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Integration of Transport and Land Use Planning by Transit-Oriented Development for Economic Sustainability of the Standard Gauge Railway Projects in Tanzania

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Abstract

Tanzania is one of the countries in Africa that has engaged in the projects for construction of the electrified Standard Gauge Railway (SGR). However, lack of integration of transportation and land-use planning threatens economic sustainability of the SGR project. This study was carried out for the purpose of finding-out how transportation can be integrated with land-use planning for economic sustainability of the project. The study was carried-out by using qualitative research approach through demonstration as case study. Findings show that construction of the SGR is not integrated with land-use planning around the stations and along the SGR corridor. It is concluded that economic sustainability of the SGR projects can be achieved by integration of transport and land-use planning. As demonstrated, it is recommended to deliberate for integration of transportation and land-use planning in the SGR projects of which the prime land within Transit Stations can be efficiently used by using Transit Oriented Development and secure more land for production activities around the Transit Stations and along the SGR corridor.

Keywords

Economic Sustainability, Standard Gauge Railway, Land Planning, Transit-Oriented Development, SGR Transit Stations

1. Introduction

Tanzania and other African countries mainly South Africa [1] [2], Ethiopia [3] [4], Morocco [5] [6] and Kenya [7] [8] [9] have embarked into the mega projects for construction of the Standard Gauge Railway (SGR). This is part of the Afri-

can Integrated High-Speed Railway Network (AIHSRN) project of the African Union (AU) Agenda 2063 that is a strategic framework for the socio-economic transformation of the continent over the next 50 years, from 2013 [6] [10]. The purpose of AIHSRN is to enable the achievement of the AU Vision of integrating Africa physically and economically by connecting all major cities, capital cities and commercial centres in the African continent as well as to support Africa's growth through trade, development and structural transformation [11].

Furthermore, as explained by [10] and [11], there are five key drivers of railway potentials in Africa. Firstly, the increase in transport demand due to the African economic growth. Secondly, the increase in global supply chains competitiveness leading to relocation of the industries from other continents to Africa. Thirdly, the increase in the number and size of African cities due to the increase of urban population. Fourthly, the new mining developments in Africa producing high volumes as they had remained unexploited for several years due to the high costs of infrastructure necessary to access those mining areas. Fifthly, the existence of the largest number of landlocked countries in Africa compared to other continents in the world.

Also, the [10] reports that the AIHSRN is expected to fast-track the implementation and realization of the six key continental frameworks and initiatives. They are firstly, the Boosting of Intra-African Trade (BIAT). Secondly, the Continental Free Trade Area (CFTA), Thirdly, the Comprehensive Agricultural Development Programme (CAADP). Fourthly, the Accelerated Industrial Development for Africa (AIDA). Fifthly, the African Mining Vision (AMV). Sixthly, the Pharmaceuticals Manufacturing Action Plan (PMPA). Additionally, AIHSRN through SGR projects is expected to become a key catalyst to bring unity, peace and security in the continent [10].

However, connecting the major cities, capital cities and commercial centres through the SGR in realization of the AIHSRN without integration of land-use along the SGR corridor and around Transit Stations threatens economic sustainability of the projects. The same concern was raised in Ethiopia and Djibouti [3] as well as Kenya [7] [12]. Furthermore, researchers have seldom conducted the empirical studies on how the SGR can be integrated with land-use planning and development for the economic sustainability of the SGR projects. This literature gap has motivated the carrying out a study on that important topical issue. In the current international discussions, "Transit-Oriented Development" is considered to be a useful concept in integrating transportation and land-use planning [13].

2. Transit Oriented Development and Land Use Planning

Transit Oriented Development (TOD) is defined as a type of urban development that maximizes the amount of mixed land-use developments of high densities around and within walking distance to the Transit Stations with lower densities spreading out from the centre. These land-use developments include residential,

commercial, recreational and community and public facilities. The recommendable walking distance of the furthest residential house to the Transit Station is 0.5 mile that is equal to 0.8045 kilometres or 804.5 metres [14]. Also, [13] explain transit network to consist a maximum distance of 3 km; regional transit with maximum distance of 30 km; and interregional transit with maximum distance of 300 km.

TOD is receiving attention all over the world as it facilitates increased accessibility by providing alternatives to automobile-based land-use developments [13]. Furthermore, it provides a real alternative to address traffic congestion in urban areas by using non-motorized transport and provide residents with improved quality of urban life by increasing the degree of human interaction in the public domain. Also, it reduces transportation costs by using a combination of non-motorized transport and transit; provide stable mixed land-use development that reduces environmental impacts; and improves the urban centres being attractive and lively places to live and work [13] [14].

[14] redefined the term TOD as Performance Based Definition to include five main variables; which are location efficiency, rich mix choices, value capture, place making and resolution of the tension between mode and place. Location efficiency is explained in-terms of placement of residential areas and Transit Stations. Residential areas should be located in proximity to Transit Stations whereas Transit Stations should be centrally or conveniently located for accessibility by walking or bicycling. Rich mix of choices is explained that residential areas should provide a mix of uses to make the residents more convenient because several errands can be completed in one trip within a walking distance. Value capture is explained that the mixed land-use developments within walking distance should enable residents to save substantially from the transportation costs that are the second highest expenditure in urban areas, after housing. Place making is explained that mixed land-use developments should be connected with attractive network of pedestrian streets to encourage walking trips. Resolution of tension between mode and place is explained that Transit Stations should provide the most favourable choice of the public transport that links the urban centres with other places.

[15] explains four strategic principles required for integration of land-use planning and transportation through TOD for achieving sustainable transport. The first principle states that urban centres should be linked to Transit Stations and with the rapid transit base. The second principle states that land-use planning and transport strategies should be reviewed for each city to asserts where urban centres need to occur, in what density and development mix. The third principle states that strategic planning base should be established to make sure that development occurs at the necessary density and design in each centre. The fourth principle states that public private funding mechanisms should be established for development of TOD. [16] also supports the fourth principle for sustainable urban development.

Generally, there are five key tools that are used for integration of land-use planning and transportation through TOD. Through the successful empirical cases, these tools are Urban and Regional Planning [17]; Regional Metro System [18]; Impacts Management [19]; Urban Planning Policy [20] and the High-Speed Railway [21].

Urban and Regional Planning was used as a tool for integration of land-use planning and transportation through TOD in Western Australia. In application of this tool, urban and regional planning provided strategies to replace the traditional model of dispersed development (urban sprawl) framed with private car transport [17].

Regional Metro System was used as a tool for integration of land-use planning and transportation through TOD in Naples and Campania in Italy. In application of this tool, Regional Metro System was integrated in the existing railway lines by building some new interconnecting links, new Transit Stations and new modal interchange facilities as well as integrating transport development with urban development [18].

Impacts Management was used as a tool for integration of land-use planning and transportation through TOD in Subi Centro in Western Australia. In application of this tool, the pre development phase was used to find out on how to manage the impact of creating TOD precincts within the existing urban fabric. Thus, the perceived issues and impacts in the pre development phase were handled in the design of land-use, transport linkages and parking as well as in the implementation stages. Furthermore, the outcomes were measured through post implementation that include retail impacts, rental growth, travel behaviour, land values, planning codes and trading regulations [19].

Urban Planning Policy was used as a tool for integration of land-use planning and transportation through TOD in Singapore. In application of this tool, the Urban Planning Policy Framework was used to guide the urban growth pattern that is highly influenced by planning and development of new towns around the public transit system. Achievement of this approach enabled Singapore to be famous in the world for development of TOD through its efficient public transport system integrated with land-use planning, urban design and housing developments. The robust articulation between land-use type, density and its distribution, walking and bicycling environment and transit has successfully shaped the practice of integrating land-use planning, urban design and public transit operation in Singapore [20].

High Speed Railway was used as a tool for integration of land-use planning and transportation through TOD in Randstad, the Netherlands. In application of this tool, a high-speed railway was constructed to link Randstad and Paris through which railway Transit Stations were built with housing, offices, work and facilities in higher densities at and around the Transit Stations. By using the Stedenbaan Plan, the high capacity of the railway and the reliable high frequency regional train services enabled users to get assured of the departure times. Thus, more people used public transport as an alternative for the car [21].

Therefore, this study aims to examine the use of TOD to integrate transportation and land-use planning for economic sustainability of the SGR projects. This is necessary for realization of the AIHSRN by connecting the major cities, capital cities and commercial centres. The focus is to make efficient use of the SGR stations in-terms of transit stations and its surrounding land-use developments and along the SGR corridor to sustain the SGR project.

3. Research Methodology

3.1. Research Approach

The study adopted qualitative research approach by demonstration as case study. This approach of using case study for demonstration is also supported by [22] as well as [23] as it answers the what (what has been done) and how (how has been done) research questions with illustrations. Furthermore, [24] explains the importance of demonstration and illustrations for the purpose of understanding how the issue should be addressed. Qualitative research approach, according to [25], was also used for the purpose of obtaining more useful and detailed information from primary and secondary sources.

3.2. Data Collection and Analysis

The study required qualitative data of which were obtained through both primary and secondary data collection methods. Primary data were collected through interviews and discussions done with the SGR Project Manager and Town Planners of the Municipal and Town Councils across the project areas. Checklists consisting structured questions were used as tools to guide the interviews and discussions with these officials to get their views, and opinions on how SGR can be integrated with land-use planning for economic sustainability of the project. This kind of interviews and discussions to obtain information is also supported by [26] [27] [28].

The secondary data were collected through literature review. This method was used to obtain useful information on how TOD has been applied in different parts of the world for the purpose of learning from the best cases on how transportation can be integrated with land-use planning. [25] also supports the use of literature review in research for the purpose of learning.

Thereafter, the collected data were analysed with the help of content analysis of which has been named by [26] [27] [29] as the method which can be used to make analysis of the obtained qualitative data. Through applying this method, the data were organized in terms of themes, clustered in related information according to the research purpose and information required to answer the research questions. Furthermore, QGIS 3.16 and ArchiCAD 22 were used to prepare figures (Maps and 3D Models) to show integration of transportation and land use planning for the purpose of demonstration.

4. Results and Discussion

The electrified SGR project in Tanzania, from Dar es Salaam Commercial City to

Dodoma Capital City with a total distance of about 541 km consists of 13 SGR stations of which, 3 are Main Stations and 10 are Intermediate Stations. The Main Stations are Dar es Salaam, Morogoro and Dodoma while the Intermediate Stations are Pugu, Soga, Ruvu, Ngerengere, Mkata, Kilosa, Kidete, Gulwe, Bahi and Makutupora. The total distance of 541 km was divided in two lots of which, Lot 1 from Dar es Salaam to Morogoro covers 205 km and Lot 2 from Morogoro to Dodoma and Makutupora covers 336 km. Lot 1 was inaugurated in April, 2017 by the late President Dr. John Pombe Magufuli when he laid the foundation stone for construction by the Turkish construction group Yapi Merkezi and the Portuguese construction group Mota-Engil. Also, Lot 2 was inaugurated by the same in April, 2018 when he laid the foundation stone for construction by the Turkish construction group Yapi Merkezi.

Standard Gauge Railway (SGR) is a railway with a track gauge of 1435 mm that has high capacity of accommodating speed trains and big volume of freight compared to other rail gauges. For instance, in Morocco the SGR has the maximum travelling speed of 320 km/h on the 180 km section from Tangier to Kenitra and 160 km/h on the 200 km section between Kenitra and Casablanca [6]. In South Africa, the SGR has the maximum travelling speed of 160 km/h for passenger train compared to the 50 km/h of the existing Cape Gauge Railway (CGR) with a track gauge of 1067 mm [1] [6] [30]. In Ethiopia and Djibouti, the SGR has the maximum travelling speed of 120 km/h for passenger train and 80 km/h for freight train compared to 50 km/h of the current Metre Gauge Railway (MGR) with a track gauge of 1000 mm [3] [4] [31]. In Tanzania, the SGR has the maximum design speed of 160 km/h for passenger trains and 80 km/h for freight trains compared to 30 - 50 km/h of the existing MGR [32] [33].

According to [32] and [33], the SGR project in Tanzania is developed in phases of which Phase 1 has 5 lots with a total distance of 1172 km. Lot 1 and 2 with a total distance of 541 km have been covered in this study while the remaining 3 lots are underway. These are Lot 3 from Makutupora to Tabora with a total distance of 249 km; Lot 4 from Tabora to Isaka with a total distance of 133 km; and Lot 5 from Isaka to Mwanza with a total distance of 249 km respectively. Phase 2 has 3 lots with a total distance of 1011 km. Lot 1 from Isaka to Kigoma with a total distance of 411 km; Lot 2 from Uvinza District, Kigoma Region in Tanzania to Musongati Region in Burundi with a total distance of 240 km with a target to transport Nickel deposit in Musongati that is estimated to be about 150 million tonnes; Lot 3 from Kativia to Karema Port in Kigoma (Tanzania) to ferry through Lake Tanganyika to Kalemie Port in the DRC has a total distance of about 360 km. Phase 3 with a total distance of about 1000 km is expected to connect Tanzania through Mtwara Port in Indian Ocean to the neighbouring countries of Zambia and Malawi through Lake Nyasa. The same SGR project is expected to connect Liganga and Mchuchuma with unexploited deposits of Iron Ore and Coal with Mtwara Port in Tanzania. All these are potentials for development of SGR projects in Tanzania in realization of the AIHSRN. Thus, economic sustainability of the SGR projects is of paramount importance.

It was found that construction of the electrified SGR in Phase 1 Lot 1 and 2 with 13 SGR stations was not connected with land-use planning around the stations and along the SGR corridor. Thus, speculation and urban sprawl developments have started around the stations. Furthermore, lack of land-use planning along the SGR corridor to remain with the existing situation threatens the availability of cargo in the main and intermediate stations. This may result to SGR being for passenger trains while freight trains may be from the beginning to the end of the rail. This situation threatens the economic sustainability of the SGR project. [3] reported the same worry in the Ethiopia and Djibouti SGR project while [7] and [12] reported the same worry in Kenya SGR project. If SGR projects are not economically sustainable, it will be not possible to achieve the purpose of AIHSRN as reported by [11], which is to integrate Africa physically and economically by connecting all major cities, capitals and commercial centres in the continent together with supporting of the Africa's growth through trade, development and structural transformation.

Conceptually, economic sustainability of the SGR projects can be achieved by integration of transportation and land-use planning. This integration of transportation and land use planning was also recommended by the SGR Project Manager and Town Planners in the Ministry of Lands, Housing and Human Settlements Developments; National Land Use Planning Commission and the Municipal and Town Councils across the project area. This study considered the use of TOD for integration of transportation and land use planning. This consideration is also supported by [13] that TOD is one the concepts that can be used to integrate transportation and land-use planning. Other concepts are such as Smart Growth [34] [35]. In application of TOD, the SGR stations are proposed to be developed in-terms of Transit Stations of which the Main Stations are proposed to be planned for development as the Urban Centres while the Intermediate Stations are proposed to be planned for development as Small Towns. With this integration, economic sustainability of the SGR projects can be achieved with availability of enough passengers and cargo through the following land use planning and TOD considerations:

1) Accommodating more urban land-uses on small land around Transit Stations through high density of mixed land-use developments such as commercial, residential and institutions (offices and community facilities/services) that are developed in a form of Urban Centres and Small Towns.

2) Providing more land along the SGR corridor to be developed in a form of Industrial Zones, Special Economic Zones, Export Processing Zones, Free Economic Zones, Logistics Centres, Agriculture Processing or Production Centres, Meat Processing Centres, Mining Processing Centres, Mining Centres, and Sports and Recreation Centres.

3) Supporting a vibrant development of economic activities such as shops, stores, jobs, banks and homes by locating them in a walking distance to each other and create walkable communities. More densely populated areas provide enough local customers and labours for viability of the business and other eco-

nomic activities.

4) Providing a wide range of residential housing choices from single-family homes to apartments and residential houses that allows people of different incomes and at different stages of life to live in the same area.

5) Improving provision of urban utility service such as water, sewerage and energy that can be delivered cost-efficiently (less costly to deliver) in more densely populated areas.

6) Improving provision of community facilities/services such as health facilities (hospitals, health centres, etc.), education facilities (colleges, secondary and primary schools) and recreational facilities (plazas, parks and leisure) that can be delivered at low cost in more densely populated areas.

7) Improving the environment by reducing car dependency and thus, lower emissions and provides better air quality.

8) The existing MGR that is parallel with the SGR will accommodate commuter trains for public transport. It is proposed to shuttle passengers and cargo between the Intermediate Stations and feed to the SGR through the Main Stations.

9) Reducing dependency on private cars and encourages people to be less dependent upon vehicles and thus, address the problem of traffic congestions in urban areas.

Therefore, the SGR Transit Stations can be well planned in a form of Urban Centres and Small Towns by using TOD concept and be connected with the planned SGR corridor for production purposes to include Industrial Zones, Special Economic Zones, Export Processing Zones, Free Economic Zones, Logistics Centres, Agriculture Processing or Production Centres, Meat Processing Centres, Mining Processing Centres, Mining Centres, and Sports and Recreation Centres. **Figure 1** shows the location of the SGR stations from Dar es Salaam Commercial City to Dodoma Capital City and their conceptual design.

Conceptually, in application of TOD, the Transit Stations are located at the centre to form the focal point of land-use developments surrounded by mixed use of commercial, residential and community facilities/service buildings. Outwardly and along the SGR corridor land developments is proposed to include Industrial Zones, Special Economic Zones, Export Processing Zones, Free Economic Zones, Agriculture Production Zones, Agriculture Processing Centres, Logistics Centres, Meat Processing Centres, Mining Processing Centres, Mining Centres, and Sports and Recreation Centres.

Compact development in a form of pyramid is proposed to depict the arrangement of urban developments. As illustrated in **Figure 2**, the tallest buildings that consist of the Transit Station and commercial buildings will be located at the centre whereby the building height will be decreasing outwards. **Figure 2** details the conceptual plan by illustrating land-use developments of one of the SGR Intermediate Station into a Small Town.

The first which is the inner zone as shown in **Figure 2** consists of the Transit Station, which is the focal point of the design. The Transit Station that is designed for mixed use development is connected with the bus terminals for modal

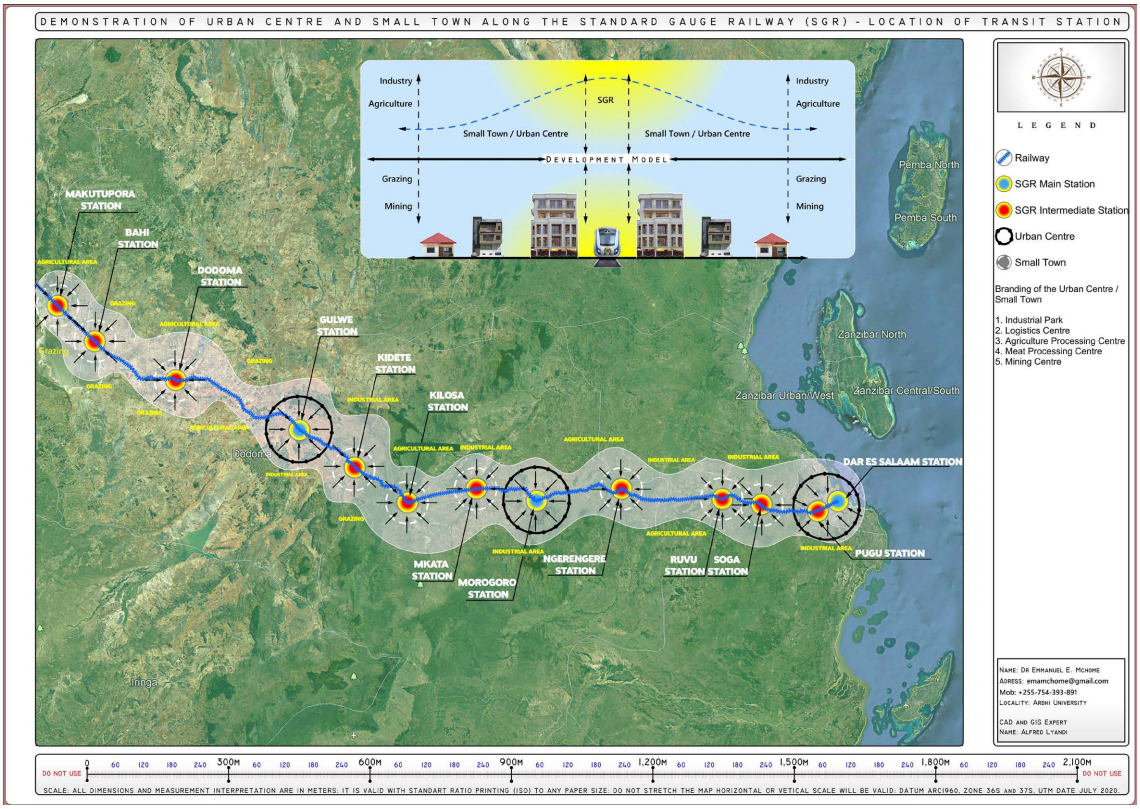

Figure 1. Location of the SGR Stations and their proposed conceptual designs. Source: TRC SGR alignment and satellite, 2021.

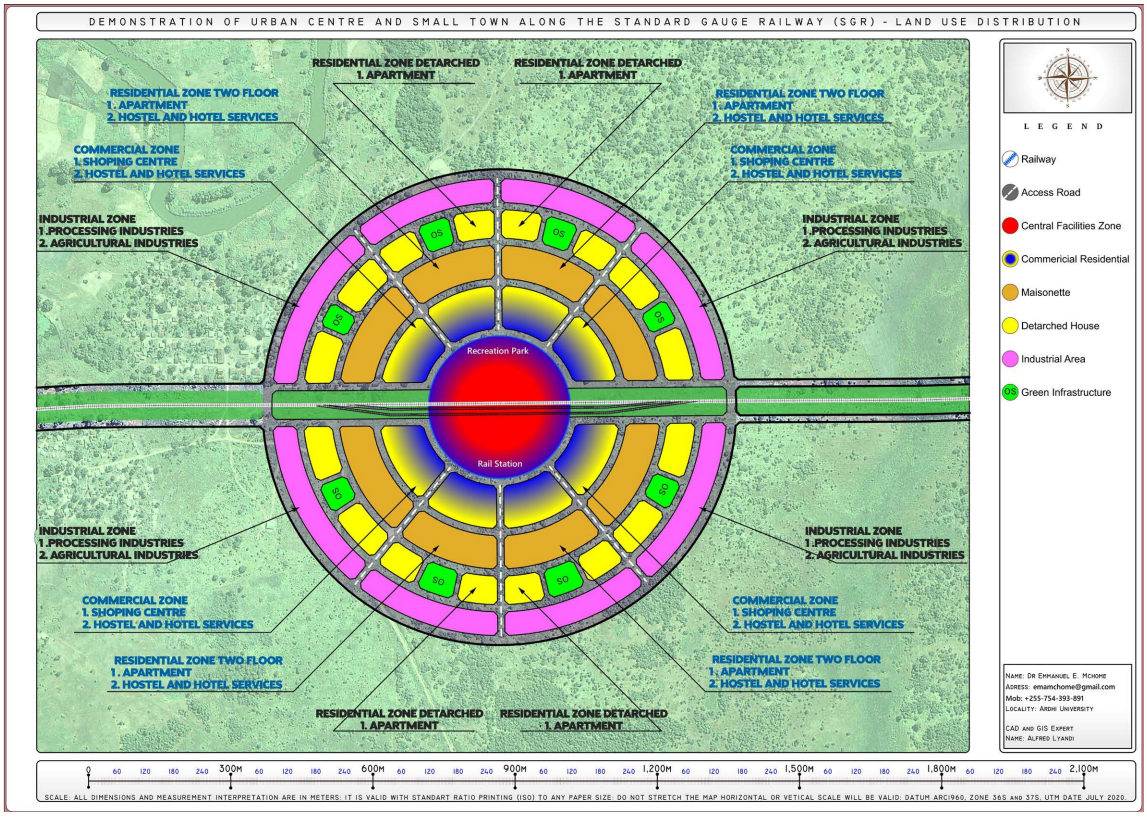

Figure 2. Proposed land-use plan of the SGR transit station as a small town. Source: Author's design of a case study.

shift from train to busses and vice-versa. The Main Stations will accommodate passenger and commuter trains while the Intermediate Stations will accommodate commuter trains. Freight trains will be accommodated in all stations. Furthermore, a park, square, plaza and community hall are proposed to be provided within this zone of Transit Station. Conceptually, the Transit Station that accommodates mixed uses is open for travellers as well as commercial premises at the ground floor whereas the first floor is recommended for commercial activities. The second floor is proposed to include SGR station offices. The proposed building height is 3 storeys.

The second zone around the Transit Station as shown in **Figure 2** consists of mixed-use houses. Within these buildings, ground floors are proposed for banks and commercial activities that are connected with shopping arcade and walkways. The first and second floor is proposed for residential activities. Thus, the proposed building height is 3 storeys.

The third zone around mixed-use houses as shown in **Figure 2** consist of a mixture of residential houses, hotels and restaurants as well as office blocks that are proposed to include public, private and urban utilities service providers such as water, sewerage and energy. A wide range of residential housing developments have been considered to provide all choices from single-family homes to apartments that allows people of different incomes and at different stages of life to live in the same area. The proposed building height is 2 storeys.

The fourth zone as shown in **Figure 2** consists of single storey residential houses. The furthest building is proposed to be one kilometre from the Transit Station for improvement of the walking environments. Community services such as education and health facilities are also proposed in this zone.

The fifth which is the outer zone that also runs along the SGR corridor as shown in **Figure 2** consists of the production zones/centres. These are Industrial Zones, Special Economic Zones, Export Processing Zones, Free Economic Zones, Logistics Centres, Agriculture Processing or Production Centres, Meat Processing Centres, Mining Processing Centres, Mining Centres, and Sports and Recreation Centres. Economically, the outer zone will provide more employment opportunities to the people as well as cargo to feed the SGR Transit Stations.

All development activities will be connected with short distance walkways that will be designed with shade trees and benches on both sides to improve the walking and cycling environments for reducing dependency on private cars. Furthermore, branding of the SGR Urban Centres and Small Towns will depend on what economic activities can be offered at best compared to other areas. **Figure 3** shows the detailed design of the SGR Transit Station as a Small Town while **Figure 4** shows its 3D Model. **Figure 5** shows part of the proposed 3D Model in detail while **Figure 6** shows the proposed 3D Model of the SGR Transit Station. **Figure 7** shows the proposed 3D Model of the Mixed-Use Buildings for illustration purposes.

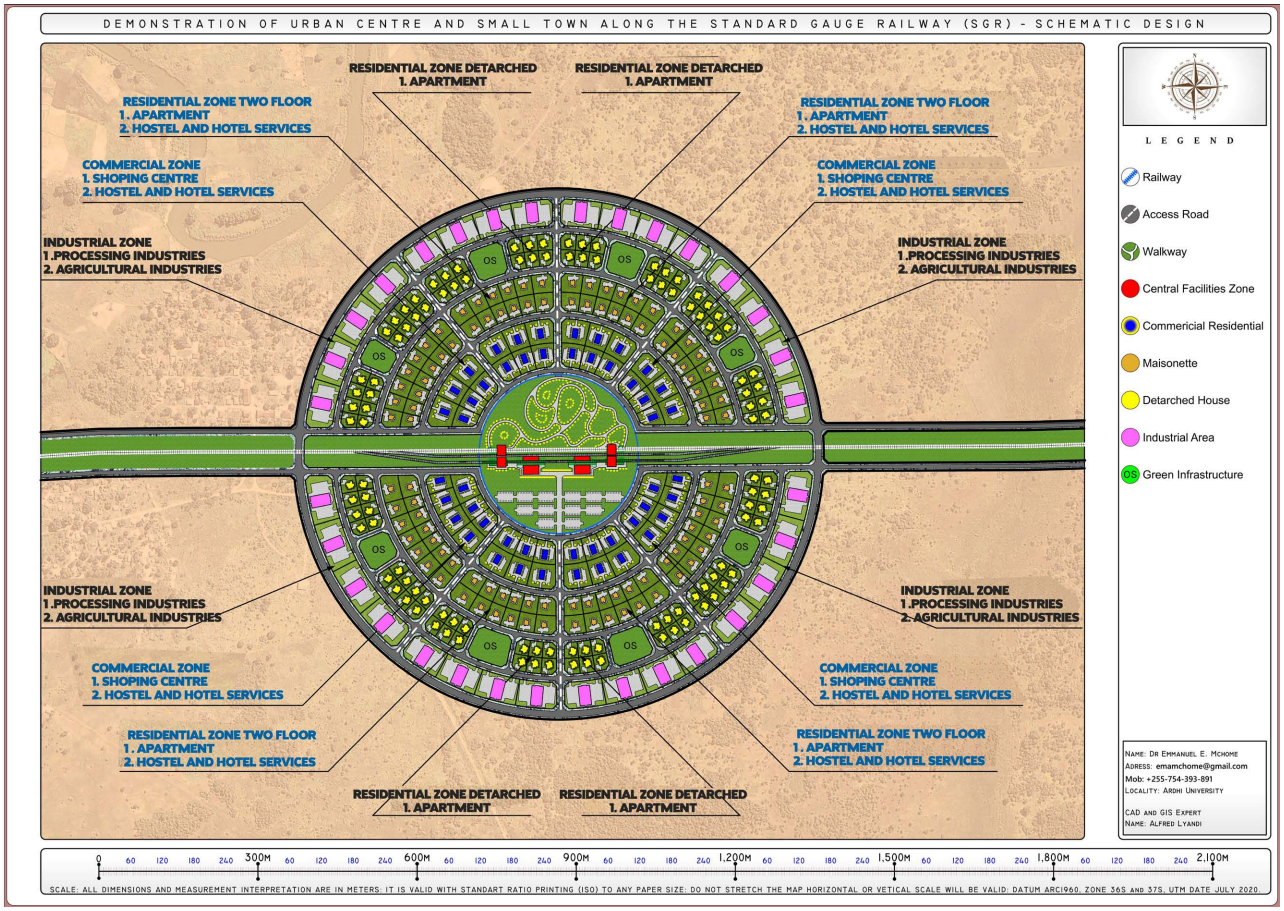

Figure 3. Proposed detail design of the SGR transit station as a small town. Source: Author's design of a case study.

Figure 4. Proposed 3D model of the SGR transit station as a small town. Source: Author's design of a case study.

However, the form of urban development will be different in actual design and implementation to correspond to the topographical nature and requirements of the key stakeholders. These key stakeholders are those responsible for SGR developments, land-use planning and attraction of investors on the one hand and investors, development partners, urban utilities service providers, community service providers and land owners on the other.

Figure 5. Proposed 3D model of the enlarge part of the SGR transit station. Source: Author's design of a case study.

Figure 6. Proposed 3D model of the SGR transit station. Source: Author's design of a case study.

Figure 7. Proposed 3D model of the mixed-use buildings. Source: Author's design of a case study.

5. Conclusion and Recommendations

Sustainably, development of the SGR can be achieved through integration of transport and land-use planning. With this integration, Intermediate and the Main Stations of the SGR will be assured of sufficient passengers and cargo to transport rather than depending from end-to-end freights. There are various concepts through which transport and land-use planning can be integrated. This study has proposed the integration by using Transit Oriented Development that has been used in different parts of the world with positive results. With this concept, small land can be used for residential and all supporting facilities connected to the Transit Stations within walking distance and more land can be secured for production activities around the Transit Stations and along the SGR corridor. These production activities in-terms of land-use are proposed to include Industrial Zones, Special Economic Zones, Export Processing Zones, Free Economic Zones, Logistics Centres, Agriculture Production and Processing Centres, Meat Production and Processing Centres, Mining Production and Processing Centres, and Sports and Recreation Centres. Thus, the Vision of the African Union to integrate Africa physically and economically by connecting all major cities, capitals and commercial centres in the African continent as well as to support Africa's growth by trade, development and structural transformation over the next 50 years, from 2013, can be achieved through the Standard Gauge Railways that forms the African Integrated High-Speed Railway Network. However, the following are the recommendations for the successful integration of transport and land-use in implementation of the Standard Gauge Railway projects through Transit Oriented Development.

Deliberation for development of the Transit Stations and the surrounding areas in a form of Urban Centres and Small Towns by using Transit Oriented Development concept should be made by the responsible railway authorities in coordination with the key stakeholders. In the Tanzanian context, the responsible authority is Tanzania Railways Corporation while some of the key stakeholders include the Ministry of Lands, Housing and Human Settlements Development; National Land-use Planning Commission; District Councils; Export Processing Zone Authority; Tanzania Investment Centre; Utility Agencies; the Private Sector and Development Partners. This deliberation is required for commitment to plan and build the Transit Stations and development activities around the Transit Stations and along the SGR corridor.

Place branding of the Urban Centres and Small Towns around the Transit Stations for place marketing should focus on the competitive market and comparative advantages of what it can offer at best compared to others in order to attract inward investment. Decision of the place branding should be made by the responsible railway authorities by involving the aforementioned key stakeholders.

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ecution of the following three assignments:

- Joint Task Force Assignment (2020-2021) to Prepare Livelihoods Impact Assessment (LIA) for the Standard Gauge Railway (SGR) for Lot 1 from Dar es Salaam to Morogogo and Lot 2 from Morogoro to Makutupora. This work was carried-out by a Team of Experts from the University of Dar es Salaam, Ardhi University and Tanzania Railway Corporation.
- Joint Task Force Assignment (2020-2021) to Update the Environmental and Social Impact Assessment (ESIA) and Prepare the Resettlement Action Plan (RAP) for the Proposed 220 kV Transmission Line from Dar es Salaam to Morogogo (LOT 1) and Morogoro to Makutupora (LOT 2) for Standard Gauge Railway (SGR) Project Power Supply. This work was carried-out by a National Team (Joint Task Force) from the University of Dar es Salaam, Ardhi University, TRC and TANESCO.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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