traffic composition and concentration of roadside commercial activities along Mnyamani road, which is a typical example of local distributor roads in highly developed informal settlements in Dar es Salaam City.

Figure 1: High traffic volumes, traffic composition and concentration of roadside commercial activities along Mnyamani local distributor road

4. 

Therefore, to achieve the road widening requirements, road functional requirements road design requirements, as well as to permit different traffic traversing on local distributor roads, the minimum cut-off point of 13.0 metre RoW is proposed for highly developed informal settlements (see Figure 2). Within this RoW space standard; 6.0 metre is proposed for carriageway with 0.5 metre shoulders on both sides of carriageway. Roadside storm water drains 1.5 metre wide are proposed on both sides of the roadway for storm water management. Due to high volume of pedestrians walking along local distributor roads, 1.5 metre is proposed for roadside footway with street lights on both sides from the edge of the road. Overhead electricity is proposed to be installed beside the footways for power distribution to the adjacent buildings as well as for street lights. Other line infrastructures such as water and sewerage are proposed to be installed under roadside footways. Functionally, the 1.5 metre roadside footway and 1.5 metre storm water drain on both sides of the carriageway will provide a buffer for roadway construction machines to operate without causing destruction to the nearby houses.

Figure 2: The minimum space standards proposed for local distributor roads



Open trapezoid storm water drains in this design functions as physical separator between the roadway and roadside footways for safe movement of motorized and non-motorized traffic and thus improve traffic mobility. The need for this physical separation is to minimize road use nuisance between motorized and non-motorized traffic. Storm water drains and roadside footways (3.0 metre on both sides of the roadway) are proposed also to serve as buffer zones for roads construction machines to operate during construction of the roadways (carriageway and shoulders) so-as-to avoid destructions of the nearby houses while shoulders are proposed for protection of the carriageway.

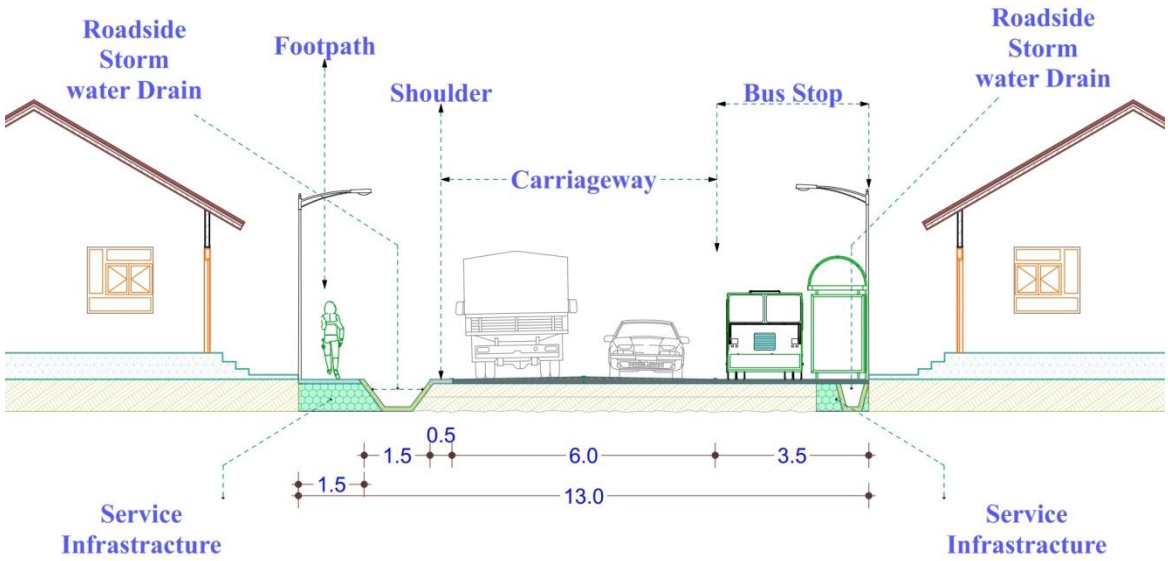


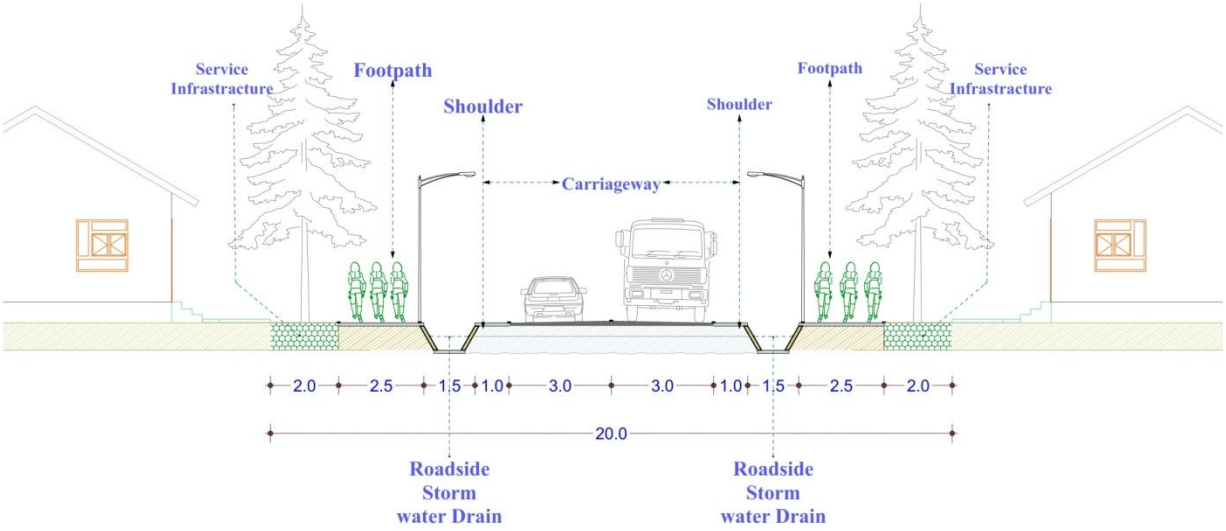
Figure 3: Provisions for bus stops and parking bays proposed along local distributor roads

At the specified sections of the road, the space provided for shoulder and storm water drain will be used for provision of bus stops and for on-street parking (see Figure 3). With this proposal, storm water drain will be provided under roadside footway. Bus stops that are proposed to be provided at an interval of about 1.5 kilometre will facilitate proper functioning of public transport while on-street parking bays will facilitate delivery of commercial goods and customers for the prospering commercial activities along local distributor roads in highly developed informal settlements.The need for provision of bus stops and parking bays along local distributor roads is due to their absence and that when commercial vehicles and commuter bus/minibus need to deliver goods and/or passengers they stop along the roads (see Figure 4). The consequence of this is the increased problems of traffic mobility in informal settlements that hinder proper functioning of local distributor roads.

Figure 4: Delivery of commercial goods along local distributor roads in highly developed informal settlements

Furthermore, for accessibility improvement of emergency services, such as fire engines, local distributor roads in highly developed informal settlements are proposed to be provided at a grid distance of one kilometre, from one road to another. A fire engine has a standard pipe length of 60 metre while a cesspit emptying truck has a standard pipe length of 45 metre. However, there is a possibility of connecting more than one pipe from the fire engine. Therefore, for the purpose of operations' flexibility, it is proposed to connect the maximum of ten (10) pipes. Therefore, it is proposed that the furthest house from local distributor road should be 600 metre. This coverage distance is ideal for accessibility of emergency vehicles such as fire engines, service vehicles such as cesspit emptying trucks and public transport vehicles such as commuter minibus/buses. In-case of upgrading less developed informal settlements, and for the purpose of achieving the road widening requirements, road functional requirements and road design requirements, it is proposed to provide the maximum of 20.0 metre RoW for improvement of local distributor roads (see Figure 5). Within this RoW space standard; 6.0 metre is proposed for carriageway with 1.0 metre shoulders on both sides of carriageway. Roadside storm water drains 1.5 metre wide are proposed on both sides of the roadway for storm water management. Roadside footway 2.5 metre on both sides of the road is proposed for movement of non motorized traffic. Furthermore, 2.0 metre on both sides from the edge of the road is proposed for greening (street trees) and provision of service infrastructure.

Figure 5: The maximum space standards proposed for local distributor roads



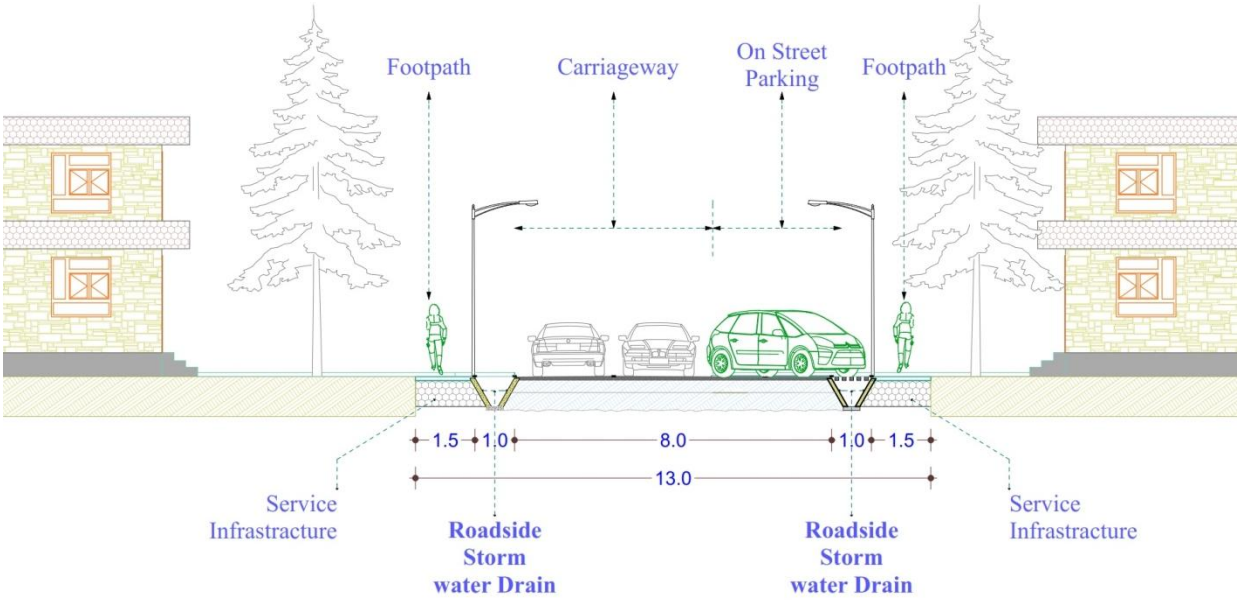
3.2 Widening of Access Roads in Shopping Areas

There are some access roads in informal settlements that are transforming from residential to commercial/shopping streets (see Figure 6). These streets are characterized by transformation of houses from single storey to multi-storey and from residential to commercial land-use activities such as hotels, shops, social/recreational halls, bar and restaurants. Commercial and service vehicles do frequently travel along these access roads to deliver commercial goods and customers as well as emptying septic tanks and soak away pits due to lack of sewerage system.

Figure 6: Shengena access road that is transforming into Commercial Street

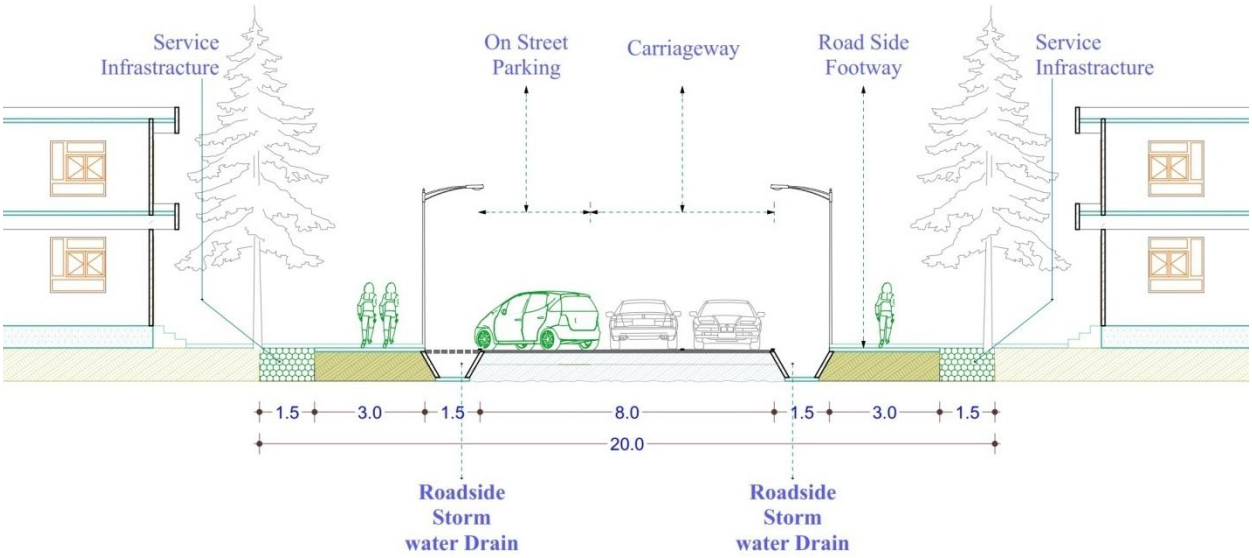
Therefore, to achieve the road widening requirements, road functional requirements, road design requirements, as well as to permit different traffic traversing on access roads in shopping areas, the minimum planning and design space standards of 13.0 metre right-of-way is proposed for the road (see Figure 7). Within this RoW space standard, 8.0 metre is proposed for carriageway of which 5 metre will be demarcated for two lanes and the remaining 3.0 metre will be demarcated for one side on-street parking especially for customer cars, on-loading and off-loading of commercial vehicles as well as for service vehicles. Furthermore, storm water drains 1.0 metre will be provided on both sides of the carriageway. Roadside footway 1.5 metre is proposed on both sides from the edge of the road for pedestrian movement while service infrastructures such as water and sewerage will be provided under roadside footways. Street lights and electricity will be provided overhead along the roadside footways.

Figure 7: The minimum space standards proposed for access roads in shopping areas



Balustrade and/or bollards and/or other means are proposed in the design of access roads in shopping areas for separation of the roadway from the roadside footways for the purpose of minimizing road use nuisance between motorized and non-motorized traffic and thus improve traffic mobility. Functionally, the 1.5 metre roadside footway and 1.0 metre storm water drain on both sides of the carriageway will provide a buffer for roadway construction machines to operate without causing destruction to the nearby houses. In-case of upgrading less developed informal settlements, and for the purpose of achieving the road widening requirements, road functional requirements and road design requirements, it is proposed to provide the maximum of 20.0 metre RoW for improvement of access roads in shopping areas (see Figure 8). Within this RoW space standard, 8.0 metre is proposed for carriageway of which 5 metre will be demarcated for two lanes and the remaining 3.0 metre will be demarcated for one side on-street parking especially for customer cars, on-loading and off-loading of commercial vehicles as well as for service vehicles. Storm water drains 1.5 metre will be provided on both sides of the carriageway. Roadside footway 3.0 metre is proposed on both sides of the carriageway. Furthermore, 1.5 meter is proposed on both sides from the edge of the road for greening (street trees) and provision of service infrastructures such as electricity, water and sewerage. Street lights will be provided overhead along the roadside footways.

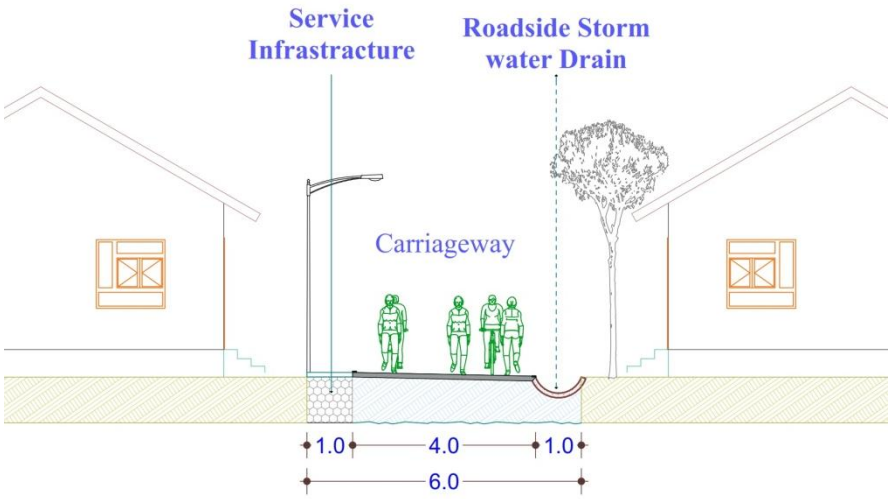
Figure 8: The maximum space standards proposed for access roads in shopping areas



3.3 Widening of Access Roads in Residential Areas

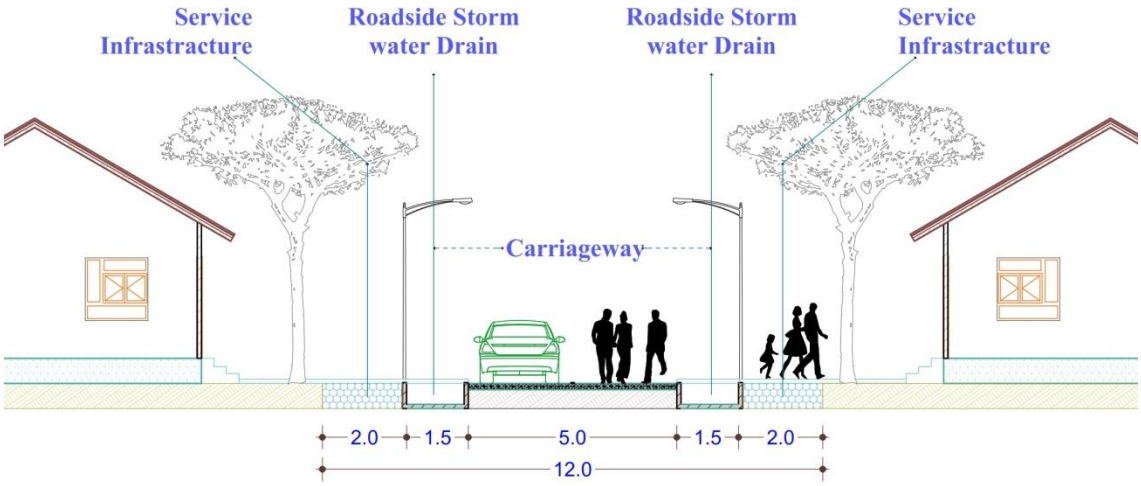
The main traffic that traverses on access roads in residential areas is non motorized traffic, mainly pedestrians. About 95% of people living in informal settlements does not own any means of transport and thus depend on walking while about 4% own bicycles and 1% own cars. However, motorized traffic such as pick-ups and other non motorized traffic such as tri-cycles, bicycles, and push and pull carts are also used along access roads in residential areas to deliver goods at commercial premises such as food stall locally known as '*magenge*', kiosks, charcoal store and markets. Furthermore, service vehicles, commercial vehicles and private cars also use access roads at lower rate. Therefore, service vehicles and commercial vehicles in informal settlements are planned to be used at restricted times of the day, with an exemption of emergency vehicles so-as-to provide safe movement of non-motorized traffic as well as safe residential living environment for children. To achieve the road widening requirements, road functional requirements, road design requirements, as well as to permit different traffic traversing on access roads in residential areas, the minimum planning and design space standards of 6.0 metre right-of-way is proposed for the road (see Figure 9). Within this RoW space standard; 4.0 metre is proposed for carriageway to serve non-motorized traffic together with motorized traffic such as private cars at occasional events and service vehicles at restricted times of the day. This will be a one way route for motorized traffic. Curved open storm water drain 1.0 metre wide is proposed on one side of the road while 1.0 metre infrastructure line is proposed on the other side. These line infrastructures are such as electricity, street lights, water, and sewerage networks.

Figure 9: The minimum space standards proposed for access roads in residential areas



In-case of upgrading less developed informal settlements, and for the purpose of achieving the road widening requirements, road functional requirements and road design requirements, it is proposed to provide the maximum of 12.0 metre RoW for improvement of access roads in residential areas (see Figure 10). Within this RoW space standard; 5.0 metre is proposed for carriageway, 1.5 metre is proposed for roadside storm water drains on both sides of the roadway for storm water management, and 2.0 metre is proposed on both sides from the edge of the road for greening (street trees) and provision of service infrastructures.

Figure 10: The maximum space standards proposed for access roads in residential areas

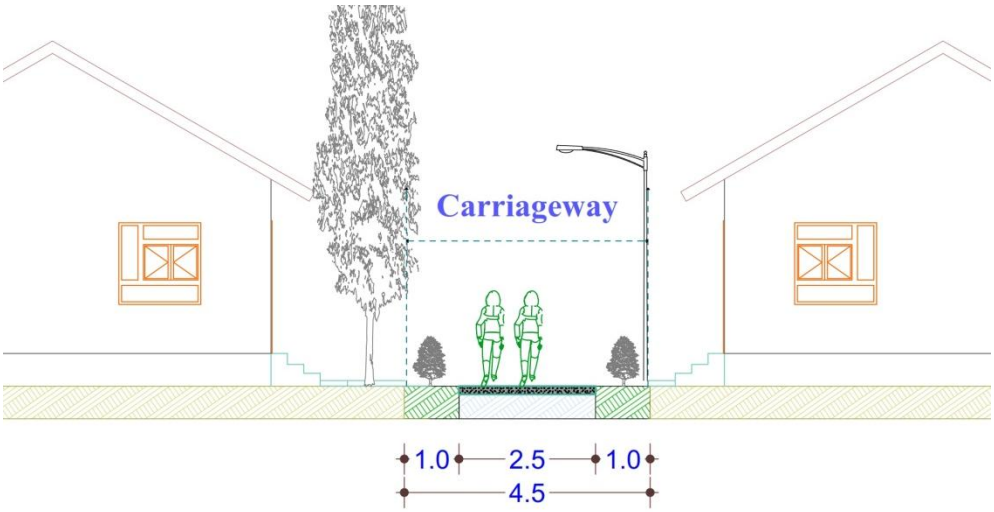


3.4 Widening of Pedestrian Footpaths

Pedestrian footpaths are special roads designated for pedestrian movement that includes roadside footways, footpaths and special pathways. The latter is designated for sharing between pedestrians and cyclists. The minimum planning and design space standards for roadside footways have been explained in the previous sections, which is 1.5-2.5 metre along local distributor roads and 1.5-3.0 metre along access roads in shopping areas. Furthermore, carriageway 4.0-5.0 metre along access roads in residential areas has been proposed for pedestrians as special pathways to be shared with cars at occasional events and service vehicles at restricted times of the day. This section therefore explains the minimum planning and design space standards for footpaths.

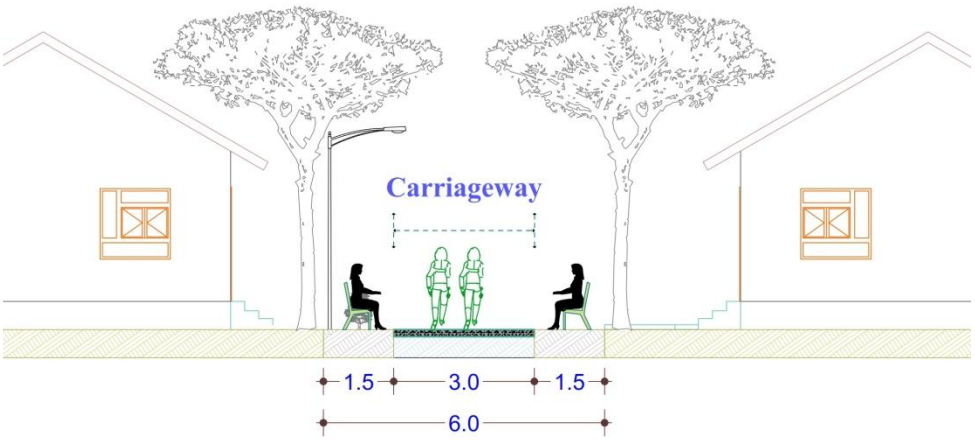
The main traffic that traverse within footpaths are mainly pedestrians, and in some cases cycling. Nevertheless, bajaj, and motorcycles are also proposed to travel along footpaths in informal settlements at occasional cases as well as for emergency events. To achieve the performance requirement of footpaths, and to permit different traffic traversing on footpaths, the minimum planning and design space standards of 4.5 metre RoW is proposed for footpath (see Figure 11). Within this RoW space standard; 2.5 metre is proposed for carriageway and 1.0 metre is proposed on both sides of carriageway for greening with street trees on one side and street lights on the other side.

Figure 11: The minimum space standards proposed for footpaths



In-case of upgrading less developed informal settlements, and for the purpose of achieving the road widening requirements, functional and design requirements, it is proposed to provide the maximum of 6.0 metre RoW for improvement of footpaths (see Figure 12).

Figure 12: The maximum space standards proposed for footpaths



Within this RoW space standard; 3.0 metre is proposed for carriageway and 1.5 metre is proposed on both sides for greening as green belt for breathing of the built up area. Street trees and benches will be provided on both sides for improvement of the walking environment and the residential living environment while street lights will be provided on one side. Table 2 provides the summary of the proposed planning and design space standards for different types of roads in upgrading informal settlements.

Table 2: The proposed planning and design space standards for roads network in informal settlements

Road Hierarchy	Type of Road	Right-of-Way (Metre)	Carriageway (Metre)
1	Local distributor roads	13.0-20.0	6.0
2	Access roads in shopping areas	13.0-20.0	8.0
3	Access roads in residential areas	6.0-12.0	4.0-5.0
4	Footpaths	4.5-6.0	2.5-3.0

5.Conclusion

A framework of planning and design space standards has been developed to provide an upper and lower limit of space standards for roads widening in informal settlements for transportation improvement. The purpose of this framework of space standards is to minimize demolition of houses and compensation costs while at the same time improve traffic mobility and accessibility in informal settlements.

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