

Land use and urban travel in Kumasi, Ghana

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Abstract Globally, transport literature indicates a strong effect of land use on urban travel as people living in low density suburban areas tend to travel more by car than people living in high density urban areas. This is because in dense areas, public transport is organised more efficiently and travellers tend to travel shorter distances. However, this assertion is frequently based on locations with efficient integration of transport within the land use planning framework. In Ghana and many African countries, it remains unknown whether the effect of land use on urban travel is strong as reported in developed countries and elsewhere. This research examines the effect of land use on urban travel in Ghana using Kumasi, the second largest city in Ghana, as a case study. Simple questionnaire survey with urban residents, semi-structured interviews with agencies and secondary data analysis were used for this research. Results indicate negative effect of land use on urban travel as there has been increased congestion in all the major road arterials in the city resulting in difficulty in

commuting using motorised transport. Findings further show a weak effect of land use on urban travel, as areas experiencing change of land use have poor locational accessibility. The paper recommends innovative ways of meeting the growing travel demand of residents in the city such as the development of a light rail and bus rapid transit systems to help ease congestion and improve public transportation.

Keywords Land use · Trips · Transportation · Mobility · Accessibility · Ghana

Introduction

In many ways, urban researchers in Ghana (e.g., Adarkwa 2012; Amoateng et al. 2013; Cobbinah et al. 2015; Obeng-Odoom 2013) have already covered many of the major urban development issues that have stimulated debate since the turn of the twenty-first century, viz urbanisation, peri-urbanisation, slum development and physical development. Arising not least from the diversity of urban development issues in Ghana such as air pollution, congestion and urban sprawl, Poku-Boansi and Adarkwa (2015) have expressed misgivings about the level of generalisation of attributing these urban challenges to inefficiencies in urban public transportation system, and the lack of explicit attention to specific urban transport-land use characteristics which Amoako et al. (2014)

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share. These characteristics include travel behaviours, pedestrian needs, and transport-land use dynamics. Although it is true that transportation and land use are globally reported to exhibit strong relationship, such a relationship remains largely unknown in urban Ghana. This relationship is revelatory in people living in low density suburban areas and travelling more by car than people living in higher density urban areas. In dense urban areas, public transport is organised more efficiently with shorter distance travels (Badoe and Miller 2000; Banister 2002, 2005; Schwanen and Mokhtarian 2005; Wee 2011). Indeed, Owusu-Ansah and O'Connor (2006) express concern about the explicit limited attention to transport accessibility in emerging residential neighbourhoods in the Ghanaian city of Kumasi by city authorities. Similarly, although transport accessibility, in terms of access roads, is an important residential location decision factor, Poku-Boansi and Adarkwa (2015) found that many residents in the Adenta Municipality of Ghana developed properties without adequate consideration to transportation infrastructure and services. Presumably, these concerns of lack of consideration for urban transport will ultimately be reflected in both the nature of, and relationship between land use planning and transportation.

Regrettably, the issue of lack of consideration for urban transport is compounded by rapid urbanisation. For example, a substantial amount of urban land use changes in Ghana over the last decade have occurred in large cities (e.g., Accra, Kumasi, Sekondi-Takoradi, Tamale) where populations are growing over 3% per annum (Ghana Statistical Service 2012) and spatial expansion is occurring at a rapid rate (see Aduah and Baffoe 2013). Many of these cities serve as the stronghold of Ghana's socio-economic development, yet have poor transport infrastructure and services, in terms of street connectivity, motorability and ease of mobility within neighbourhoods particularly in emerging residential and peri-urban neighbourhoods (Cobbinah et al. 2017; Gyimah 2001; Owusu-Ansah and O'Connor 2006). As Poku-Boansi and Adarkwa (2015) indicate, the relationship between land use and urban travel remains equivocal in Ghana. In summary, some of the most severe pressures exerted by rapid urban growth and expansion on the ability of urban and local authorities to cope with the challenges of urban management relate to land use changes and transportation and their interactions thereof. It is

reports of such urban development issues which perhaps present some of the most despairing images (e.g., slums, haphazard development) of the twenty-first century in urban Ghana (see Amoako et al. 2014; Cobbinah et al. 2015; Owusu-Ansah and O'Connor 2006).

With increasing urban expansion, considerable changes have taken place in the pattern and structure of land use and transportation in Ghanaian cities (Amoateng et al. 2013; Poku-Boansi and Adarkwa 2011). For example, the increasing urban expansion has resulted in changes in land uses with the conversion of residential uses in the core of urban areas to commercial uses and the emergence of mixed use development. The consequence of the urban land use conversion in the core areas has been the movement of people from the core areas to the peripheries of the cities contributing to urban sprawl. As widely reported, urban sprawl leads to longer travel time and increased travel distances by households. As a result, there has been an increasing pressure on city managers on how to appropriately respond to land use changes and transportation within urbanising cities (Adarkwa and Tamakloe 2001). Even though previous research findings suggest that major changes in the transport system can influence patterns of urban development and locational choices of households and firms (Poku-Boansi and Adarkwa 2011, 2015), little is known about the effect of land use on urban travel in Ghana. This paper, using Kumasi as the case study, seeks to: (1) analyse the pattern of land use in Kumasi over the past two decades; (2) appraise transportation infrastructure and services in Kumasi; and (3) establish the effect of land use on urban travel in Kumasi.

Transport and land use relationship: a review

Worldwide, there has been a variety of studies that have investigated the interaction between transportation and land use (see Badoe and Miller 2000; Cervero 1994; Gordon and Richardson 1997; Schwanen and Mokhtarian 2005; Wee 2011). Since the early 1990s, much of the research has been concerned with impacts of land use on transport and vice versa. Amongst these, land use-travel behaviour, land use determinants and travel time have been particularly visible (Meurs and Haijer 2001; Stead 2001). Their elements have been

many but feature understanding of the influence of land use on travel behaviour, the importance of accessibility in residential location choices, the extent of basic amenities and services and their influence on residential location of urban residents. These elements of urban travel and land use currently hold great sway in urban design and land use planning as well as environmental policy discourse and, somewhat more concretely, they have shaped the planning and management of major cities in the developed countries (Stead 2001; Wee 2011).

Wee (2011) has argued that the most important land use related determinants that have impacts on travel behaviour are densities, the level of mixed use development and the distances between origins and destinations, and public transport nodal points. The demand for travel is not an end in itself¹ but rather aimed at helping the traveller reach locations where activities such as housing, work, services and facilities take place (Wee 2011). This implies that even though the quality of transport is important, land use characteristics, particularly the location of activities is equally important. This therefore brings to the fore, the importance of having an effective land use planning regime.

Land use planning ensures environmental benefits (Daniel et al. 2009), minimises resource use, limits pollution (Jabareen 2006), restricts the rate of conversion of, and encroachment on natural areas and ecosystems, and promotes sound environment for urban residents (Naess 2001). In developed countries, research (see Badoe and Miller 2000; Stead 2001) indicates that land development is primarily driven by transportation, and that there are hardly locations within urban areas without transport accessibility. In many cases, sites for development are often prepared with good transport access and utility services (e.g., water, electricity) before development commences (Stead 2001). This situation is fundamental in the land use practices occurring across most cities in developed countries (Badoe and Miller 2000). Given that across developed countries there is a strong relationship between land use and transportation because of sustainable land use planning practices which integrate transport variables within the framework of an integrated planning approach (see Hrelja 2015; Meurs

and Haijer 2001; Wee 2011), it is expected that the relationship between land use and transportation in Africa in general, and Ghana in particular, will exhibit similar characteristics based on sustainable land use planning.

Regrettably, poor land use planning defined by complex land tenure system and uncoordinated land management practices has contributed to the generation of an urban landscape where development precedes planning (Cobbinah et al. 2015; Fuseini and Kemp 2015; Obeng-Odoom 2013). This, of course, is not to say that no efforts have been made in Ghana to support sustainable land use planning. In fact, nationwide urban planning effort to ensure effective relationship between land use and transportation began following the introduction of the Town and Country Planning Ordinance (CAP 84), and the establishment of the Town and Country Planning Department (TCPD) in 1945. Cobbinah and Korah (2015) have indicated that the CAP 84 mandated the TCPD with responsibility of planning and managing growth and development of communities in Ghana. Following the introduction of the decentralisation system in 1988, several planning legislations including the Local Government Act of 1993 (Act 462) which declared all communities in Ghana as statutory planning areas, the National Development Planning Systems Act of 1994 (Act 480) and National Building Regulation Act (LI 1630) were enacted to support sustainable planning practices in Ghana. These legislations provide a context for metropolitan, municipal and district assemblies (MMDAs) to perform land use planning functions at the district and community levels, and without prejudice mandated the MMDAs to:

.....prohibit, abate, remove, pull down or alter to bring into conformity with the approved plan, a physical development which does not conform to the approved plan, or the abatement, removal, demolition or alteration of which is necessary for the implementation of an approved plan (Local Government Act of 1993 (Act 462, Section 53).

Despite the availability of planning laws and administrative setup, land use planning in Ghana remains a challenge as urban areas are characterised by unplanned development. Cobbinah and Korah (2015, p. 6) describe the predicament of land use planning in Ghana as “the product of the inadequacies, distortions,

¹ Not all travel is derived—see Mokhtarian et al. (2001).

contradictions and conflicts between various socio-cultural elements (e.g. land tenure systems, beliefs/faiths), political factors (e.g. activities of traditional leaders), economic issues (e.g. growing informal activities) and institutional factors such as under-resourced urban planning agencies, as well as limited public knowledge on urban planning issues, that continue to operate in urban Ghana.”

In such a situation, it is understandable that there remains considerable debate within academic circles in Ghana regarding the state, understanding and the effect of land use on urban travel in Ghana (Gyimah 2001; Owusu-Ansah and O’Connor 2006; Poku-Boansi and Adarkwa 2015). For example, while Owusu-Ansah and O’Connor (2006) acknowledge that despite the importance of transportation in land use, there is a weak association between transport investments and physical development and that recent housing in urban Ghana has generally occurred in poorly accessible locations, Poku-Boansi and Adarkwa (2011) unequivocally indicate that there is a strong relationship between transportation and land use. Besides, several studies on Ghana have reported a lack of effective land use planning across urban Ghana, generating conditions where many housing units within the urban setting have poor accessibility (see Amoako and Cobbinah 2011; Amoateng et al. 2013; Cobbinah and Amoako 2012; Cobbinah and Korah 2015). The fact remains, for example, that very few studies (see Owusu-Ansah and O’Connor 2006; Poku-Boansi and Adarkwa 2015) have examined the effect of land use on urban travel in Ghana. However, these studies examining these issues have avoided a direct examination of land use and transportation but focused on aspects of this relationship such as transport infrastructure and physical development (Owusu-Ansah and O’Connor 2006) and accessibility as a residential location decision factor (Poku-Boansi and Adarkwa 2015). In this case, the understanding of the effect of land use on urban travel which informs and shapes the design of neighbourhoods and promotes effective land use planning appears to be lacking in Ghana.

This limited research on transportation and land use in Africa, particularly Ghana raises more concerns in this era of rapid urbanisation. The level of urbanisation in Africa is alarmingly high with official statistics estimating the rate of urbanisation to reach about 58% in 2050 (UNDESA/PD

2012) although there are wide variations across countries and remains a contested issue (Potts 2009). This implies that urban areas in Africa will be hosting nearly a quarter (1.3 billion) of the world’s urban population. In Ghana, recent studies (Aduah and Baffoe 2013; Gyimah 2001) provide some indications of the extent of impacts of rapid urbanisation on land use, residential choices and urban travel. For instance, Aduah and Baffoe (2013) assert that due to rapid urbanisation, urban areas in Ghana such as Sekondi-Takoradi are rapidly expanding spatially with limited consideration to accessibility. Similar findings were reported in Accra, the national capital, by Gyimah (2001) who found that rapid urbanisation in the form of migration is impeding mobility in the city. Without a careful assessment of the effect of land use on urban travel in Ghana, urban areas may be overwhelmed with urban travel and land use challenges, and may be dysfunctional and unlivable. This study uses Kumasi as a case study to explore the effect of land use on urban travel and its influence on urban functionality and urbanism.

Case study area and research methods

Case study area

This study focuses on the city of Kumasi in the middle belt of Ghana, West Africa. Kumasi remains the second largest city in Ghana with a total population of 1,730,249 as at 2010 (Ghana Statistical Service [GSS], 2012, 2014). It is centrally located in the Ashanti Region of Ghana (see Fig. 1) forming an important transport and commercial hub for both domestic and international traffic (Adarkwa 2011). Kumasi’s vital role in transportation, commerce, education and administration prior to Ghana’s independence in 1957 has continued to attract migrants from various parts of Ghana and beyond (Cobbinah and Amoako 2012). With a population growth rate of 5.7% per annum between 2000 and 2010 (GSS 2012), Owusu-Ansah (2015) asserts that it is the fastest change in recent decades. Ensuing from this population outburst is land use intensification in the inner city and spill over in the peripheral zones beyond the administrative boundaries of the city in mostly an unplanned manner without consideration to

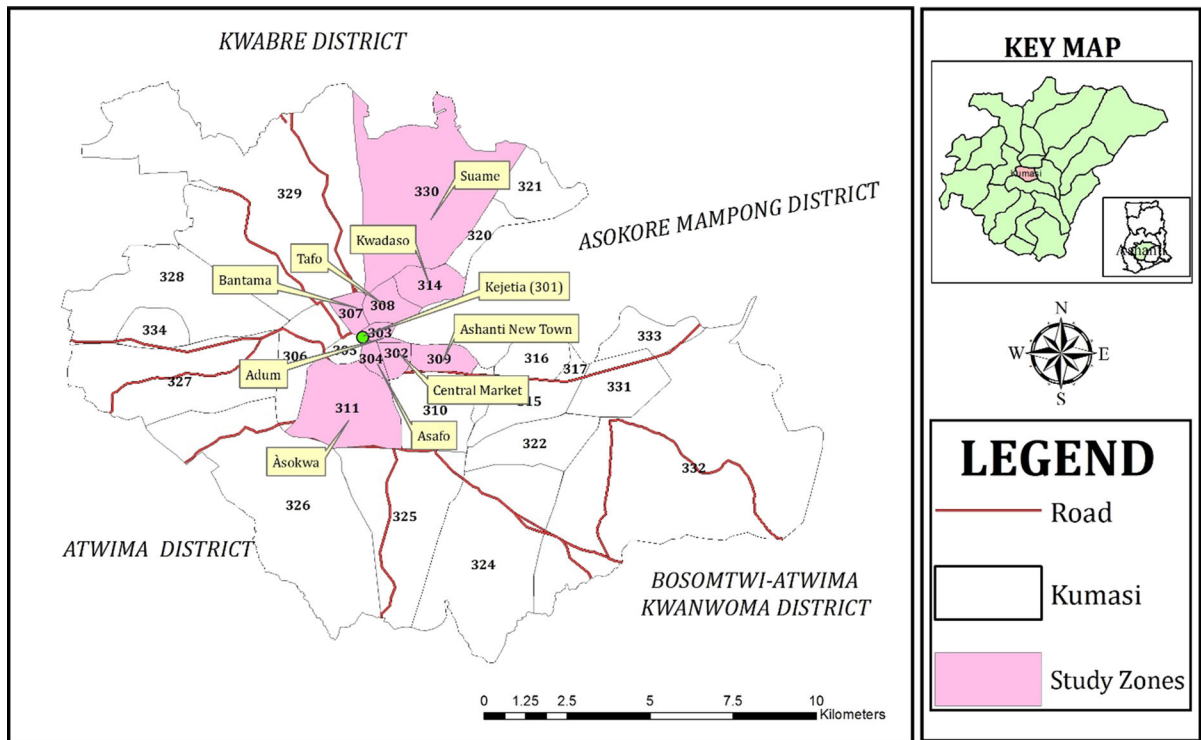


Fig. 1 Traffic zones of the Kumasi Metropolitan Area. *Source* Adapted from Department of Urban Roads (2015)

transportation and land use changes. As the analysis will show, this situation is creating urban travel complexities and land use development challenges across the various neighbourhoods in the city.

Since colonisation, when transport infrastructure (e.g., rail, road) were established and received considerable improvement as part of a colonial strategy of extracting and exporting natural resources, very few improvements or additions have been made to transport infrastructure despite the rapid demographic growth. For instance, rail transport in Kumasi has collapsed putting pressure on road transport. Exacerbating the problem, Kumasi’s urban planning system has been ineffective in terms of managing the demographic growth and ensuring orderly physical development (Cobbinah and Korah 2015). Given the haphazard development coupled with limited improvement in transport infrastructure and services, the roads in Kumasi are heavily choked with traffic characterised by informal transport service operators (e.g., taxis and trotros) and private vehicles. For instance, the choice of transport service in Kumasi is

estimated to be 43% by public transport, consisting of 23, 18 and 2% by Taxis, Minibuses, and Large Occupancy Buses respectively on a weekday (Poku-Boansi 2008). As a result, the traffic generating points in Kumasi have increased considerably over the years, affecting the socio-economic activities of urban residents. As illustrated in Fig. 1, the main traffic generating points in Kumasi are mostly in Kumasi central including the Central Business District (CBD), Suame, Ashanti New Town, Bantama, New Amakom and Asokwa where over 9178 vehicles use the single carriage roads in early mornings (6:00–10:00 local time) and evenings (15:00–18:00 local time) (Poku-Boansi 2008). Hence, it is unsurprising that about 90% of internal traffic in Kumasi occurs in and around the CBD area due to the multitude of functions it performs: production, consumption and distribution (Poku-Boansi 2008) as well as poor land use planning. However, this increasing traffic generation has considerable implications on transportation and land use dynamics in the city, as discussed in the analysis section.

Research methods

This research analysed the pattern of land use in Kumasi over the past two decades, appraised the types and extent of transport infrastructure and services in Kumasi and established the effect of land use on urban travel in Kumasi. The focus was on both the community and institutional contexts, especially current urban travel patterns and complexities in this era of rapid demographic growth in Kumasi.

Literature review was undertaken from two levels: a global level focusing on the relationship between land use and urban travel drawing insights from journal articles, books and international organisations' reports; and a local level review examining documents on urban travel and urban development dynamics in Ghana, focusing on the city of Kumasi. These documents include the medium-term development plan used for monitoring socio-economic and physical development of Kumasi (KMA 2013), and Ghana's population and housing census reports (GSS 2012, 2014). Other documents such as consultancy reports on urban travel in Kumasi (e.g., Kumasi Metropolitan Roads Department 2011), and annual reports of some decentralised government agencies such as Urban Roads Department-Kumasi and the Town and Country Planning Department-Kumasi were reviewed. Document review was important in understanding the extent of land use changes and their relationship with urban transport in Ghana, and the seemingly limited attention to urban transport infrastructure and services in Kumasi.

Using semi-structured interviews, three urban planning and transport authorities in Kumasi were selected and their officials involved in interview conversations. These institutions included the Town and Country Planning Department (TCPD)—Kumasi, Urban Roads Department-Kumasi, and the Metropolitan Roads Department-Kumasi Metropolitan Assembly (KMA). Three main questions were asked: (1) What are the patterns of land use in the city? (2) What is the extent and conditions of transport infrastructure and services in Kumasi? (3) What is the effect of land use on urban travel in Kumasi? The interviews lasted between 60 and 120 min depending on the interests, knowledge and the experience of the institutional officials.

In the community, the collection of survey information was done primarily using simple structured questionnaires administered to a sample of urban residents.

The survey was conducted using the multi-stage sampling procedure. First, a traffic zones map of Kumasi was obtained from the Department of Urban Roads—Kumasi, which identified the 31 traffic zones in Kumasi (see Fig. 1). The traffic zones were delineated by the Department of Urban Roads based on homogeneous social and economic characteristics such as income, housing quality, the general culture of the people, and the level of economic activities generated in the area (Poku-Boansi and Adarkwa 2013). Second, with the aid of the traffic zones map and a reconnaissance survey, 10 out of the 31 traffic generating zones were identified and purposively selected for this research, based on their high level of traffic generation, road infrastructure, services and conditions. The selected traffic generating zones included: Asafo (zone 304), Adum (zone 303), Central Market (zone 302), Kejetia (zone 301), Suame (zone 330), Ashanti New Town (zone 309), Bantama (zone 307), Kwadaso Estate (zone 314), Tafo (zone 308) and Asokwa (zone 311) (see Table 1). Third, to provide explanations to the patterns of land use and transportation from the perspectives of urban residents, 20 respondents were randomly selected from each of the ten traffic generating zones and involved in the simple survey questionnaire administration after seeking their consent and based on their willingness to participate in the research. A total sample size of 200 respondents was obtained (see Table 1). The interviews were conducted between January and March 2015.

The interview protocol included questions on (1) residents' perspectives on patterns of land use in Kumasi over the past two decades; (2) residents' knowledge and experience of the type and extent of transportation infrastructure and services in Kumasi; and (3) residents' description of the effect of changing land uses on urban travel. These questions were partly informed by the findings from the literature review which highlights the effect of changing land uses on urban travel in terms of trip purpose and mode of travel as these changes can lead to longer travel time and increased travel distances by households. In addition, new questions were added to reflect locational characteristics. The results section presents the findings and discussion of the data collected from the field. Several variables such as the land use composition over a 20-year period, classes of roads and their respective lengths, volume of trips made on weekends and weekdays were analysed in an attempt to establish the effect of land use on urban travel.

Table 1 Sample size determination. *Source* Field survey, January–March 2015; Department of Urban Roads (1997)

Traffic zone	Traffic generation level	Description	Sample size	Male	Female
Asafo	High	Tenement sector area dominated by large compound houses of two or three storey blocks of walk-up flats	20	9	11
Adum	High	Intense commercial area	20	10	10
Central Market	Very high	Core of Kumasi	20	8	12
Kejetia	Very high	Intense commercial area	20	10	10
Suame	High	High cost sector areas dominated by low density bungalows and flats occupied by senior government and company employees and wealth businessmen/women	20	10	10
Ashanti New Town	High	Indigenous sector areas of tradition. Mainly single storey compound houses including villages developed b or still separated from the city areas. The sector also has some ethnic minorities who are mainly low income earners	20	10	10
Bantama	Low	Indigenous sector areas of tradition. Mainly single storey compound houses including villages developed b or still separated from the city areas. The sector also has some ethnic minorities who are mainly low income earners	20	10	10
Kwadaso Estate	Low	Government built sector area with estates by government agencies and ran as rentals or hire purchase	20	10	10
Tafo	Low	Indigenous sector areas of tradition. Mainly single storey compound houses including villages developed b or still separated from the city areas. The sector also has some ethnic minorities who are mainly low income earners	20	9	11
Asokwa	High	High cost sector areas dominated by low density bungalows and flats occupied by senior government and company employees and wealth businessmen/women	20	10	10
Total			200	94	104

Very high traffic level, average daily trips between 11 and 13; high traffic level, average daily trips between 7 and 10; low traffic, average daily trips between 4 and 6

Broad categories of data such as the demographic and socio-economic characteristics have been discussed. Table 2 provides a socio-economic profile of respondents who participated in the research. The sample was dominated by female respondents (52%) and most of the respondents fell in the 20–29 age groups (32%). About, 92% of the respondents had at least some formal education, with 10% having earned a tertiary degree/certificate.

To examine if the sample represented the general population of Kumasi, the profile of the respondents was compared to descriptions provided in the 2010 Population and Housing Census of Kumasi. Overall, the profile of the respondents in this study matched well with the city's population

characteristics in terms of gender, education and age (see Table 3).

Results and discussion

This section analyses the land use patterns, the city's transport infrastructure and services, and the relationship between land use and transportation.

Pattern of land use in Kumasi (1995–2015)

An analysis of land use patterns over the past two decades available from the Town and Country Planning Department in Kumasi showed considerable

Table 2 Basic characteristics of sampled urban respondents. *Source* Field survey, January–March 2015

Variable	Frequency	%
Gender		
Male	96	48
Female	104	52
Total	200	100
Age of respondents		
20–29	64	32
30–39	52	26
40–49	48	24
50–59	36	18
Total	200	100
Monthly disposal household income (GHS)		
Below 1000	84	42
1000–3000	60	30
Over 3000	56	28
Total	200	100
Educational level of household head		
Never	24	12
Primary	36	18
Junior High School	80	40
Senior High School	40	20
Tertiary	20	10
Total	200	100
Residency location		
In-Kumasi	104	52
Communities beyond Kumasi's boundary	92	48
Total	200	100

changes in the various land uses (see Table 4). According to the agency interviews, out of the 250 km² land area of Kumasi (prior to the creation of the Asokore Mampong Municipality in 2012), 79% is planned² based on land use planning schemes by official planning activities. The remaining 21% remains unplanned³ although developed and occupied by urban residents. The representative of the Town and

² Planned here implies a situation where the Metropolitan Planning Authority has prepared and approved a planning scheme to guide the development of the area.

³ Unplanned here implies a situation where there is no approved planning scheme to guide the development of the area by Metropolitan Planning Authority.

Country Planning Department in Kumasi mentioned that:

... Kumasi is a big city of about 250 km²... About 79% of this figure [250 km²] is planned and approved by us [Town and Country Planning Department] for occupation. We have planning schemes for all the planned neighbourhoods... TCPD, January 2015.

While the above quote suggests most parts of Kumasi are planned, further clarifications with the institutional representatives show that even within the planned neighbourhoods there are widespread cases of haphazard development. The interview findings indicate that inadequate capacity of planning institutions (logistics, personnel and legal support) to effectively monitor and manage the growth of the city has contributed to haphazard development (e.g., encroachment on road reservation, nature reserves and open spaces) in planned neighbourhoods such as Ahodwo. In this case, it is not surprising that many neighbourhoods in Kumasi have poor transport accessibility, in terms of motorability, street connectivity and mobility (see Cobbinah et al. 2017). This situation has implications on the effect of land use on urban travel in the city. However, to appreciate the extent of this relationship, this section examines land use patterns and dynamics in the city over the past two decades. Land use data obtained from the Town and Country Planning Department show that the major land uses in Kumasi include residential, commercial, industrial, educational, civic and cultural, open space, and circulation (roads). These land uses are discussed in the following sections.

Residential land use

The residential land use covers the largest land area in Kumasi, and comprises the various housing units across the city. Residential land use which covered a total land area of 109.2 km² representing 43.7% in 1995 increased to 112.3 km² representing 44.9% of the total land area in 2015. An analysis of the change in residential land use shows a gradual change over the past two decades (see Table 4). While it may be reasonable to argue that the change in residential land use from 1995 to 2015 does not reflect reality given the rapid demographic growth in the city (5.7% per annum) (Owusu-Ansah 2015), analysis of the simple

Table 3 Comparison of sample and Kumasi census data. *Source* Field survey, January–March 2013; GSS (2014)

Variable	Kumasi population	Sample population
Gender	Female dominated population (52.2%)	Female dominated population (52%)
Education	About 9.1% of the population have had no formal education	About 12% of the population have had no formal education
Age category	Dominated age group is 20–24 years (11.8%)	Dominated age group is 20–29 years (23%)

Table 4 Land use composition over the years (1995–2015). *Source* Town and Country Planning Department (2015)

Land Use	1995		2000		2005		2010		2015	
	Area (km ²)	%	Area (km ²)	%	Area (km ²)	%	Area (km ²)	%	Area (km ²)	%
Residential	109.2	43.7	109.6	43.8	110.3	44.1	111	44.4	112.3	44.9
Commercial	6.0	2.4	6.0	2.4	6.0	2.4	6.0	2.4	6.3	2.5
Industrial	10.3	4.1	10.6	4.2	10.3	4.1	10.1	4.0	9.8	3.9
Educational	43.8	17.5	43.8	17.5	43.8	17.5	43.3	17.3	43.2	17.3
Civic and cultural	18.8	7.5	18.8	7.5	18.1	7.2	18.1	7.2	17.7	7.1
Open space	28.8	11.5	28.1	11.2	28.1	11.2	27.5	11.0	26.2	10.5
Circulation	33.1	13.2	33.1	13.2	33.4	13.4	34	13.6	34.5	13.8
Total	250	100.0	250	100.0	250	100.0	250	100.0	250	100

questionnaire survey revealed a different pattern of residential land use. The simple questionnaire survey results show that 48% of respondents across the 10 traffic generation points reside in peri-urban areas in adjoining districts beyond the political or administrative boundaries of Kumasi (see Table 2). The agency officials also confirmed this pattern of residential land use arguing that many urban residents reside beyond the boundaries of Kumasi. One agency official reports that:

... I can't say all those who work and make their living in Kumasi daily are residents of Kumasi... Many urban residents of Kumasi now live in peri-urban areas such as Esreso, Feyiase, Abuakwa, Ejisu, Pakyi among others and work in Kumasi. Administratively, these communities are not part of Kumasi metropolis... KMA-Roads Department, January 2015.

In this case, it implies that the population of Kumasi is spilling over into the neighbouring districts with peri-urban communities playing dormitory roles. This finding is consistent with those of Cobbinah et al. (2015) and Amoateng et al. (2013) who found that peri-urban areas of Kumasi particularly Feyiase (in the Bosomtwe District) and Abuakwa (in the Atwima

Nkwabiagya District) respectively are undergoing rapid growth in residential land use and both have over 40% of their inhabitants being relocated urban residents from Kumasi. These residents, according to the researchers (see Cobbinah et al. 2015; Amoateng et al. 2013) commute daily to Kumasi to perform their socio-economic activities.

Unfortunately, the steady increase in residential land use in Kumasi mostly results from the conversion of open spaces, road reservation and areas liable to flooding into residential land use. This situation, according to the agency officials, is prevalent across the metropolis—both planned and unplanned neighbourhoods—because of many factors, including lack of cooperation among the planning agencies particularly between traditional leaders and Town and Country Planning Department, ineffective planning institutions (in terms of logistics, personnel and legal mandate), and activities of nonchalant urban residents who develop without development permits.

Commercial land use

The commercial land use comprises locations within the built-up environment meant for markets, transport terminals, warehouses, hotels and guest houses and

shops. As at 1995, commercial land use was 6 km² representing 2.4% of the total land area. Over the past two decades, commercial land use has increased marginally (6.3 km² representing 2.5% of the total land area in 2015). Considering that Kumasi is touted as a major commercial hub in Ghana and beyond because of its Central Market which is the largest open market in West Africa (Adarkwa 2011), one would have expected a substantial increase in commercial land use over the past two decades. The reconnaissance survey and institutional interview findings show that several residential housing units particularly in Adum, Bantama, Asafo, Tafo and Asokwa have been converted into mixed uses (residential and commercial) but are frequently classified as residential land use. This situation may explain the relatively marginal increase in commercial land use over the past two decades. It is worth mentioning that most commercial activities are concentrated in central Kumasi, which acts as the commercial centre of the city, generating traffic management and land use planning challenges as the city centre has become relatively congested.

Industrial land use

Industrial land use covers locations designed for bakeries, metal and wood works as well as large-size companies (e.g., Coca Cola). In 1995, industrial land use in Kumasi covered 10.3 km² representing 4.1% of the total land area. However, in 2015, industrial land use has reduced to 9.8 km² representing 3.9% (see Table 4). Although Kumasi is not considered as an industrial centre like Tema and Takoradi, it plays, to some extent, an important industrial role in the middle belt of Ghana. Findings from the institutional interviews show that the recent establishment of a wood village (Sokoban Wood Village) has strengthened Kumasi's role of meeting the furniture and wood related needs of its residents and beyond. In addition, the Suame Magazine which is a collection of artisans in metal engineering and vehicle repairs employing an estimated 200,000 workers is the most industrialised zone in Ghana and is one of the largest industrialised zones in Africa. However, the near collapse of timber firms in Asokwa and the gradual conversion of Kaase, which was traditionally earmarked for industrial activities, into residential use have influenced the decline in industrial land use. Other reasons for the

decline in industrial land use, as revealed through the reconnaissance survey, maybe the poor location of some industrial activities (e.g., wood and metal works) on road reservations and open spaces within residential areas generating noise to the discomfort of residents. This has come about because of the non-adherence to planning schemes and the weak enforcement of planning regulations by the city's planning authorities (Nunbogu and Korah 2016; Owusu-Ansah 2015). Consequently, the location of these activities is often not classified as industrial land use because they are not found in official planning schemes and documents.

Educational land use

Educational land use covered 43.8 and 43.2 km² in 1995 and 2015 respectively of the total land area of Kumasi. As presented in Table 4, there is a marginal decline in educational land use between 1995 and 2015. Major educational institutions include the Kwame Nkrumah University of Science and Technology, Garden City University, Kumasi Technical University, St Louis Training College and a host of secondary, technical and basic schools. The decline may be explained by encroachment on school lands for mostly residential development. Discussions with an agency official supports this assertion:

... The issue of encroachment on school lands is gradually gaining prominence in the city. We have been receiving complains from some school authorities concerning encroachment of their school lands. Subsequently, we are liaising with the Assembly members where these schools are to stop the practice by embarking on sensitisation programmes and enforcement of planning schemes..... TCPD, January 2015.

Civic and cultural land use

This land use covers public buildings such as places of worship, palaces, hospitals, administrative structures, offices of public institutions including police. In 1995, civic and cultural land use covered a land area of 18.8 km² which was quite substantial. According to the institutional officials, this was only a reflection of the traditional status of Kumasi as the seat of the Otumfuo, the King of the Ashanti Kingdom, and the

administrative capital of the Ashanti region of Ghana. In this case, it was not surprising that as at 2015, civic and cultural land use remained resilient in the face of rapid urbanisation and increase demand for residential and commercial uses (see Table 4). However, the poor location of some noise making civic and cultural activities particularly places of worship in residential areas and nature reserves makes them a source of nuisance to residents and put at risk the survival of these natural areas. Similar findings were reported by Cobbinah and Korah (2015) when they found that nature reserves and educational facilities in Kumasi have become a prime location for places worship despite the dangers (e.g., flooding, destruction of ecologically sensitive areas) associated with such development.

Open space

The major open spaces in Kumasi include Abbeys park, Baba Yara Sports Stadium, Dogo Moro park, Kumasi golf course, Kumasi zoological garden, Amakom children's park, Addo's park, Suntreso park, Jackson park, Rattray park among others which are in various state of encroachment and conversion (see Owusu-Ansah 2015 for details). Table 4 shows that open spaces in Kumasi occupied 28.8 km² of the total land area of Kumasi representing 11.5% in 1995. However, in 2015, it occupied 26.2 km² representing 10.5% of the total land area. This reduction is attributed to encroachment and conversion of such areas for commercial and residential purposes. The institutional representatives identify the activities of street hawkers/traders, poor management by city authorities and apathy amongst urban residents as factors contributing to the decline of open spaces in Kumasi.

Consequently, Kumasi, once the Garden City of West Africa, has lost its accolade (Quagraine 2011) and it is gradually losing the function of open spaces as 'softening' physical development and toning down harsh weather conditions. Regrettably, this situation is not only limited to the city of Kumasi but peri-urban communities such as Abuakwa (see Amoateng et al. 2013) and Feyiase (see Cobbinah et al. 2015). Designated open spaces such as play grounds and public recreational grounds are fast diminishing in Kumasi (see Owusu-Ansah 2015; Quagraine 2011). In this case, it is understandable when the institutional

officials reported that there are regular road blocks within many neighbourhoods in Kumasi to make way for social events such as funerals, because of lack of, and rapid diminishing rate of public open spaces in the city.

Circulation/transportation

Transportation in Kumasi is mostly about road transport due to the collapse of the rail transport, lack of water transport due to poor management of water resources, and relatively expensive air travel. For example, the Subin River in the city which has an annual mean flow rate of 0.243 m³ s⁻¹ and covers an area of about 230 km² (Meteorology Services Department 2000) can be used for inland water transport but has been polluted by industrial and hospital waste and waste from the wood processing plants. The hierarchies of roads identified in Kumasi include major arterials, minor arterials, distributors/collectors and local access roads. The major arterials are those connecting the city to other regional capitals and West African countries, while the minor arterials are those connecting neighbourhoods or communities within the city. Further details on the city's roads are presented in the next section. Occupying a total land area of 33.1 km² as of 1995, circulation in the city expanded to 34.5 km² by 2015, with a total road length of 1931.18 km. While the expansion of circulation land use may reflect the increasing urban demand resulting from rapid demographic growth, institutional interview data indicate it was not commensurate with the rate of demographic and economic growth as many neighbourhoods have inadequate, if not lack, of transport accessibility, in the form of motorability, street connectivity and mobility. Given that the extent of circulation may determine transport infrastructure and services in the city as well as urban travel patterns, the following sections discuss these issues.

Transport infrastructure and services in Kumasi

Findings from this research show that road transport remains the major mode of transport, after walking, in Kumasi, because of the collapse of rail transport and relatively expensive nature of air transport as well as the non-existent of water transport. The research examines the types and conditions of road infrastructure in Kumasi. An analysis of urban roads

classification data of Kumasi provided by the Metropolitan Roads Department of KMA shows that the city has an extensive network of roads totalling 1931.18 km. As illustrated in Table 5, the road network in Kumasi comprises major and minor arterials, distributor or collector roads, and local roads. About 7.06% of the total road network are major arterials, which are the main roads leading into and out of the city. In addition, about 5.72% of the network constitutes the minor arterials, which are the roads connecting the local level roads to the major arterials such as Old Bekwai road, Asafo Roundabout—Zongo Police Station/Roman Hill and Airport Roundabout—Manhyia roads.

Data obtained from the Urban Roads Department shows that the condition of Kumasi's roads varies considerably; with 69.1% of the roads being in 'Good' condition (tarred and without potholes), 7.9% in 'Fair' condition (tarred with some potholes), and 23.0% in 'Poor' condition (untarred/unsealed). This is an improvement on the 2008 estimates where 61.9% of the total urban road network was in 'Good' condition, 3.1% in 'Fair' condition, and 35% in 'Poor' condition (Poku-Boansi and Adarkwa 2013).

With the available road network and relatively good condition, one would expect free flow of traffic and easy movement in the city. However, the institutional officials asserted that the strategic location of Kumasi has attracted a lot of through traffic from other parts of Ghana. This situation has contributed to the growth in traffic on the arterial roads to levels of congestion. A recent study by Poku-Boansi and Adarkwa (2011) on congestion analysis in Kumasi revealed that all the major arterial and the distributor roads fell into the service level of F using speed levels as a criterion to measure congestion (see Fig. 2). This implies that the recorded speed levels along these roads were less than 32 km/h. In addition, the Kumasi—Mampong and

Kumasi-Bekwai road corridors recorded heavy congestion when average daily traffic per lane is used to assess congestion. The Kumasi—Offinso corridor recorded severe traffic congestion while the Kumasi—Sunyani and Kumasi—Accra road corridors recorded extreme congestion conditions during the peak hours of between 5 and 6 pm (Poku-Boansi and Adarkwa 2011). This may partly be due to the increased number of people living along the peripheral areas of the Kumasi—Accra corridor (Kentinkrono, Kwamo, Oduom, Fumusua and Ejisu) and Kumasi—Sunyani corridor (Abuakwa, Akropong, Ntensere, etc.) who commute to the city to transact business daily.

Major transport services in Kumasi are provided by public transport services operators predominantly the private sector, as is the case for the country. These services are provided through shared taxis, mini-buses (trotro) and large buses. Amongst these road transport services, 54% of survey respondents mentioned shared taxis as the dominant one, followed by mini-buses (38%) and large buses (8%). Similarly, Poku-Boansi (2008) found that shared taxi is the dominant mode in Kumasi, carrying about 44% of daily commuters in the city. Consistent with the situation in other Ghanaian cities, Abane (2011) found that the vehicles used for public transport services in Accra (Ghana's capital) are characterised by 32.6% minibuses; 7% large buses and 39.2% shared taxis and are largely patronised by the urban poor particularly the minibuses. In the case study zones, Kwadaso Estate, Bantama and Tafo recorded the least number of weekday trips, while Kejetia, Adum and Central Market recorded the highest number of trips (see Table 6). Mirroring the findings of Abane (2011), findings from this research indicate that the characteristics of the households in the least travelled zones reflect mainly the poor who usually embark on fewer trips compared to the high travelled zones, which have relatively enhanced income levels. These least travelled zones are mainly traditional areas with mainly single storey compound houses including villages developed by or still separated from the city areas, and mostly house some of the city's ethnic minority groups.

On the other hand, the highest travelled zones particularly Central Market and Suame recorded between 7 and 10 trips daily. The characteristics of these zones indicate a highly dense area with many activities during the weekends. As indicated earlier,

Table 5 Classes of urban roads in Kumasi (2008). *Source* Metropolitan Roads Department, KMA (2011)

Road class	Length (km)	Proportion (%)
Major arterials	136.40	7.06
Minor arterials	110.39	5.72
Distributor/collectors	90.61	4.69
Local	1593.78	82.53
Total	1931.18	100.00

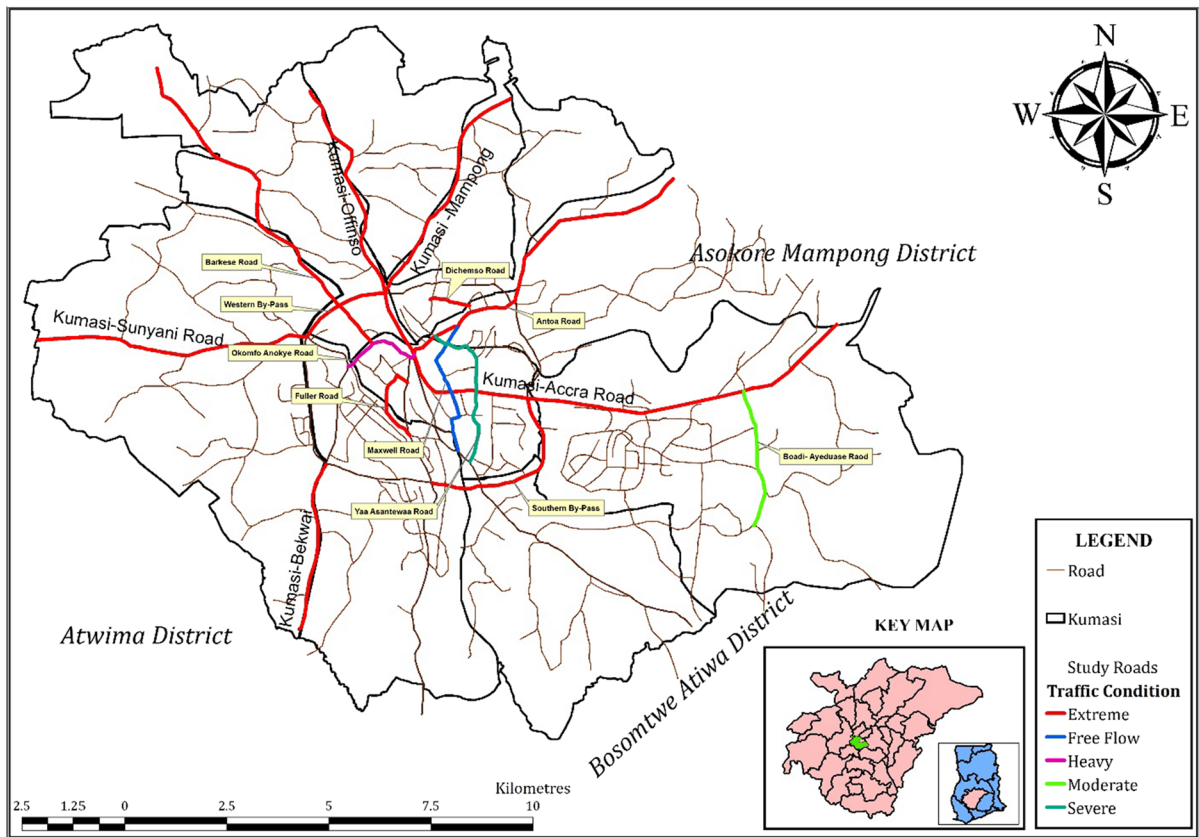


Fig. 2 Major and minor arterials and their level of congestion in the Kumasi Metropolitan Area. *Source* Adapted from Poku-Boansi and Adarkwa (2011)

Suame is home to the largest metal engineering and vehicle repairs centre and the Central Market is the largest open market in West Africa. Given this situation, one would expect quality transport services and improved transport infrastructure in Kumasi, and Ghana in general. Unfortunately, the reconnaissance survey indicates that the quality of road transport service is poor because most vehicles are old and rickety, and maintenance standards extremely low. While majority of survey respondents (62%) mentioned high vehicle maintenance costs as inhibiting transport operators from maintaining their vehicles, all the three institutional officials consistently mentioned poor road surfaces and conditions as well as acute congestion on the roads as main reasons constraining transport operators from investing in new vehicles. In such situations, it is unsurprising that official statistics from the Department of Urban Roads (2005)

indicate that the average age of the vehicles for transport services provision is 18 years for Accra and 13 years for Kumasi, the two largest cities in Ghana. In Poku-Boansi and Adarkwa’s (2013) view, this situation may reflect the influx of more used vehicles from developed countries into the Ghanaian market.

Effect of land use patterns on urban travel in Kumasi

As earlier discussed in the literature review section, the effect of land use on urban travel particularly in developed countries is based on the philosophy that the pattern of land development is contingent on the availability of transport infrastructure and services and vice versa. This philosophy implies that there are hardly any land developments at a location without transport accessibility, and in the same way, transport

Table 6 Average weekend and weekday motorised trip mode in Kumasi. *Source* Estimates from Department of Urban Roads (2015)

Traffic zone	Trip mode	Weekday trips		Weekend trips	
		Average number	%	Average number	%
Asafo	Taxi	35,312	58.93	34,932	60.24
	Minibuses	21,879	36.51	20,034	34.55
	Large buses	2730	4.56	3021	5.21
	Total	59,921	100.00	57,987	100.00
Adum	Taxi	37,978	61.91	37,235	62.89
	Minibuses	20,978	34.20	18,989	32.07
	Large buses	2389	3.89	2987	5.04
	Total	61,345	100.00	59,211	100.00
Central Market	Taxi	39,126	63.46	35,955	60.03
	Minibuses	19,967	32.38	20,431	34.11
	Large buses	2564	4.16	3511	5.86
	Total	61,657	100.00	59,897	100.00
Kejetia	Taxi	42,082	67.53	42,824	64.75
	Minibuses	17,765	28.51	19,899	30.08
	Large buses	2465	3.96	3421	5.17
	Total	62,312	100.00	66,144	100.00
Suame	Taxi	38,456	64.56	40,811	62.85
	Minibuses	17,999	30.22	21,008	32.36
	Large buses	3112	5.22	3113	4.79
	Total	59,567	100.00	64,932	100.00
Ashanti New Town	Taxi	38,486	64.61	41,186	68.79
	Minibuses	17,868	30.00	14,689	24.53
	Large buses	3213	5.39	3998	6.68
	Total	59,567	100.00	59,873	100.00
Bantama	Taxi	26,206	57.15	33,010	62.03
	Minibuses	16,657	36.33	16,987	31.93
	Large buses	2989	6.52	3216	6.04
	Total	45,852	100.00	53,213	100.00
Kwadaso Estate	Taxi	25,129	55.15	36,212	65.58
	Minibuses	17,003	37.31	15,678	28.40
	Large buses	3435	7.54	3325	6.02
	Total	45,567	100.00	55,215	100.00
Tafo	Taxi	27,684	59.89	24,959	54.41
	Minibuses	15,567	33.68	18,345	39.99
	Large buses	2970	6.43	2567	5.60
	Total	46,221	100.00	45,871	101.49
Asokwa	Taxi	40,987	67.21	38,439	61.35
	Minibuses	16,759	27.48	20,001	31.93
	Large buses	3241	5.31	4212	6.72
	Total	60,987	100.00	62,652	100.00

accessibility cannot occur at locations without any land use. Drawing from this general philosophy, urban residents in the selected case study communities were

asked to describe the effect of land use on urban travel in the city. Findings from the survey questionnaire indicate a generally weak effect of land use on travel

Table 7 Respondents' relationship between land use and transport in Kumasi ($n = 200$). *Source* Field Survey, January–March (2015)

Case study zone	Strong effect (%)	Neutral effect (%)	Weak effect (%)
Asafo	45.0	0.0	55.0
Adum	55.0	0.0	45.0
Central Market	10.0	20.0	70.0
Kejetia	50.0	30.0	20.0
Suame	30.0	30.0	40.0
Ashanti New Town	45.0	0.0	55.0
Bantama	40.0	35.0	25.0
Kwadaso Estate	65.0	0.0	35.0
Tafo	15.0	5.0	80.0
Asokwa	40.0	25.0	35.0
Overall	39.5	14.5	46.0

Strong effect, when land use determines transportation network and transportation network determines land use and that all land uses are adequately accessible; neutral effect, when land use and transportation are perceived to have no link; weak effect, when land uses are not connected by transport network, or where there is poor accessibility

pattern in Kumasi. As illustrated in Table 7, majority of the respondents believe there is weak effect of land use on travel patterns in Kumasi.

Across the 10 case study zones, about 46% of respondents reported weak effect of land use on travel patterns (see Table 7). This situation was particularly ominous in Central Market, Tafo, Ashanti New Town and Asafo where over 50% of respondents indicated weak effect of land use on travel pattern. According to the respondents who reported weak effect of land use and travel patterns, particularly in Central Market and Tafo, the transport network in these neighbourhoods since independence (1957) has not been expanded to accommodate the increasing population growth and economic activities in these zones. As earlier discussed, the Central Market, for example, is the largest open market in West Africa, yet transport network within the zone has not received improvement commensurate to the level of economic activities and population in the zone. In this case, it was understandable when majority of respondents (78%) across the ten case study zones indicated that they have resorted to walking as a primary mode of transport due to poor accessibility in these zones.

Similarly, although estimates by Poku-Boansi (2008) indicate that 1,451,424 vehicular trips are made in Kumasi to work places on a typical weekday and 1,125,135 vehicular trips to social places in a weekday,

walking remains the dominant mode of transport due to the generally poor accessibility within the city. For example, Poku-Boansi (2008) estimates that 2,778,231 trips are made to work daily by walking in Kumasi. As presented in Table 8, findings from this research show that non-motorised travel (i.e. walking) is dominant for both weekday and weekend trips in the case study zones. Non-motorised trips constitute over 56% of all weekday trips and more than 52% trips of all weekend trips in the case study zones (see Table 8). For example, Bantama recorded the highest use of non-motorised means of commuting during both weekdays (62.57%) and weekends (63.24%). This was closely followed by Kwadaso Estate which recorded 60.59% for weekdays and 60.87% for weekends. While the dominance of non-motorised travel may perhaps be a sign of healthy lifestyle of urban residents in Kumasi, interviews with the institutional officials attributed the situation to the increased difficulty of commuting in the city using motorised transport due to the increasing level of congestion on all the arterial roads which have seen limited expansion since Ghana's independence despite rapid urbanisation and expansion of commercial activities.

Considering that non-motorised mode of transport dominates daily trips in Kumasi, this research analysed the purpose for urban mobility. As presented in Table 9, movements within Kumasi are generally to

Table 8 Average weekend and weekday trips in Kumasi. *Source* Estimates from Department of Urban Roads (2015)

Traffic zone	Mode	Weekday trips		Weekend trips	
		Average number	%	Average number	%
Asafo	Motorised	59,921	43.21	57,987	43.57
	Non-motorised	78,745	56.79	75,100	56.43
	Total	138,666	100.00	133,087	100.00
Adum	Motorised	61,345	43.23	59,211	43.05
	Non-motorised	80,546	56.77	78,345	56.95
	Total	141,891	100.00	137,556	100.00
Central Market	Motorised	61,657	43.49	59,897	43.06
	Non-motorised	80,132	56.51	79,213	56.94
	Total	141,789	100.00	139,110	100.00
Kejetia	Motorised	62,312	41.14	61,144	41.11
	Non-motorised	89,156	58.86	87,574	58.89
	Total	151,468	100.00	148,718	100.00
Suame	Motorised	59,567	42.74	64,932	47.03
	Non-motorised	79,789	57.26	73,125	52.97
	Total	139,356	100.00	138,057	100.00
Ashanti New Town	Motorised	59,567	42.74	59,873	43.54
	Non-motorised	79,789	57.26	77,653	56.46
	Total	139,356	100.00	137,526	100.00
Bantama	Motorised	45,852	37.43	43,213	36.76
	Non-motorised	76,642	62.57	74,345	63.24
	Total	122,494	100.00	117,558	100.00
Kwadaso Estate	Motorised	45,567	39.41	42,215	39.13
	Non-motorised	70,045	60.59	65,678	60.87
	Total	115,612	100.00	107,893	100.00
Tafo	Motorised	46,221	39.73	45,871	39.98
	Non-motorised	70,125	60.27	68,876	60.02
	Total	116,346	100.00	114,747	100.00
Asokwa	Motorised	60,987	43.26	57,652	42.61
	Non-motorised	79,997	56.74	77,651	57.39
	Total	140,984	100.00	135,303	100.00

work places, accounting for 90% of all trips on weekdays. These trips usually terminate at the Central Market, Adum and the Kejetia where most jobs in the city are concentrated. The situation is also severe during weekends as 74.40% of all trips, even though social trips still find their way to the Central Market, Adum and Kejetia area. Between 87 and 93.69% of all trips during weekdays were work related while between 73.42 and 77.74% of all trips made during weekends were for social purposes. These social visits include funerals, churches and local food selling joints. Unfortunately, these are areas within Kumasi

that have witnessed limited improvement in road infrastructure since Ghana's independence. As a result, although the institutional officials admitted that the increasing population and commercial activities have contributed to congestion and poor conditions of roads, they consistently emphasised that the limited investment in transport in terms of maintaining and expanding existing roads and providing new ones are the major cause of poor movement in many parts of the city. This may further explain why many survey respondents (46%) reported weak effect of land use on travel pattern in Kumasi (see Table 7).

Table 9 Average weekend and weekday trip purpose in the study zones. *Source* Estimates from Department of Urban Roads (2015)

Traffic zone	Trip purpose	Weekday trips		Weekend trips	
		Average number	%	Average number	%
Asafo	Work	123,653	89.17	30,932	23.24
	Social	13,263	9.56	101,036	75.92
	Work and social	1750	1.26	1119	0.84
	Total	138,666	100.00	133,087	100.00
Adum	Work	127,761	90.04	29,771	21.64
	Social	12,920	9.11	105,798	76.91
	Work and social	1210	0.85	1987	1.44
	Total	141,891	100.00	137,556	100.00
Central Market	Work	127,961	90.25	29,632	21.30
	Social	12,769	9.01	107,288	77.12
	Work and social	1059	0.75	2190	1.57
	Total	141,789	100.00	139,110	100.00
Kejetia	Work	137,565	90.82	31,965	21.49
	Social	11,313	7.47	115,615	77.74
	Work and social	2590	1.71	1138	0.77
	Total	151,468	100.00	148,718	100.00
Suame	Work	126,456	90.74	35,668	25.84
	Social	10,569	7.58	101,365	73.42
	Work and social	2331	1.67	1024	0.74
	Total	139,356	100.00	138,057	100.00
Ashanti New Town	Work	122,986	88.25	26,582	19.33
	Social	12,048	8.65	110,325	80.22
	Work and social	4322	3.10	619	0.45
	Total	139,356	100.00	137,526	100.00
Bantama	Work	111,636	91.14	26,868	22.86
	Social	9869	8.06	89,566	76.19
	Work and social	989	0.81	1124	0.96
	Total	122,494	100.00	117,558	100.00
Kwadaso Estate	Work	100,597	87.01	25,612	23.74
	Social	13,010	11.25	79,988	74.14
	Work and social	2005	1.73	2293	2.13
	Total	115,612	100.00	107,893	100.00
Tafo	Work	106,789	91.79	25,097	21.87
	Social	8592	7.38	88,335	76.98
	Work and social	965	0.83	1315	1.15
	Total	116,346	100.00	114,747	100.00
Asokwa	Work	132,087	93.69	29,497	21.80
	Social	7658	5.43	104,586	77.30
	Work and social	1239	0.88	1220	0.90
	Total	140,984	100.00	135,303	100.00

Conclusion

Experiences described by respondents and supported by land use and transport data revealed that there is a weak effect of land use on urban travel pattern in Kumasi, with negative effects on urban functionality in terms of congestion and poor land use planning. This finding is contrary to the influential literatures of land use and transportation interactions often arguing that there is a strong relationship between land and transportation (Badoe and Miller 2000; Cervero 1994; Gordon and Richardson 1997; Schwanen and Mokhtarian 2005; Wee 2011). With rapid demographic growth and changes in land use transcending the administrative boundaries of Kumasi, people in the research area were affected by the rapid demographic growth, poor conditions of transport services and limited transport infrastructure and congestion. For instance, close to 20% of the roads in the city are classified as being in poor condition, which implies they are near immotorable.

Land use planning, important for effective land use and transportation interaction and the general urban functionality, has become increasingly uncertain and increasingly ineffective due to non-adherence to, among others, planning requirements and weak capacity of planning institutions, leading to encroachment on public open spaces, nature reserves and road reservations. Development in Kumasi is preceding land use planning efforts. However, the effects of poor land use planning differed amongst different land uses with higher negative impacts for open spaces, road reservation and nature reserves. These land uses have been severely encroached upon and converted into residential, commercial and related uses without planning approval and consideration for transport infrastructure and services.

The case study zones appear to be struggling to adapt to the changing population growth, land use changes and transport challenges. For example, walking remains the dominant mode of transport in the city, constituting close to half of the total trips generated across the city. While walking is encouraged in many geographical jurisdictions, findings from this research indicate that urban residents are choosing walking over motorised transport because of poor location accessibility and congestion. Many respondents preferred walking to motorised transport because it provides easy accessibility to various activity zones

in Kumasi. Interestingly, those using motorised means of public transport are also faced with poor transport services with widespread use of rickety vehicles, often with an average age of 13 years, and low vehicular maintenance culture, which often threaten the safety of commuters. Regrettably, these motorised means of public transport provide services to many urban residents in Kumasi (43%), particularly the low-income groups (Poku-Boansi 2008).

Immediate support in the areas of road transport infrastructure investment, improvement in public transport services and sustainable land use planning of the city is needed. With the increased congestion on the city's roads, there is also a need for investment and research into ways of diversifying transport services in Kumasi by understanding, testing and adopting new modes of transport particularly light rail and bus rapid transit systems to help reduce congestion, support safe commuting, promote urban functionality and ensure strong relationship between land use and transportation in Kumasi.

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