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Local Perspectives on Spatial Accessibility to Market in the Afram Plains, Ghana

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ABSTRACT

The capacity to reach surrounding areas from a location, commonly known as spatial accessibility, is crucial in the economic development of such a location. The Afram Plains in Ghana, despite been touted as the food basket of the country, has long struggled with poor spatial accessibility due to the lack of reliable transport infrastructure. This problem negatively impacts the movement of people and products, which ultimately hinders the economic development of the area. This research aimed at capturing the perspectives of Afram Plains' residents regarding their spatial access to nearby markets. A mixed-method approach comprising survey questionnaire, interviews, and geographic information system (GIS) was utilized. The results affirmed that movement within the area, particularly to market, is difficult. Again, due to limited transport facilities, many people resort to walking as their primary means of transportation. These findings are expected to provide some vital ideas for future road planning in the area.

KEYWORDS

Economic Geography, Ghana, Human Perception, Location Science, Market Infrastructure, Proximity Analysis, Rural Transportation, Spatial Accessibility, Sub-Saharan Africa

INTRODUCTION

Spatial accessibility is described as the capacity to reach the surrounding areas from a specified location (Luo and Wang, 2003; Ahlström et. al., 2011). Sometimes identified as transferability, spatial accessibility is a key component in establishing the physical interaction between places (Theriault et al. 2005; Rodrigue et al., 2013). The other components include complementarity (supply and demand between the interacting locations) and intervening opportunity (presence or absence of better alternatives) (Rodrigue et al., 2013). For spatial access to be established, the place of origin and destination must be physically linked through some sort of transport infrastructure such as road or

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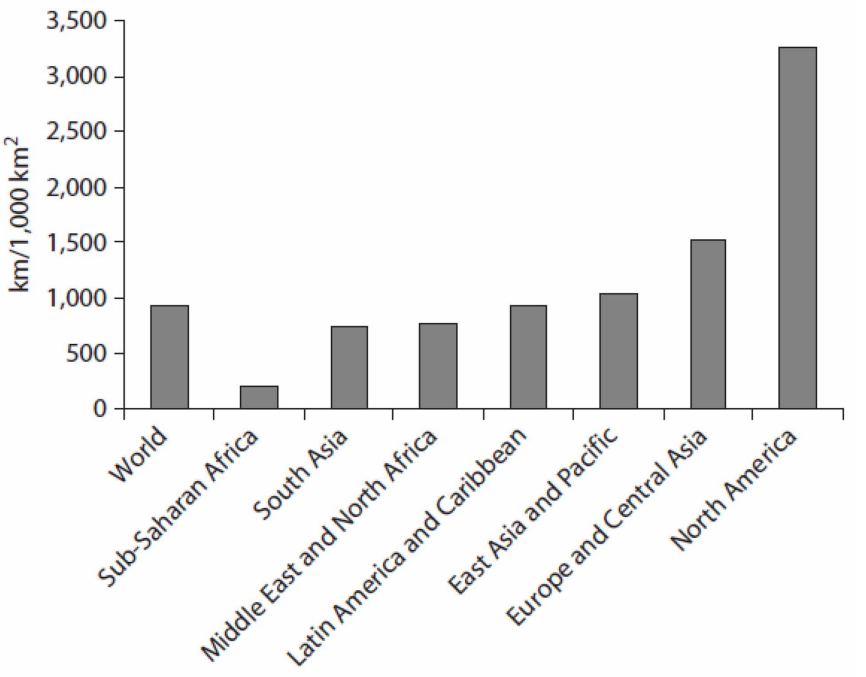
rail (Olsson, J. 2009; Ahlström et. al., 2011; Rodrigue et al., 2013). Where transport infrastructure is limited or unreliable, spatial accessibility is negatively affected, and ultimately, constrains interaction severely within the region and beyond (Roehner, 1996; Guimarfies and Uhl, 1997; Porter, 2002b; Nutley, 2003).

In the developing world, the lack of adequate and reliable transport infrastructure is widespread, particularly, in rural areas. This phenomenon is considered as one of the main obstacles to economic development in various regions around the world (Guimarfies and Uhl, 1997; Porter, 2002b; Nutley, 2003; Olsson, 2009). Sub-Saharan Africa (SSA) for example, is considered as the worst accessible region in the world in terms of road density (Buys et al., 2006; Gwilliam, 2011) (figure 1). SSA has an average road network density of 3.4 km per 1,000 people, compared with the world average of 7.1 km (Gwilliam, 2011). Motorable roads form a small portion (about 34%) of rural road network but almost half are in deplorable conditions (African Development Bank (ADB), 2010). The remainder include tracks or paths that link local communities to farms and market centers (Riverson et al., 1991).

The lack of adequate and reliable roads in SSA has been blamed for limited access to necessary amenities like schools, clinics, and market centers (Riverson et al., 1991; Porter, 2002(b)). It also led to persistent low agricultural productivity, poor food distribution (World Food Program, 2009; Gwilliam, 2011) and minimal trading opportunities (Hoyle and Knowles, 1998; Lamport, 2009) in the sub region (Naude et al., 1999). With agriculture being the principal economic activity in SSA (World Bank, 2008; Abatena, 2009; Gwilliam, 2011), it is crucial to study and address the issue of poor spatial accessibility.

The primary and obvious positive effects of improved transport infrastructure are clearly acknowledged through the reduction of both travel time and cost of production (Mwase, 1989; Roehner, 1996; Kilkenny, 1998; Peters, 2003; Olsson, 2009). Others comprise improved interaction and trade

Figure 1.
Global spatial density of road networks



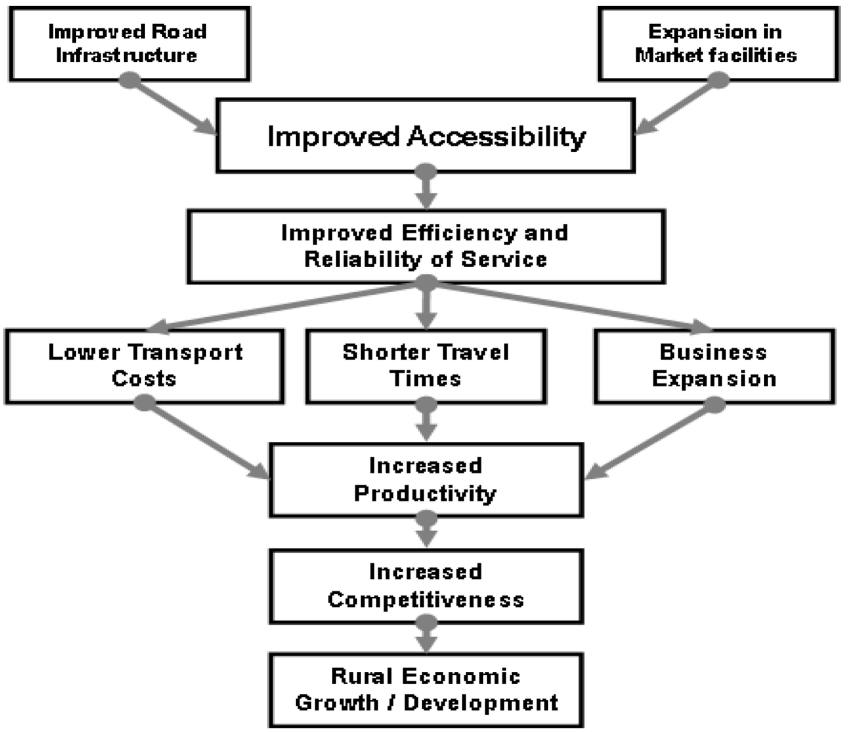
Source: Gwilliam (2011)

relations among distant communities (Roehner, 1996), business expansion, and attraction of investors (Porter, 2002b; Olsson, 2009). Yet, one effect which is often under-reported is the improvement in spatial access to alternative or profitable markets which in turn, results in increased income levels for farmers in rural areas (Riverson et al., 1991). Besides, there are also indirect benefits as well. According to Tighe (2008), market centers are generally the primary destination for residents in the rural parts of SSA. Even though they are mainly centers of commerce, markets also serve as information centers where residents obtain useful information about their farming activities like produce prices, pest control and credit facilities (Leinbach, 1995; Hoyle and Knowles, 1998; Olsson, J. 2009). Markets also provide avenues for other cultural and socioeconomic activities such as marriage arrangements, loan payments, theatrical performances, and renewal of friendships to occur (Berry and Parr., 1988). Thus, a limited access to a market does not only affect residents economically, but it also entrenches their cultural and social isolation (Tighe, 2008). The impact of reliable transport infrastructure and spatial accessibility is illustrated in figure 2 below.

PROBLEM

The conditions in the Afram Plains of Ghana (figure 3) epitomize the above discussion. The Afram Plains is located in the Eastern Region of Ghana, and it is largely regarded as the food basket of the country (Ghana District News, 2013). Yet, it is one of the economically deprived areas in Ghana (ADB, 2006; Daily Graphic, 2006). There is virtually no reliable access road connecting the area to the rest of the country as it is almost completely cut off by Lake Volta and the Obosom River. Currently, the

Figure 2.
The effects of improved spatial accessibility



Source: Adapted from Rodrigue et al. (2013)

main entry to the area is via a ferry service or private canoe services (figure 4). According to Afram Plains Catholic Apostolic Prefecture (APCAP, 2010a), the area's geographic isolation is a major contributing factor for its persistent economic problems.

Moreover, transport networks within the area are limited, thus, several communities cannot easily access social services available in the major towns (MOFA, 2013). Even among the few privileged areas with some road networks, many roads are in a bad condition (APCAP, 2010a). The situation worsens during the rainy or wet farming season, which is characterized by torrential rains and flash floods that render many agricultural areas practically inaccessible, disrupt economic activities, and cause significant post-harvest losses (APCAP, 2010b). Such conditions also limit access to local social facilities like markets, health centers, schools and credit facilities (ADB, 2006; MOFA, 2013).

Moreover, existing market facilities in the area are few and quite far from many villages, meaning the residents who are mostly farmers need to pay more in hauling their produce to market to sell (ADB, 2006; Ghana District News, 2013). The long travels and hauling result in high cost of production (ADB, 2006). It is therefore not surprising that markets in the area are all periodic (organized once or twice per week), and hence part time and itinerant trading are very common. These practices allow the residents to offset their operating cost by minimizing the number of travels to market (Berry and Parr., 1988). The high cost of production also discourages investors from conducting business in the area (Ghana District News, 2013).

The realization of the significant impact of poor spatial accessibility on rural development in the Afram Plain have led to the introduction of various intervention projects in the past. One of them was the Afram Plains District Agricultural Development Project (APDADP) which ended in 2012 (MOFA, 2013). The main goal of the project was poverty reduction by ways of increasing agricultural

Figure 3.
Afram Plains area

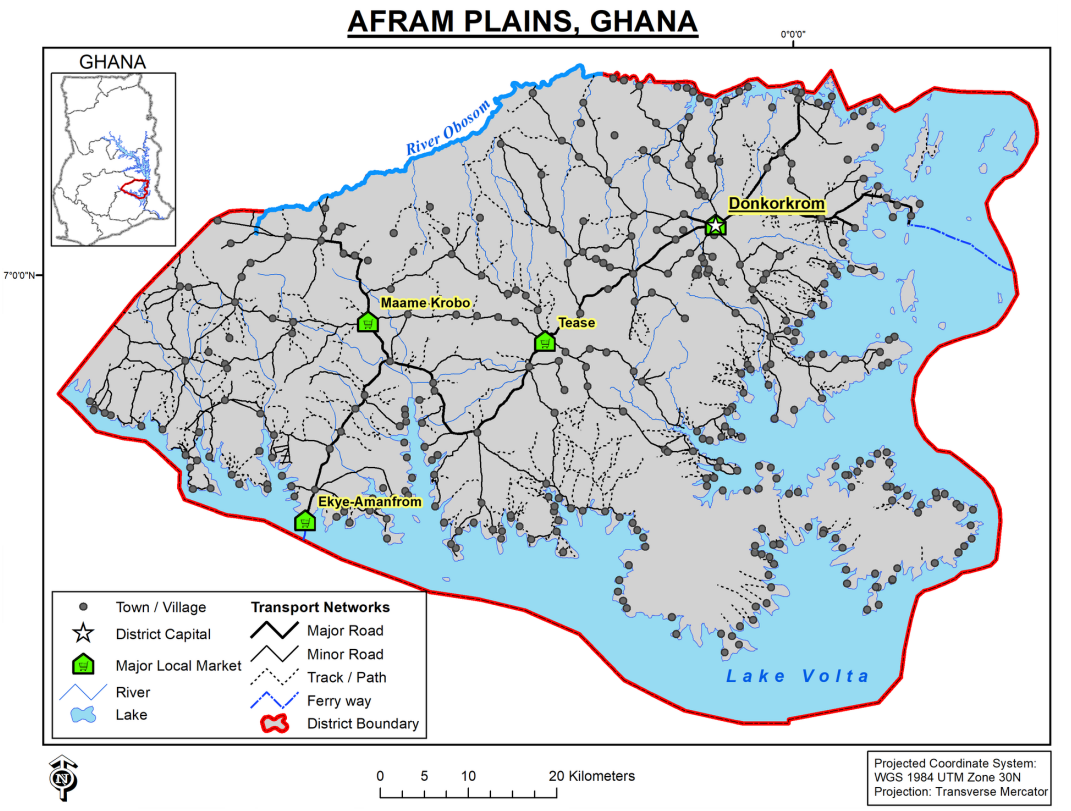


Figure 4.
Ferry service (left) and canoe operators (right)

outputs and improving existing feeder (dirt) roads (Kwahu North District Assembly (KNDA), 2013. District Profile.). Besides APDADP, there was also the Millennium Challenge Account which focused on three main areas: agricultural commercialization, transport infrastructural development and rural development. Under the transportation segment, the key objectives were to enhance access to international air and sea ports, improve trunk road networks as well as ferry services (ADB, 2006; Ghana District News, 2010; KNDA, 2013).

Despite some notable successes made through the above projects, spatial accessibility to social facilities, particularly markets in the Afram Plains, remains acutely limited (MOFA, 2013). Some past studies in Ghana have shown that factors like late development (Porter, 2002b), low population density, low-income levels (APCAP, 2010c; Gwilliam, 2011), poor road planning and maintenance capabilities (Riverson, et al. 1991; Riverson and Carapetis, 1991), and lack of community involvement (Riverson and Carapetis, 1991; Porter, 2002b) explain why the prevailing problem remains unresolved.

Porter (2002b) for example indicated that, the late development of transport infrastructure in Ghana (just as in many SSA countries) is originally the cause of the problem. Earlier developments which occurred during the colonial era were concentrated mainly in selected resource-rich areas. The large part of the country was left undeveloped hence, why there is still low spatial density of transport networks.

Furthermore, the situation reflects the general low population densities of many areas of SSA (Gwilliam, 2011). Unlike regions like South Asia, population in rural SSA is sparsely distributed. Sparse population coupled with low productivity and low per capita income make the rural areas less economically attractive to governments and investors hence, the continual neglect and marginalization of these areas (Deichmann et al., 2006).

Moreover, the lack of effective road planning and regular maintenance has been proven as drawbacks to infrastructural development in rural Ghana and SSA as a whole (Riverson, et al. 1991; Buys et al., 2006). Riverson et al. (1991) noted that many SSA governments lack reliable data on production and transport activities as well as the technical know-how of building and maintaining durable infrastructure. As a result, they are unable to track changes in travel and haulage activities to effectively forestall the deterioration of the few existing infrastructure. Again, it has been observed that some new road developments and maintenance tend to be biased towards areas that support the government. Hence, such decisions are more politically motivated rather than supported by sound planning or research (Oppong, 1997). Besides, some local government authorities practically abandon periodic road maintenances which are essential in ensuring the longevity of the roads (Riverson and Carapetis, 1991).

Finally, the exclusion of communities in local infrastructural development and maintenance programs are also blamed as part of the problem for poor road infrastructural development. Due

to such exclusion, some communities become indifferent about new programs or projects. Such apathy ultimately leads to abandonment and subsequent deterioration of such projects (Riverson and Carapetis, 1991; Porter, 2002b). Tighe (2008) therefore argued that it is necessary to involve communities in decisions regarding local road development in order to receive their contribution towards future road maintenance.

Considering the above factors particularly the final one, this study sought to capture the perspectives of residents of Afram Plains regarding accessibility to markets. Documenting these perspectives was considered as an attempt at creating a body of local knowledge that could be incorporated into future road planning. To fulfil that, the following questions were asked:

1. What are the travel experiences of residents (farmers) within the area?
2. How does perceived travel time compare with GIS-Modeled travel time?
3. What factors control movement of residents in the area?
    a. Is there any geographic disparity among the factors?
    b. Is there any socio-demographic disparity among the factors?

MATERIALS AND METHODS

Study Area

The Afram Plains[1] is located in the northern part of the Eastern Region of Ghana; between latitudes 6^{o} 33' N and 7^{o} 12' N and longitudes 0^{o} 15' E and 0^{o} 45' W. It occupies a total area of approximately 5,300 km^2 (dry land constitutes about 3,752 km^2). It shares boundary with the following districts: Sekyere Afram Plains to the Northwest and West, Kwahu East to the Southwest, Kwahu South to the South, Kpando to the East, and Sene and Atebubu districts to the North. There are over 300 towns or communities in the area with Donkorkrom being the largest. Figures 5 and 6 show the location and some of the geographic features named above.

In 2021, the population in Afram Plains was estimated to be 276,020, representing about 26% change from the 2010 census (218,235) (Ghana Statistical Service (GSS), 2020). The population density in 2020 was estimated at about 77 persons/km^2. The population in Afram Plains is also slightly dominated by females; 50.8%. Majority of the population are active labor force: 15-64 years (53.3%) followed by the young dependent group: 0-14 years (43.5%)[2]. The population is predominantly rural[3] (80.4%). Town population range from a low of 20 in the hamlets to over 10,000 in the big towns like Donkorkrom and Maame Krobo.

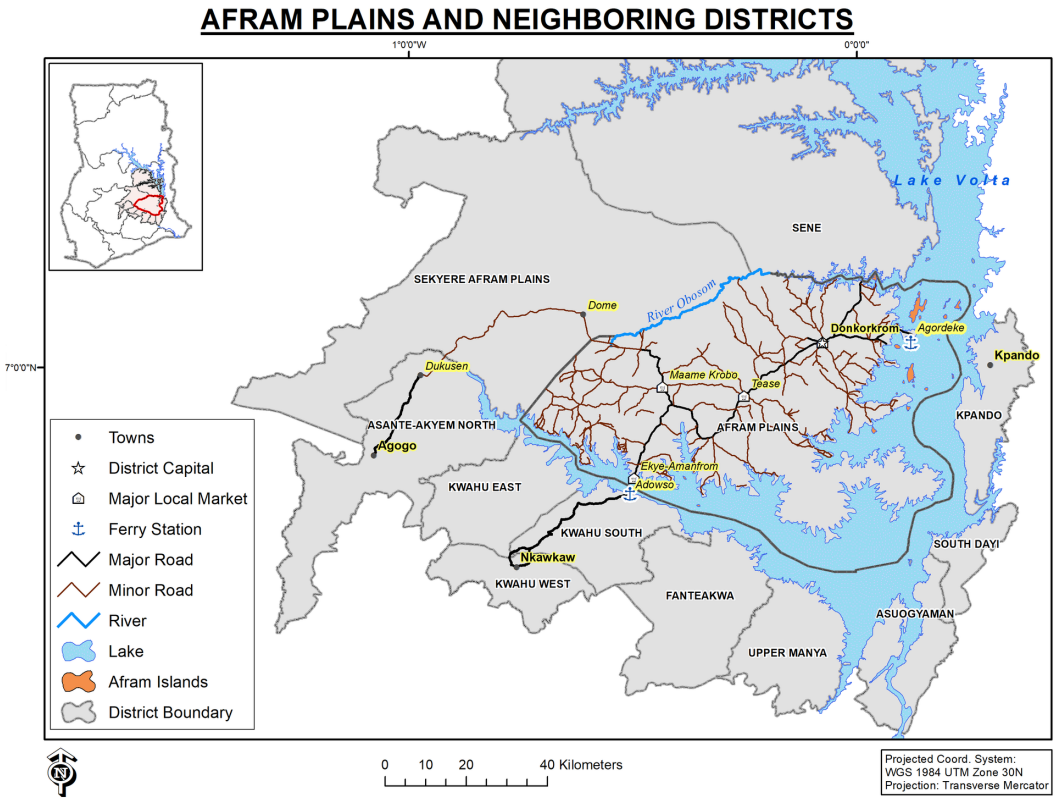
Agriculture is by far the dominant economic activity accounting for about 80% of the employed labor force; 87.2% of that are subsistence farmers and the rest, agro-industry or commercial farmers (MOFA, 2013). Farm produce are mainly sold locally in the four major market centers in the area: Maame Krobo, Donkorkrom, Ekye Amanfrom and Tease markets (KNDA, 2013; MOFA, 2013). Figure 7 shows the production of the top three crops in the area between 2006 and 2012.

Data

To answer the research questions, the authors collected both quantitative and qualitative data through a survey questionnaire in 2013. The quantitative data accounted for things like resident's travel experience to a market based on metrics like total travel time and average number of travels in a week to a market. In the same survey, open-ended questions were used to solicit in-depth information about resident's usual commute to market (qualitative data).

Using a stratified random sampling approach, a total of 202 households were sampled from 20 towns (out of 378 identified towns). To ensure sampling representativeness, the sampling was stratified among the top 20 largest (population) towns across the area (their populations ranged between 10,180 and 883). Using population size as weights, the proportionate sample size of each

Figure 5.
Study area

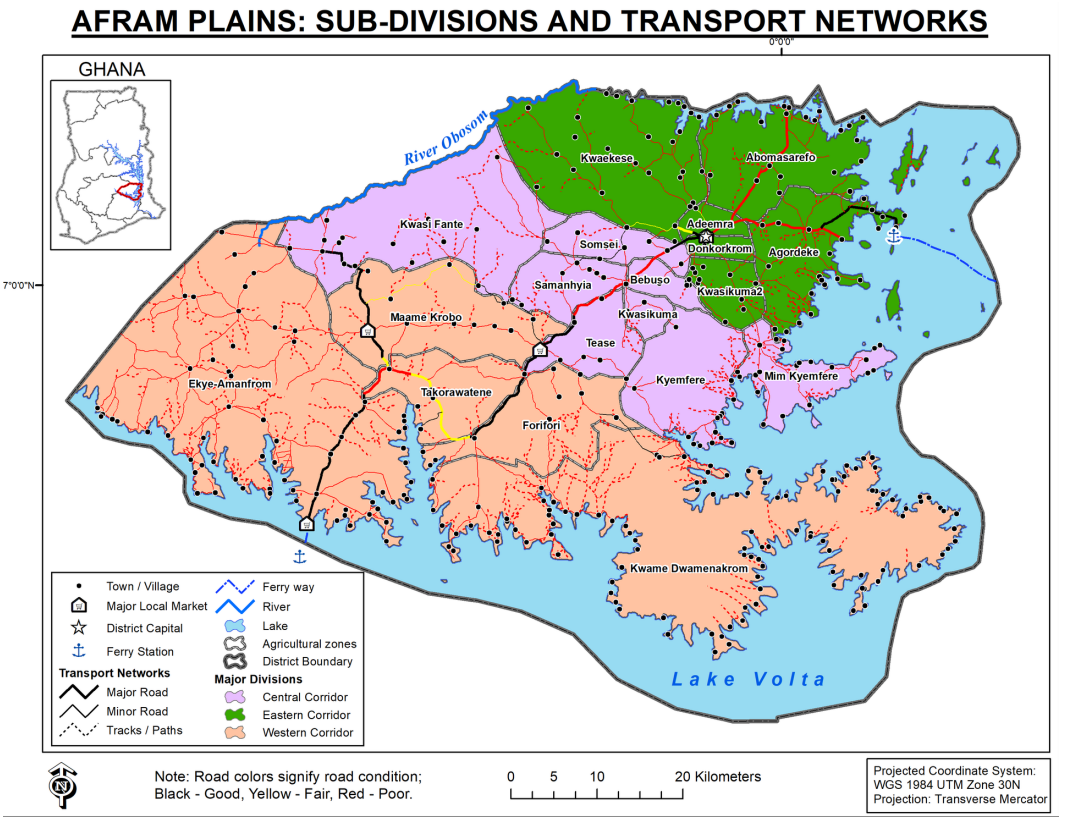


community was determined. The survey was aimed at household heads. In the absence of a household head, the spouse or next available adult household member (over 18 years old) was recruited. Each respondent was recruited after they had voluntarily given their consent to participate in the survey. Prior to recruiting any participants, the survey instrument was subjected to an Institutional Review Board (IRB) [Application Number: 2012Q1825] scrutiny at Texas State University to ensure that the rights and privacy of all research participants were duly protected. Table 1 below shows a breakdown of the characteristics of all the respondents.

Besides survey data, geospatial data were also acquired for both mapping purposes and network analysis. Table 2 provides a list of these data and their sources. To ensure the quality of the geospatial data, the authors verified them against other high resolution and authoritative datasets including a cloud-free 15-meter resolution Landsat 8 panchromatic images (acquired on April 28, 2013, and May 22, 2013) and a 2013 topographical map of Afram Plains.

There were a few instances where the panchromatic images were fuzzy and blurry, thus making it difficult to verify the existence of some geographic features. In such cases, the authors relied on high-resolution (ranged between 1 to 5 meters) orthophotos from Google Earth and Microsoft Bing Maps. These online-based images, however, were very limited in scope; they were mostly available in the major towns, and thus, they were sparingly used. Other methods such as direct observation and local knowledge through public participation were also employed to support the verification process. Through these series of checks and updates, the quality of the acquired spatial datasets was improved. Features like agricultural zone (agro-zone) boundaries, roads, water bodies, market centers, and location of towns as well as their current toponyms were verified, revised or updated accordingly.

Figure 6.
Sub-divisions and transport networks in Afram plains



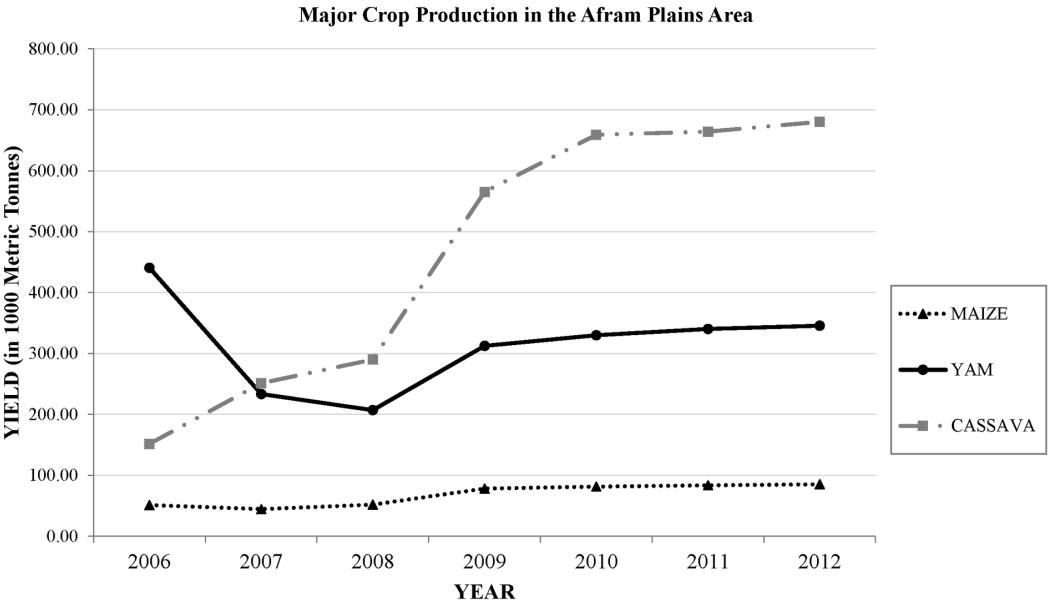
Overall, 378 towns were identified or verified. Although this number fell short of an estimate of 500 (according to the 2010 Census), some participants revealed that most of the smaller villages tended to be temporary due to migratory farming practiced by some local folks in the area. They also added that, town name-change is a common practice in the area, even though the national census tends to stick with the old names. These factors possibly explain why certain communities could not be identified. Regarding the agro-zones, 20 of them were digitized but a satellite zone that is not directly within Afram Plains. For ease of classification and statistical analyses, the 19 remaining agro-zones were collapsed into 3 divisions: East, Central and West corridors based on the guidance of a local government official (see figure 6).

Analyses

The authors examined the residents' perceived travel time (PTT): survey respondents drew from their experience and estimated the travel time from their town of residence to their preferred market based on their preferred mode of transport. The goal for PTT was to understand how residents perceived the effects of the existing transport infrastructure or resources on their regular commute to market.

Another dataset called 'modelled travel time' (MTT) was created purposely to compare with the PTT values. The goal for this comparison was to gauge how perceptions could possibly affect future transportation planning and improvements. The MTT represents incremental travel time from respondent's town of residence to their preferred market based on their preferred mode of transport. It was modelled using ArcGIS's path distance (PD) tool, which is comparable to the cost distance

Figure 7.
Production of major crops



Source: MOFA (2013)

(CD) tool in ArcGIS as both are used to determine the minimum accumulative cost of movement from a source point to every location in a raster surface. But, unlike the CD, the PD allows for terrain conditions (based on elevation) to be accounted for. Hence, PD produces a more realistic surface distance (Esri, 2011(a)). The impedance factors included existing roads/paths, landcover, water bodies, bridges, and elevation.

The results of the MTT modelling were six raster surfaces depicting travel times to the four market centers based on six different modes of transportation identified by the survey respondents. Then, in respect to participants responses: town of residence and preferred mode of transport, corresponding MTT values were extracted. The MTT values were later compared to their PTT counterpart to establish whether there was any significant relationship between the two variables. The authors expected to see a positive correlation between the two variables since they were obtained from the same geographic location and were based on similar travel experiences and circumstances. A Spearman correlation was used for this test. A Wilcoxon Signed Ranks was also used to test whether the two variables were significantly different from each other. The above statistical tests and other subsequent ones were all conducted using IBM Statistical Package for the Social Sciences (SPSS) version 22.

To answer the other research questions, further statistical analyses were conducted on the survey data. Prior to all this, the authors first entered or coded all survey responses into the SPSS system. Afterwards, descriptive statistics like count or frequency, percent, mode and means were run to provide a general distribution and understanding of the responses given by the participants. Various charts including bar, line and pie charts were also employed to visualize the data.

Regarding inferential statistics, besides the two that have already been noted, Chi Square analyses and Kruskal-Wallis H test were conducted. They were used to answer the research question three: factors that influence movement of residents in the area. Specifically, Chi Square analyses were used to explore significant associations between major divisional areas or gender and the following factors: choice of market and reason for choice, and choice of transportation and reason for choice. As part of answering the question pertaining to factors controlling residents' movement in the area, the authors

Table 1.
Socio-demographic characteristics of survey respondents

Demographic Variable	Group	Frequency[4]	Percent
Sex	Male	129	64.5
	Female	71	35.5
	Total	**200**	**100**
Age	18 – 25	16	8.2
	26 – 35	51	26
	36 – 45	48	24.5
	46 -60	58	29.6
	> 60	23	11.7
	Total	**196**	**100**
Size of household	< 5 persons	47	31.1
	5-7 persons	59	39.1
	> 7 persons	45	29.8
	Total	**151**	**100**
Ethnic origin	Akan	62	31.3
	Ewe	43	21.7
	Northern Tribe	64	32.3
	Other	29	14.6
	Total	**198**	**100.0**
Highest level of Education	None	51	25.9
	Basic/Primary	97	49.2
	Secondary/High School	46	23.4
	Tertiary/Polytechnic	3	1.5
	Total	**197**	**100**
Primary occupation	Artisanal	2	1
	Farming	189	95
	Trading	4	2
	Other	3	1.5
	Unemployed	1	0.5
	Total	**199**	**100**
Average Seasonal Household income	<GHC1000[5]	85	49.7
	GHC1000-2000	24	14
	GHC2000.1-3000	5	2.9
	GHC3000.1-4000	2	1.2
	GHC4000.1-5000	2	1.2
	>GHC5000	6	3.5
	Can't tell	47	27.5
	Total	**171**	**100**

Table 2.
Spatial data and their sources

Spatial data	Source
Afram Plains area topographical map (paper map)	Afram Plains Development Organization (2013)
Afram Plains area boundary (shapefile)	Ghana Survey Department (2006)
Afram Plains Towns and Villages (shapefile)	Ghana Survey Department (2006)
Afram Plains Roads and Water bodies (shapefiles)	Ghana Survey Department (2006)
Agricultural sub-division boundaries or agro-zones (digital map; JPEG)	Ministry of Food and Agriculture, Ghana (2013)
Landsat 8 image (panchromatic); 15m resolution	USGS (2014)

conducted a spearman correlation analysis to test for any significant relationship between average frequency of market visits in a week and travel time to preferred market location. In other words, did travel time influence the frequency of visits to a market?

Regarding the analyses of the survey open-ended questions, the author's used QSR International's NVivo 10 qualitative data analysis software (NVivo, 2012). NVivo was used to perform analyses such as text frequency and identifying recurring themes. These analyses helped to understand and generalize the qualitative opinions of the respondents.

RESULTS AND FINDINGS

Residents' Travel Experiences

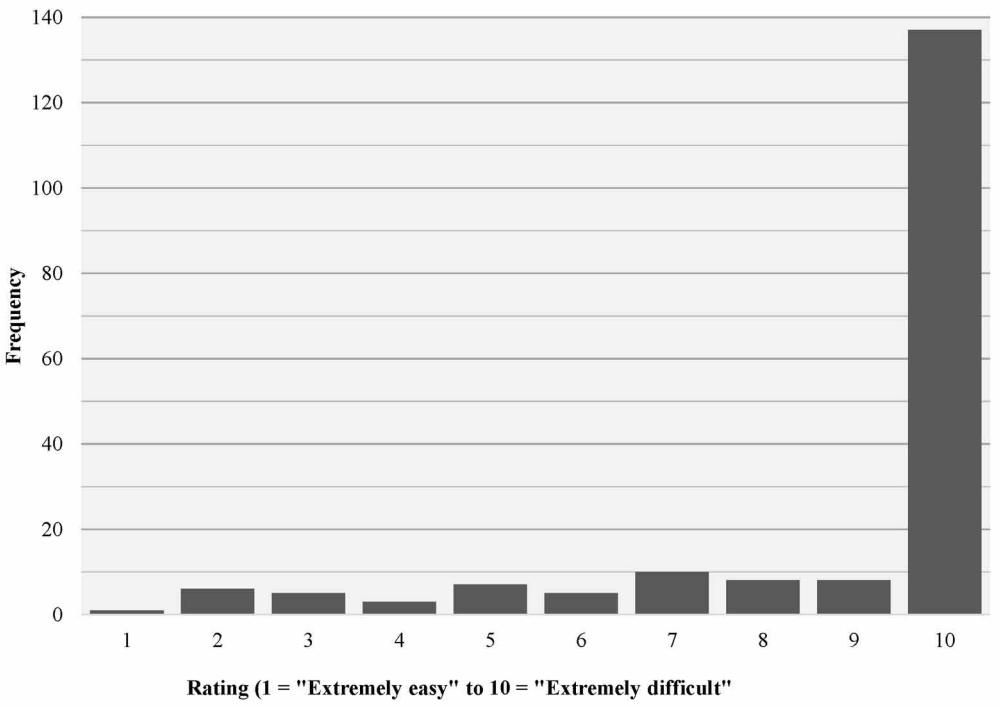
The first question this research sought to answer was, understand residents personal travel experiences to market. Through the survey, participants were asked to indicate the level of difficulty experienced in their routine commute to their preferred market. Their responses were captured using a Likert scale of 1 to 10, where "1" meant "extremely easy" and "10", "extremely difficult". The results are illustrated by figure 8. It is clear from figure 8 that, most of the respondents (over 70%; $n = 190$) perceived their travel experience as extremely difficult.

Related to the above, participants were asked to identify the main challenge (or support system) associated with their perception indicated previously and show how critical it was to them (figure 9). Figure 9 shows that, poor nature of existing roads is the major concern to most residents in the area. Following that is the lack of vehicles.

Furthermore, to gain insight into resident's travel experiences, respondents were also asked to briefly describe the journey to their preferred market (including nature of roads or paths, challenges, or hazards and how they affect their trip). The responses were analysed by NVivo (based on word frequency) and the results are shown in table 3. According to table 3, snake infestation is the common problem encountered by the residents particularly, those who resort to walking. In fact, these networks are footpaths or tracks created by individual farmers or tractors as opposed to paved roads. These paths are usually narrow and quickly taken over by weeds thus, becoming hideouts for poisonous snakes. A check with some local health centers (example: Tease Health Center) revealed that snake bites were among the commonly reported health cases in the area thus confirming the problem.

The next major problem identified was bad roads which comprised issues like narrow paths, rough terrain, and the lack of or collapsed bridges. Vehicular breakdowns/accidents, which are associated with road conditions was the third major problem. The respondents revealed that means of transportation, particularly cars and trucks, often overturned or broke down due to poor road conditions. They indicated that some roads had huge gullies caused by water erosion, thus making vehicular movement difficult, dangerous and sometimes utterly impossible.

Figure 8.
Perception of how challenging travel to market is



Periodic flooding of roads and paths was also noted among the top problems. As noted previously, the nature of the drainage system of the area makes it prone to flooding particularly, in the rainy or wet farming season. The lack of bridges and paved roads in the area further aggravates the existing mobility problems (APCAP, 2010b). The respondents further revealed that, after flood waters recede following a major flood, they leave behind puddles, soggy and muddy roads which hamper vehicular movement. This cycle of floods, continuous road usage and limited road maintenance also lead to development of potholes and further deterioration of the fewer paved roads in the area. As the roads deteriorate, vehicular breakdowns increase and in turn, lead to considerable post-harvest losses. Other less cited problems included loss of buyers, long travel distances or delays in travel, increasing cost of transportation and decreasing number of transport operators.

Perceived vs. Modelled Travel Times

The second research question was about how PTT (perceived travel time) compared against GIS-Modeled travel time (MTT). According to the survey, PTT or residents perceived travel time varied considerably. About half of them though travelled within an hour to their preferred market. The mean and median were 113 and 75 minutes respectively (standard deviation of 106.45 minutes). The minimum and maximum travel times were 10 and 900 minutes (15 hours) respectively. Table 4 shows these breakdowns.

A further look at the distribution according to the major geographic divisions in the area showed stark differences (table 5). The Central corridor had both the lowest mean and median travel times; 90.16 and 60 minutes respectively and had the least variability as well; standard deviation of 77.37. The other two corridors had greater mean and median travel times and wider variability too (standard deviation $\geq$ 90 minutes). A Kruskal-Wallis H test indicated that the differences among the three major divisions

Figure 9.
Main challenges (a) to travelling to market and their rating (b)

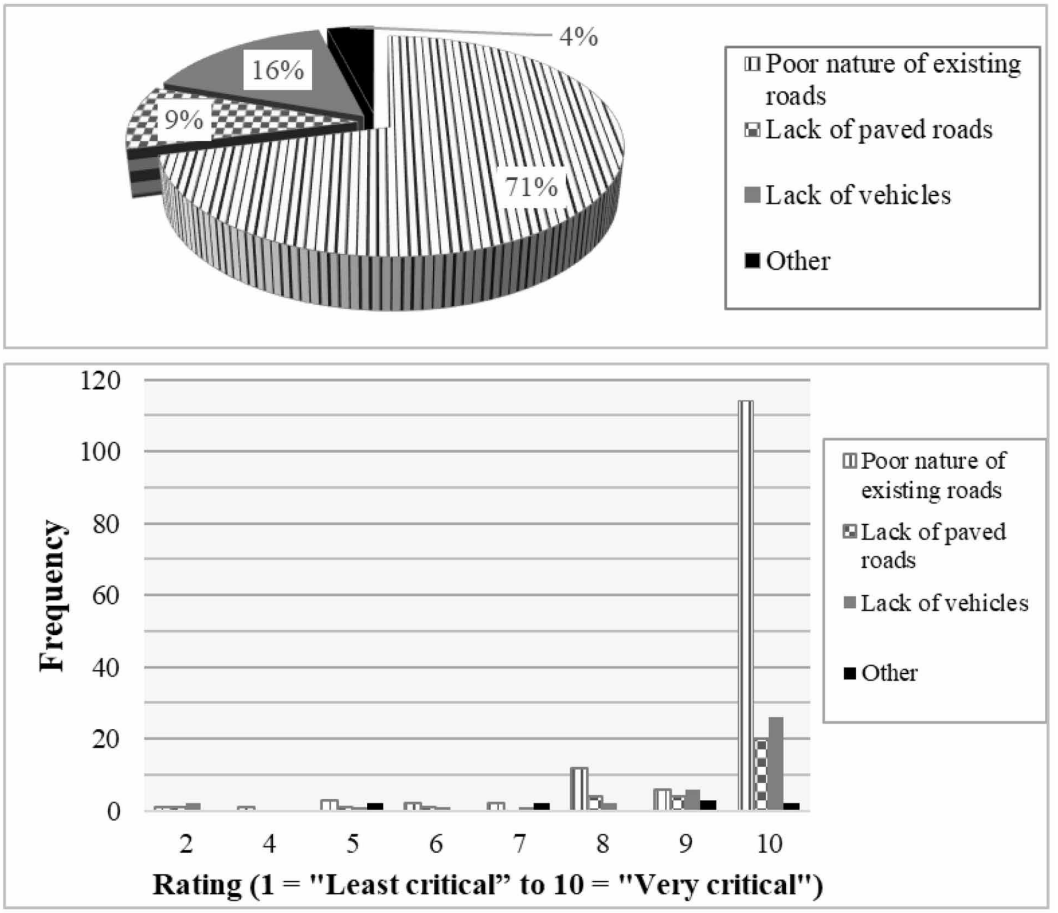


Table 3.
Problems encountered during farm-to-market trips

Problem	Frequency
Snakes	56
Bad roads	35
Vehicular breakdown / accidents	22
Loss of produce	17
Flood / Waterlogged roads / vehicles get stuck in mud	14
Potholes	12

indeed were significant ($\chi^2 = 9.67$, df = 2, $p = 0.008$). In a post-hoc analysis, the results showed that, the significant differences existed only between the Central and Western corridor ($p = 0.006$) but not between the Central versus Eastern ($p > 0.05$) and Eastern versus Western ($p > 0.05$) pairings.

Table 4.
Comparing PTT and MTT statistics

Statistic	Perceived Travel Time (PTT; in minutes)	Modelled Travel Time (MTT; in minutes)
N	176	176
Minimum	10.00	5.0
Maximum	900.00	992.51
Median	75.00	36.52
Mean	113.41	113.29
Std. Deviation	106.45	177.36

As noted in the methods section, another dataset, MTT, which represented travel time from respondent's town of residence to their preferred market based on their preferred mode of transport was also created. MTT was also subjected to the same statistical test and the results compared to that of PTT to determine the level of accuracy of residents' perception. The MTT results (also in table 4) varied considerably from that of PTT except in the mean values (113.29 minutes). About 65% of respondents were modelled to have a travel time within an hour from their preferred market (table 6). The major departure though was observed under the analyses of the major geographic divisions (also in table 5). Interestingly, the Western corridor have the lowest travel times (lower travel times are preferred) across all the descriptive statistics (i.e., mean, median, standard deviation, maximum), and yet the statistics of perceived travel time (e.g. mean and median) were not the "best" among the regions. The Central corridor, on the other hand, which had the lowest travel times under PTT, had the largest values in terms of mean or median MTT. Regardless, a Kruskal-Wallis H test confirmed that there are significant differences in modelled travel time among the major divisions just as in the case of PTT: $\chi^2 = 29.38$, df = 2, $p < 0.001$. A post-hoc analysis showed that, the differences existed between two pairings: Central-Eastern ($p < 0.001$) and Central-Western ($p = 0.002$). The post-hoc results along with the descriptive statistics in Table 5 suggest that travel experiences within the Central area are more similar (lowest standard deviation indicating least spread) than in the other divisions.

Based on the above results, travel times clearly varied significantly across the major geographic divisions in the area. But the case of significant contrast between modelled and perceived travelled times was not strongly established yet. To assess that, a Wilcoxon Signed Ranks test was conducted. The results affirmed that MTT differed significantly from PTT ($Z = -2.47$, $p = 0.013$). In addition, a Spearman rho correlation test showed a significant but weak negative relationship between the two variables ($r_s = -0.184$, $p = 0.014$). The two results were quite interesting as they hinted that, resident's perception of travel time could be very different from modelled results. This observation, however, conforms to a known phenomenon associated with analysis of perceptions especially about spatial characteristics. It is possible that some of the local perceptions contained some inaccuracies; a direct result of poor judgment either by overestimation or underestimation of distance measures on the part of respondents (Leach and Mearns, 1996; Briggs, 2005). On the other hand, it is also plausible that the GIS-based model, like all models, might have not fully accounted for some real-life factors like actual road conditions (which affect speed limits) in certain areas. Regardless, the authors note that this result only confirm a difference between PTT and MTT values, and not actual travel time measured from the field. Yet, as hinted above, this finding could be indicative of some factors that might be influencing local perception of spatial accessibility that were not specifically or fully accounted for in the modelled dataset, MTT. Despite such uncertainty, the results still revealed an interesting finding worth looking into in a future study.

A similar paradox was also observed in the PTT and MTT statistics among the area divisions particularly, between the Central and Western corridors; averagely, the Western corridor had lower travel times under MTT but not PTT, while the Central corridor had the reverse. As noted above, the

Table 5.
Comparing PTT and MTT statistics among the area divisions

Major Division	Statistic	Perceived Travel Time (PTT; in minutes)	Modelled Travel Time (MTT; in minutes)
East	N	64	64
	Minimum	10.00	5.00
	Maximum	900.00	992.51
	Median	90.00	44.72
	Mean	123.98	80.69
	Std. Deviation	136.16	146.366
Central	N	61	61
	Minimum	10.00	5.00
	Maximum	360.00	706.69
	Median	60.00	54.40
	Mean	90.16	203.33
	Std. Deviation	77.37	223.98
West	N	51	51
	Minimum	30.00	5.00
	Maximum	420.00	347.79
	Median	120.00	13.68
	Mean	127.94	46.49
	Std. Deviation	90.00	84.27

Table 6.
Comparing PTT and MTT statistics for commute to market

Commute	Perceived Travel Time (PTT)		Modelled Travel Time (PTT)	
	Frequency	*Percent*	*Frequency*	*Percent*
Within 0-60 minutes	88	50.00	114	64.80
Within 61-120 minutes	50	28.40	23	13.00
Over 120 minutes	38	21.60	39	22.20
Total	176	100.00	176	100.00

reason for the variation between MTT and PTT values were not established in this study. The authors, however, could posit about the variance in MTT values between the two corridors: the Western corridor unlike the Central corridor, has two market centers and more better roads (see figure 6) and thus, may have influenced the modelled results in favor of the former. A further study though, will be necessary to explain these two paradoxical patterns sufficiently.

Controlling Factors of Spatial Accessibility to Market in Afram Plains

Travel distance or time and consumer choice have been cited two major factors that significantly impact people's spatial accessibility to facilities or services (Haynes et al., 2003; Geurs and van Wee, 2004). The influence of these factors was tested in this study using Chi-Square test and contingency table. Regarding choice, two separate strands were looked at: consumer choice of market and consumer choice of mode of transportation.

Travel Distance / Travel Time

In the survey, respondents were asked to indicate how distance influenced their decision in choosing a particular market over others and how frequently they visited their market of choice. Regarding the first question, a crosstab/chi square analysis revealed that there was a strong significant association ($\chi^2 = 148.4$; df 8; $p < 0.001$) between residents' choice of market and their location (table 7). Majority of the respondents selected the nearest market or one within their vicinity. For instance, residents within the Eastern corridor predominantly patronized Donkorkrom market (87%) which is located within the Eastern corridor. A similar trend was seen in the case of the Western corridor where most respondents (84.7%) patronized the markets in Maame Krobo (57.6%) and Ekye Amanfrom (27.1) which are in the Western corridor. Maame Krobo is the largest market in the Western corridor (in terms of size and traders), and thus is considered more attractive.

Regarding the Central corridor, the association was not as clear as it was in the other sub-divisions. Even though, Tease market is the main market in the Central corridor, it was the second preferred market (27.5%). Such preference for Tease could be attributed to the centrality of the corridor thus, giving the residents the liberty to patronize markets in the adjoining sub-divisions; either Donkorkrom market (31.9%) in the East or Maame Krobo market (17.4%) in the West. In fact, the average travel time by tractor (the second preferred means of transport to market) in the central corridor, was less than an hour from both Donkorkrom and Maame Krobo markets.

Moreover, participants' reasons for their market preferences made it obvious that travel distance was crucial in their travel decisions (table 8). Among the reasons given, "proximity" to market was number one (48.7%) across all the major sub-divisions. The second reason was "availability of buyers" (33.9%); a factor closely associated with the size or attractiveness of the market (Hotelling, 1929; Huff, 1964; Church and Murray, 2009). The reasons were also highly associated with the major sub-divisions ($\chi^2 = 26.206$, df = 6, $p < 0.001$). As shown in table 8, "proximity" primarily influenced the decision among majority of residents in the Eastern (69.1%) and Western (46.3%) corridors. In the Central corridor, "availability of buyers" was the main reason (47.8%); a further attestation to the broader availability of choice for residents in the area as noted previously.

Table 7.
Relationship between major divisions and respondent's preferred market

		Preferred choice of market					Total
		Donkorkrom	*Ekye Amanfrom*	*Maame Krobo*	*Tease*	*Other*	
Major division	Central	22 (31.9%)	3 (4.3%)	12 (17.4%)	19 (27.5%)	13 (18.8%)	69
	East	60 (87.0%)	1 (1.4%)	4 (5.8%)	1 (1.4%)	3 (4.3%)	69
	West	1 (1.7%)	16 (27.1%)	34 (57.6%)	3 (5.1%)	5 (8.5%)	59
Total		**83 (42.1%)**	**20 (10.2%)**	**50 (25.4%)**	**23 (11.7%)**	**21 (10.7%)**	**197 (100.0%)**

Table 8.
Relationship between major divisions and main reason for preferred choice of market

		No. 1 reason for preferred choice of market				Total
		Good sale price	**Availability of buyers**	**Proximity**	**Other**	
Major division	Central	7 (10.4%)	32 (47.8%)	20 (29.9%)	8 (11.9%)	67
	East	8 (11.8%)	11 (16.2%)	47 (69.1%)	2 (2.9%)	68
	West	3 (5.6%)	21 (38.9%)	25 (46.3%)	5 (9.3%)	54
Total		**18 (9.5%)**	**64 (33.9%)**	**92 (48.7%)**	**15 (7.9%)**	**189 (100%)**

Furthermore, a comparison between respondents' preferred market choice and reasons for choosing a market provided a similar confirmation (table 9). Among the four major markets, there were at least 59% of the respondents indicated that "proximity" was the main reason for choosing three of them except Maame Krobo (17.8%). Maame Krobo though was preferred by 57.8% respondents for the "availability of buyers". Maame Krobo's case here might be due to its size and specific function (main market for produce like tubers), making it appealing to many traders and buyers from all over Afram Plains and even other parts of Ghana.

Notwithstanding, distance had insignificant influence on resident's frequency of visit to market (results are not shown). A correlation analysis ($r = -0.056$, $N = 172$, $p = 0.469$) revealed that there was no significant relationship between the average visits to a market in a week and the travel time to a preferred market location. The result reflected the popular view from the field interview that residents usually travelled to market only during the harvest season when they had some produce to sell. Some market travels also occurred during the planting season when they visited the market to get farm tools and agro-chemicals for their farms. According to the interviewees, a regular visit to market was not a common practice. It could therefore be asserted that improvements in road systems might not necessarily increase the number of times farmers/residents visit the market. Nonetheless, enhanced spatial accessibility could give the residents options and possibly create new opportunities for people to diversify their economic activities and investments in other areas due to possible reduction in transportation cost.

Consumer Preference

Consumer preference was also found as influential in participants' access of social facilities in this study. Here consumer preference was confined to participants' preference for a market location and a specific mode of transportation. The study results are presented as following.

a. Preference for market:

As already noted, table 7 shows the relationship between the major divisions and respondent's preferred market. Moreover, it provided evidence in support of distance as a controlling factor of spatial accessibility to market in the Afram Plains. It also supports the factor of consumer preference as well. From table 7, overall, Donkorkrom was respondents' most patronized market (42.1%). The others fared, in a descending order, as following: Maame Krobo (25.4%), Tease (11.7%), Other Markets (10.7%), and Ekye Amanfrom (10.2%). An analysis of respondents' level of preference of a market (rating from 1 to 5 with 5 being, most preferred and vice versa), provided a further understanding of resident's preference for markets in the area. A Kruskal-Wallis H test showed that the preference for the top two large markets, Maame Krobo and Donkorkrom, varied significantly among the major

Table 9.
Relationship between preferred choice of market and main reason for choosing such market

		No. 1 reason for preferred choice of market				Total
		Good sale price	*Availability of buyers*	*Proximity*	*Other*	
Preferred choice of market	Donkorkrom	3 (3.7%)	20 (24.7%)	55 (67.9%)	3 (3.7%)	81
	Ekye Amanfrom	2 (10.0%)	3 (15.0%)	13 (65.0%)	2 (10.0%)	20
	Maame Krobo	7 (15.6%)	26 (57.8%)	8 (17.8%)	4 (8.9%)	45
	Tease	1 (4.5%)	6 (27.3%)	13 (59.1%)	2 (9.1%)	22
	Other	5 (25.0%)	8 (40.0%)	3 (15.0%)	4 (20.0%)	20
Total		**18 (9.6%)**	**63 (33.5%)**	**92 (48.9%)**	**15 (8.0%)**	**188 (100.0%)**

sub-divisions ($\chi^2 = 14.574$, df = 2, $p < 0.01$ and $\chi^2 = 21.629$, df = 2, $p < 0.001$ respectively). A post-hoc analysis showed that, for Maame Krobo, the differences were only significant between the Eastern versus Central corridors ($p < 0.01$) and the Eastern versus Western corridors ($p < 0.001$). But in the case of Donkorkrom, significant differences existed between all sub-divisions ($p < 0.05$). No such significant differences were recorded for the other markets.

The above results coupled with results seen in tables 8 and 9 support the fact that consumers preference influence their accessibility to facilities. In tables 8 and 9, although distance (represented as proximity) was noticeably the main factor, it was also clear that other factors such as good sale price and availability of buyers influenced consumers travel to market decisions.

b. Mode of Transportation:

As noted already, six main modes of transportation were identified from the survey, with "walking" (also called headloading; 39%) being the most popular choice followed by tractor (34.1%) (table 10). Similar to preferred choice of market, residents' choice of transportation mode also varied across the study area. Preferred mode of transportation was significantly associated with the major sub-divisions ($\chi^2 = 35.443$, df = 10, $p < 0.001$).

Notwithstanding, the chi-square analysis violated one assumption; 55.6% of the cells had expected count less than 5 instead of the maximum bar of 20%. Thus, this result could not be firmly used to make a claim. Nevertheless, walking was clearly popular among residents in the Central (47.6%) and Eastern corridors (43.5%) while in the West, it was mainly tractor (38%) (table 10).

Concerning the reason(s) for choosing a particular mode of transportation, they comprised Space (61.7%), Affordability (17.7%); Availability (12%) and Other (8.6%) (table 11). This showed that space (ability to carry more) was cherished the most by many residents. The space factor was considered as helpful in reducing cost by minimizing the number of trips to market as well as reducing losses due to vehicular breakdowns or accidents. Again, these reasons were observed to have high place

Table 10.
Relationship between major division and preferred choice of transportation

		Preferred choice of transportation to market						Total
		Car/Taxi	*Tractor*	*Truck*	*Motorbike*	*Bicycle*	*Walking*	
Major division	Central	3 (4.8%)	23 (36.5%)	7 (11.1%)	0 (0%)	0 (0%)	30 (47.6%)	63
	East	6 (8.7%)	20 (29.0%)	4 (5.8%)	1 (1.4%)	8 (11.6%)	30 (43.5%)	69
	West	3 (6.0%)	19 (38.0%)	1 (2.0%)	7 (14.0%)	9 (18.0%)	11 (22.0%)	50
Total		**12 (6.6%)**	**62 (34.1%)**	**12 (6.6%)**	**8 (4.4%)**	**17 (9.3%)**	**71 (39.0%)**	**182 (100.0%)**

Table 11.
Relationship between major division and main reason for choosing a preferred mode of transportation

		No. 1 reason for preferred choice of transportation				Total
		Availability	**Affordability**	**Space**	**Other**	
Major division	Central	15 (24.6%)	10 (16.4%)	28 (45.9%)	8 (13.1%)	61
	East	5 (7.5%)	16 (23.9%)	43 (64.2%)	3 (4.5%)	67
	West	1 (2.1%)	5 (10.6%)	37 (78.7%)	4 (8.5%)	47
Total		**21 (12.0%)**	**31 (17.7%)**	**108 (61.7%)**	**15 (8.6%)**	**175 (100.0%)**

association with the major sub-divisions ($\chi^2 = 23.371$, df = 6, $p = 0.001$) and confirmed by table 11. Table 11 shows that, while Space was overwhelmingly the deciding factor in both the Eastern (64.2%) and Western (78.7%) corridors, it was comparatively mild in the Central corridor (45.9%). A similar trend was observed with regards to the second important reason, affordability: in both Eastern (23.9%) and Western (10.6%) corridors. However, availability was ranked second most important reason (24.6%) in the Central corridor, whereas it was less and least important in the Eastern (7.5%) and Western corridors (2.1%) respectively.

DISCUSSION

Results from this study corroborate the issues discussed in the introduction and problem statement section concerning poor road infrastructural development and limited spatial accessibility in the developing world. In response to the first research question (what are the travel experiences of locals within the area?) for example, the results showed that general commuting particularly to market is extremely difficult in the Afram Plains. This observation was mainly attributed to the poor nature of existing roads and the lack of vehicles. Considering that reliable access to markets is crucial for the sustenance of the local economy (mainly agriculture) (Riverson, et. al, 1991), the lack of it causes many problems. Some of these problems include increased post-harvest losses and loss of income (Porter, 2002b). The lack of reliable access also creates a ripple effect such as decline in the business potential of the area and abandonment by potential investors and traders (Gwilliam, 2011). This abandonment causes the local economy to lose essential revenue necessary to develop and maintain the few remaining roads (Tighe, 2008). It is therefore not surprising why economic development remains low in the area as it reflects the findings of other scholars (Gwilliam, 2011; Porter, 2002b; Deichmann et al., 2006 and Riverson, et. al 1991).

Furthermore, with the incorporation of geospatial analysis to determine the minimum accumulative cost of moving from Point A (homes/farmlands) to Point B (places of trade) (MTT), the second research question was put into perspective. This comparison was considered important as it could provide a reason why local transportation problems might not be taken seriously by stakeholders; an erroneous perception better than reality could mislead planners from prioritizing local needs and vice versa. Comparing the MTT values to that of PTT, the values appeared strikingly different from each other: the two variables correlated negatively albeit very weak ($rs = -0.184$, $p = 0.014$). Such discrepancy obviously raised a concern about the practicality and reliability of local perceptions about spatial elements like distance. The concern stemmed from the fact that local knowledge is generally considered as pragmatic, thus relatively reliable (Mcconchie and Mckinnon, 2002; Briggs, 2005). However, the results appear to corroborate assertions made by Leach and Mearns (1996) that local perceptions tend to be riddled with inaccuracies as familiarity of local phenomenon sometimes result in either overestimation or underestimation of values.

Additionally, false claims, people's biases and prejudices and populism rather than factual ideas sometimes make their way into captured perceptions (Leach and Mearns, 1996; Briggs, 2005). That might be the case in this study; some respondents may have exaggerated travel distance and time based on their unpleasant travel experiences while others, in anticipation for a solution or positive intervention for example, may have described their travel experiences in the direst way. In contrast, the authors equally acknowledge that general GIS modelling challenges such as the inability to fully account for certain real-life factors like actual road conditions, perhaps, influenced the MTT values. In view of these reasons, the authors recommend further field investigation to sufficiently explain such geographic discrepancy between MTT and PTT.

Regarding factors that control residents' movement decisions in the area (research question three), it was found that consumer preferences play a significant role especially with commute markets. The survey responses showed that "proximity" to market and "availability of buyers" were the main factors that influenced their decision to commute to a particular market. The two factors were

closely associated with the residents' preference for the two largest markets in the area: Donkorkrom and Maame Krobo (table 9). These findings affirm established theories about consumer behaviour regarding proximity to facilities and size of markets (indicated by availability of buyers) (Hotelling, 1929; Huff, 1964; Church and Murray, 2009).

Moreover, residents' choice of transportation also played a key role in their commute decisions. Though such choice varied significantly across the study area, the most popular forms of transportation for commuting to market were "walking" (also called headloading) and tractor. These modes of transportation, however, are comparatively slow and thus further contributes to the poor accessibility levels in the area. Yet, such choices seemed quite justified judging from the reasons given for making those transportation choices: space/convenience, affordability, and availability. Space/convenience for example aligns perfectly with tractor (ability to carry more and traverse the poor road conditions to market within a comparatively minimum time) while walking is affordable and readily available.

Besides the above, this study also revealed some new problems not captured or emphasized in previous studies. These problems comprised snake infestation/bites, narrow paths, drenching from dew on weeds and collapsed or the lack of bridges at key crossings. Although they were not noted as major factors limiting access to markets in the area, their impact on productivity was seen as quite considerable thus, needed attention as well.

Finally, the findings in this study provide some insights about where the greatest needs are regarding adequate vehicles, new market centers, and new motorable roads (Central and Eastern corridors). This study thus, provides some crucial ideas for both future research and infrastructural development in the Afram Plains.

CONCLUSION

Transportation challenges are a common phenomenon in the developing world, and they are partly blamed for the low economic development that is widespread in the developing world region. Limited spatial accessibility for instance, hinder interaction which is a necessary stimulus for economic growth (Kilkenny, 1998; Roehner, 1996). The Afram Plains in Ghana is just one of numerous areas in the country that lack adequate and reliable transportation system. The existing roads are few and in poor condition leading to disruptions in economic activities of the residents. The limited and deplorable road conditions further impact residents wellbeing as it constrains their access to facilities such as health centres which already are in limited supply in the area. The aim of the study, therefore, was to understand and document the perspectives of the local residents in relation to their spatial accessibility to markets in the area. The following questions were posed to guide the study:

1. What are the travel experiences of locals within the area?
2. How does perceived travel time compare with GIS-Modeled travel time?
3. What factors control movement of residents in the area?
    a. Is there any geographic disparity among the factors?
    b. Is there any socio-demographic disparity among the factors?

It is apparent from the findings that poor road networks in the area present a serious challenge to residents' spatial accessibility to markets. Even with the few vehicles that are available, they often experienced breakdowns due to the damages they sustained from traversing the bad roads. Lastly, residents' preferences significantly influenced nature of movement within the area. Factors like proximity to a market, availability of buyers, and mode of transportation were cited as the determinants of commuting especially, to market centers. Considering that availability of buyers was a major factor that influenced residents commute decisions, future road development could focus on trunk roads that link the main population centers to the big markets. Regarding modes of transportation, walking

was by far very popular. Nevertheless, the residents expressed explicitly that they would rather use a means that is more reliable, readily available, and would enable them to carry more goods to the market within the shortest possible time frame.

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ENDNOTES

1 As of 2021, the area comprised two districts: Kwahu Afram Plains North and Kwahu Afram Plains South.
2 A fairly large younger population indicates a promising future labor force.
3 ‘ Rural’ is defined in Ghana as a place with a population of less than 5,000 (GSS, 2020).
4 Represents only those who answered the question.
5 GHC – Ghana Cedi; at the time of data collection, GHC 1 was equivalent to USD 0.49 (XE.com, 2013).

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