THE INFLUENCE OF TRAVEL TIME ON ACCESSIBILITY IN LAGOS ISLAND

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Abstract

The influence of travel time on accessibility in Lagos Island, Nigeria was determined. It was observed that generally, average driving speed was observed to be lower over short than over long distance routes. High speeds tend to be concentrated within a distance band of over 2.7 km. But beyond 6.0 km, average driving speed was low, probably as a result of interruptions on the route. The mean driving speed for all nodes of the network was calculated to be 0.31 kmpm (approximately 19 kmph). The average driving speed was found to be significantly related to the link distance, with a correlation value of (r = 0.76). Based on the findings, recommendations were proffered towards reducing financial and time costs and increasing accessibility.

Introduction

Kansky (1963: p. 1), defined network as "a set of geographical locations connected in a system by a number of routes". Atubi (2007a: p. 7) also defined network as "a set of interconnected route-ways along which movement takes place". Network has the basic function of linking places together for example a farm to a market, a factory to a railway station or one town to another.

Rather than merely asking planners what philosophy they assume when making transport and landuse plans, it is thought more revealing to internalise the problem. By this it is meant that actual planning cases should be cited and accessibilities to work etc determined both before and after the plans have taken effect. Access in this case can be thought of a s a surrogate measure of spatial justice, from which the social justice concept used can be inferred (Bruinsma, 1994).

Connectivity of a network in this context means the degree of connection between all centres (vertices) or the degree of completeness of the routes (links) between centres (vertices) (Atubi and Onokala, 2004a; Atubi and Ali, 2006). Apparently, the more routes there are in any transportation network the more complex will be the connection between the various routes.

For several decades now, accessibility has been the focus of much literature in various fields of study. This undoubtedly reflects the different study purposes for which any particular measure may have been proposed. However, there does not appear to be a common definition of accessibility. Some researchers discuss accessibility to some place (or places) as opposed to accessibility from some place (or places). Some researchers characterise accessibility as a measure of transportation system (Ikhrata and Michell, 1997). In the context of this study, therefore, relative accessibility is used to imply the relative ease of movement along transport route (road) from one centre to another.

Gravity-type accessibility measures have been used to measure access to medical facilities (Knox, 1978); Grocery stores (Handy, 1992); railway stations (Giannopoulos and Boulonguris, 1989); Shopping (Lee and Goulias, 1997; Bhat et al, 1999; employment (Kockelman, 1997; Niemeier, 1997; Cervero et al, 1999 and access to public facilities (Atubi, 2008 and 2012).

Study area

The study area is located within Lagos State. Lagos State is situated at the South-Western corner of Nigeria and is a coastal state. Lagos Island, which is the study area, is one of the 20 Local Government Areas in Lagos State (see Fig. 1). Lagos Island is the second largest urban complex in Nigeria after Kano and claims 2% of the nation's population on a less than 0.2% land area.

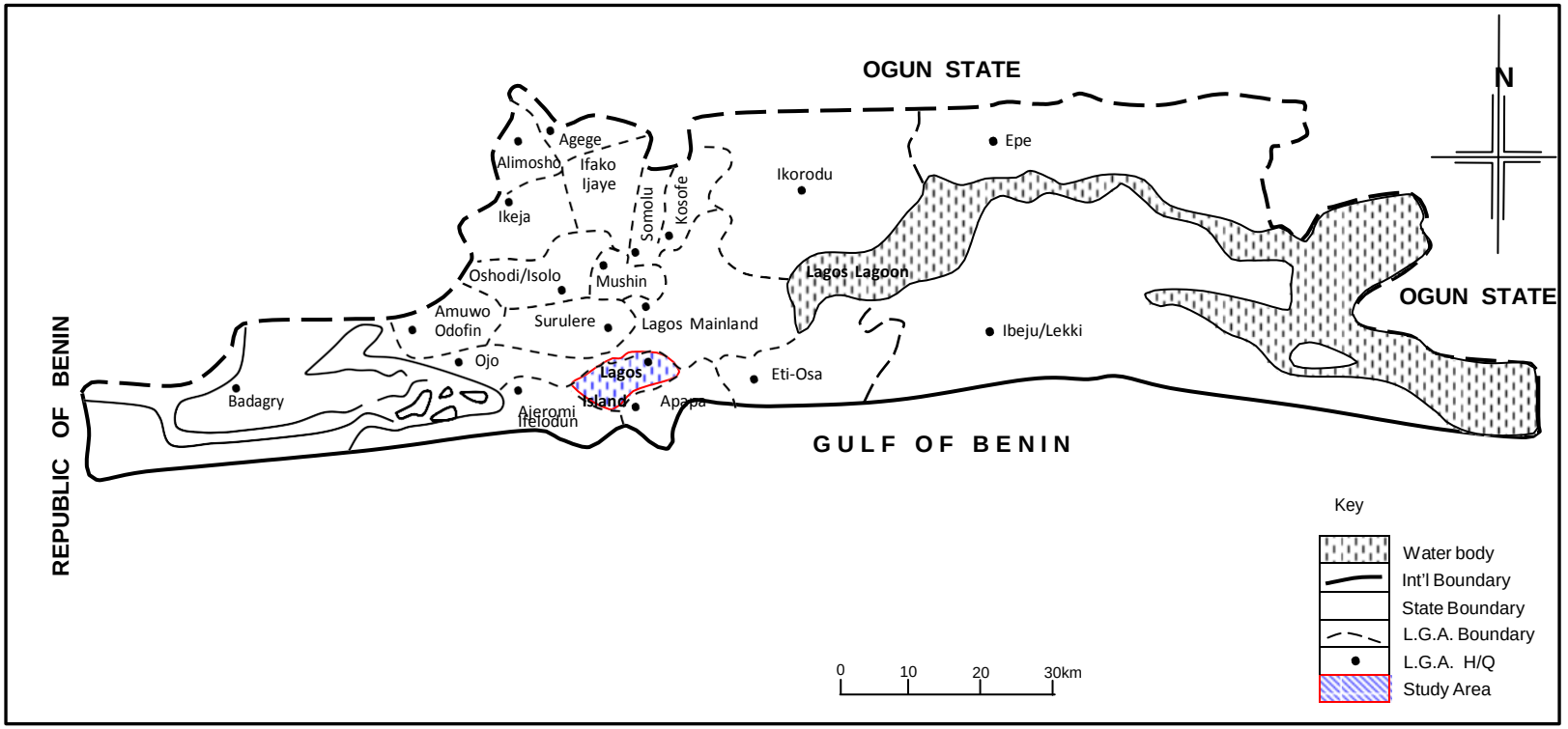

Fig. 3.1: ***Map of Lagis State showing the 20 LGAs***
Source: Lagos State Ministry of Environment and Physical Planning (1999)

Methodology

Travel time was differentiated into transit time and waiting time. Transit or driving time describes the period a traveller takes off from the park at the origin point and alights at the park on arriving at his destination point. Waiting time on the other hand refers to the time the traveller waits for the vehicle to arrive or to be fully loaded.

Generally, the waiting time is affected by such variables as traffic volume, mode of transport and route. Although waiting time may increase the total journey time, it is the driving time, when the traveller has actually boarded the vehicle that determines the time he reaches the destination.

Results and Discussion

The length of time a traveller takes to reach his destination may have a lot of influence on his ability or even willingness to use a particular facility. Like travel cost two types of arriving time can be calculated along the same link – i.e. direct driving time between two major centres, say Ilubirin and Idumagbo, assuming the driver does not stop en route and the time considering that driver stops at intermediate centres (See Fig. 2). Based on these two values of driving time 39 links were considered along with the 30 sampled centres (See Fig. 3.3).

It was not however easy to record this direct time accurately as drivers often had cause to stop for various purposes: refuelling, alighting passengers, police checks, etc. Nonetheless the figures presented in Appendix 1 gives us a true estimate of actual time spent in travelling. Again the driving time so identified is a function of many variables such as the road surface, traffic flow the condition of the vehicle and even the personal disposition of the driver. Because of these factors more detailed data and investigation are necessary to throw greater understanding on the issue than the present study can contain. Here, only a single reading of driving time along a particular link was recorded.

To further investigate the importance of time we can also calculate the average driving speed along each link by dividing the link distance by the driving time. This is given in kilometre per minute (kpm) in Appendix 2. The average speed may reveal variations in the nature of the road surface.

The mean driving speed for all nodes of the network was calculated to be 0.31mpm approximately 19mph. The average driving speed was found to be significantly related to the link distance ($r = 0.76$, Appendix 3).

However, when the frequencies of observed speeds are grouped according to link distances as given in Table 1, we observe the following points – that majority of the links are concentrated within a distance band of 0-2.7km which collectively make up about 53.9% of the observations, that high average driving speeds of over 0.52kmpm (or 31kmph) are notcommon with short distances of under 2.7km. Rather, speeds of over 0.52kmpm occur within a distance band of 4.9 and over 6.0km which makes up about 5.2% of total observation. Ironically on distances of over 6.0km drivers tend to operate an average speed of under 0.52 kmpm. This apparent low speed on long distance journeys may be attributed to constant stops en route and the road surface.

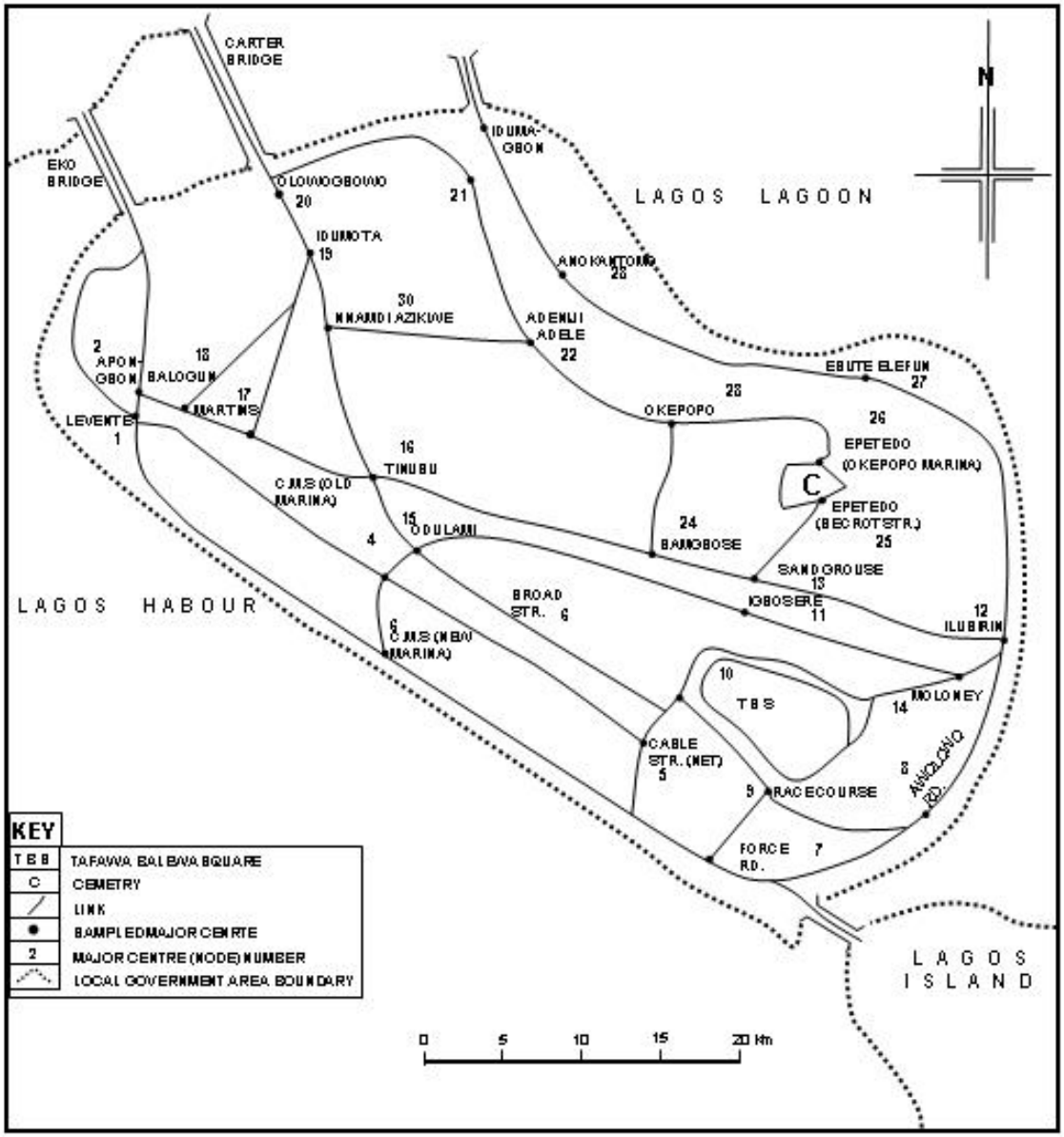

Fig. 3.2: ***Location of sampled major centres in Lagos Island LGA***
Source: Fieldwork, 1998, revalidated 2009

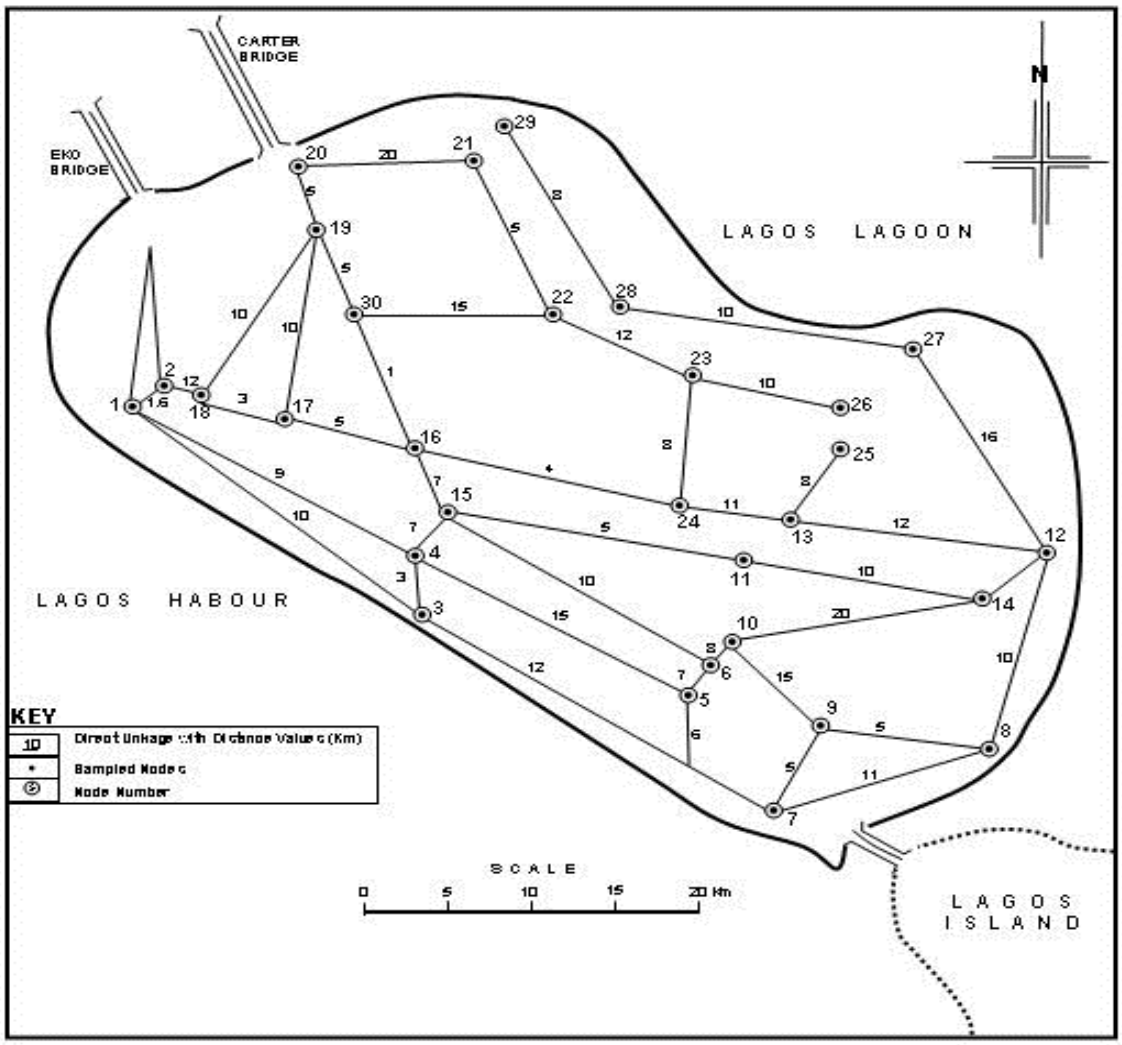

Fig. 3.3: ***Graph representation of road network with travel time values***

Table 3.1: ***Frequency distribution of average driving speeds with link distance***

Link Distance (km)	0.0-0.10	0.2-0.30	0.31-0.41	0.42-0.52	Over 0.52	Total
0-1.6	1 2.56%	7 17.9%	2 5.1%	0	0	10 25.64%
1.7-2.7	0	10 25.6%	1 2.6%	0	0	11 28.21%
2.8-3.8	0	5 12.8%	1 2.6%	1 2.6%	0	7 17.95%
3.9-4.9	0	0	2 8.10%	2 8.10%	1 2.60%	5 12.82%
5.0-6.0	0	0	1 2.60%	3 7.70%	0	4 10.25%
Over 6.0	0	0	0	1 2.60%	1 2.60%	2 5.13%
Total	1 2.56%	22 56.3%	7 18.00%	7 18.00%	2 5.20%	39 100%

Finally, low average speed of under 0.10kmpm (i.e. 6.0kmph) is found within short distances of under 1.6km. It contributes about 2.56% of the links. This observed general pattern of average speeds would imply that drivers tend to drive faster within a distance of 2.7 – 4.7km but beyond, that their average speed may be reduced by other obstructions such as carrying "half-way" passengers, or refuelling. This would mean that travellers for long distance journeys may not arrive at their destination as early as they expected if the journey were direct. Thus we find that the Anokantamo – Idumagbo road has higher average speed (0.54kmpm or 33kmph) than the journey from Odulami to Igbosere with average speed of about 25kmph.

Another implication of the observation is that nodes in the study area located at short distance journeys may be just as disadvantaged as those at long distances journey as drivers tend to operate on relatively low speeds. But another factor in addition to the constant need to alight passengers en route could be urban traffic. The combined effect of all this is to extend driving time beyond the expected.

Policy Implications and Recommendations

To ease traffic flow along the routes, better road network characteristics must be ensured. For example, the roads have to be better connected to improve their accessibility, also roads have to be widened to more lanes to increase their carrying capacity and these are especially true for the routes headed to the island. Better road network characteristics would not only lead to a faster flow of traffic along the routes, it would also make for a well structured road network system and also a faster pace at curbing traffic delays in the study area.

The strategy of constructing new links to improve accessibility may involve heavier financial investment. Thus a proper cost benefit analysis may be needed to determine the desirability of such investment. For example, it will normally take a traveller going to Olowogbowo from Idumagbo Avenue some 18.1km. But when a direct road is constructed linking Idumagbo to Olowogbowo it would definitely reduce cost, time, and accessibility will increase. The same thing can be said of other centres like Anokantamo to Adeniji Adele and Ebute-Elefun to Sand Grouse.

Conclusion

We touch upon the very issue of financing road projects. Since we have recommended some roads to be constructed, someone might ask where is the money all going to come from? What of the cost – benefit analysis? These are important questions and the specialist may have an answer. However, it is pertinent to point out that the social benefit of constructing a road that increase accessibility, saves time and reduces cost goes beyond the financial evaluation. It touches on human value. It takes the political will to provide such needs.

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Appendix

Appendix I: ***Analysis of link cost and the characteristic***

S/N	Route Title	Link distance (LD)	Travel cost (N) (TC)	Cost/ Km (TR)	Driving (Min.) (DT)	Average Speed (ADS)
1	Leventis-Apongbon	1.6	5.0	3.13	4.0	0.40
2	Leventis-C.M.S (New Marina)	4.4	5.0	1.14	10.0	0.44
3	Leventis-C.M.S (Old Marina)	4.3	5.0	1.16	9.0	0.48
4	Apongbon-C.M.S. (Old Marina)	5.9	10.0	1.69	13.0	0.45
5	Apongbon-C.M.S. (New Marina)	6.0	10.0	1.67	14.0	0.43
6	Apongbon-Balogun	2.7	5.0	1.85	12.0	0.23
7	C.M.S. (Old-Cable Net)	5.7	5.0	0.88	15.0	0.38
8	C.M.S. (New)-Force road	7.2	5.0	0.69	12.0	0.60
9	Force road-race course	1.0	5.0	5.00	5.0	0.20
10	Force road-Awolowo road	2.3	5.0	2.17	11.0	0.21
11	Cable (net)-C.M.S. (New)	1.5	10.0	6.67	18.0	0.08
12	Cable (net)- force road	1.5	5.0	3.33	6.0	0.25
13	Awolowo-race course	1.2	5.0	4.17	4.0	0.30
14	Tafawa Balewa-Broad street	3.8	5.0	1.32	8.0	0.48
15	Broad street – Tinubu	3.3	10.0	3.03	17.0	0.19
16	Tinubu-Nnamdi-Azikiwe	1.0	5.0	5.00	5.0	0.20
17	Nnamdi-Azikiwe-idumota	2.0	5.0	2.58	10.0	0.20
18	Idumota-Balogun	1.5	5.0	3.33	10.0	0.15
19	Idumota-Martina	3.0	5.0	1.67	10.0	0.30
20	Martins-Tinubu	1.7	5.0	2.94	5.0	0.34
21	Awolowo-Ilubirin	4.0	5.0	1.25	10.0	0.40
22	Ilubirin-Ebute-Elefun	7.0	10.0	1.43	16.0	0.44
23	Ebute-Elefun-Anokantamo	3.0	10.0	3.33	10.0	0.30
24	Anokantamo-Idumagbon	4.3	5.0	1.16	8.0	0.54
25	C.M.S. (Old)-Odulomi	1.8	5.0	2.78	7.0	0.26
26	Odulami-Igbosere	5.0	10.0	2.00	12.0	0.42
27	Igbosere-Moloney	2.0	5.0	2.50	12.0	0.20
28	C.M.S. (Old)-C.M.S. (New)	1.0	5.0	5.00	3.0	0.33
29	Moloney-Ilubirin	1.0	5.0	5.00	4.0	0.25
30	Ilubirin-Sand-grouse	2.7	10.0	3.70	12.0	0.23
31	Sand-grouse-Bamgbose	2.5	5.0	2.00	11.0	0.23
32	Sand-grouse-Enetado (Becret)	2.0	5.0	2.50	8.0	0.25
33	Bamgbose—Tinubu	4.0	10.0	2.50	10.0	0.40
34	Bamgbose-Okepopo Marina	1.8	5.0	2.78	8.0	0.23
35	Adenidi-Adele-Nnamdi Azikiwe	3.0	10.0	3.33	15.0	0.20
36	Epetedo (Okepopo)- Okepopo Marina	3.8	5.0	1.32	10.0	0.38
37	Okepopo Marina-Adeniji-Adele	2.5	5.0	2.00	12.0	0.21
38	Adeniji-Adele-Offin	1.2	5.0	4.17	5.0	0.24
39	Offin-Olowogbowo	3.5	10.0	2.86	20.0	0.18

Observation (n)	=	39
Sum of link distances Σ(LD)	=	117.7
Mean link distance (LD)	=	3.02
Standard deviation (σLD)	=	1.71
Sum of travel cost (ΣTC)	=	250

Mean travel cost (TC)	=	6.41
Standard deviation (σTC)	=	2.28
Sum of driving time (ΣDT)	=	389
Mean driving time (DT)	=	9.97
Standard deviation (σDT)	=	4.12
Sum of average driving speed (ΣADS)	=	12.0
Mean average driving speed (ADS)	=	0.31 kmpm
Standard deviation (σADS)	=	0.12 kmpm

Appendix 2: ***Correlation between link distance (LD) and travel cost (TC)***

Correlation coefficient (r) is given by:

$$rLD.TC = \frac{n\left(\sum LD.TC\right) - \left(\sum LD\right)\left(\sum TC\right)}{\sqrt{n\sum LD^2 - (LD)^2\ x}\ \sqrt{n\sum TC^2 - (TC)^2}}$$

$$= \frac{39(813) - 1177 \times 250}{\sqrt{39(466.43) - (13853.29)\ x}\ \sqrt{39(1800) - 62500}}$$

$$= \frac{2282}{2779.22}$$

$$= 0.39$$

The correlation coefficient (r) between link distance and travel cost is 0.39. In testing for the significance of the correlation we use the student's 't' test which is given by

$$t = \frac{r\sqrt{n-2}}{\sqrt{1-r^2}}$$

Where

t	=	Calculated value
r	=	Correlation coefficient
n	=	The number of observations

Hence

$$t = \frac{0.39\sqrt{37}}{\sqrt{1-0.39}}$$

$$t = \frac{2.37}{0.92}$$

$$= 2.57$$

Ho: There is no significant relationship between link distance and link cost.

Hi: There is some statistically significant relationship between link distance and link cost.

Table value n – 2 degree of freedom

39 – 2 = 37
0.01 = 1 – 0.01 = 0.99 = 2.42
But t cal. > t = 0.01

Hence at 0.01 probability level we reject Ho and state that there is some statistically significant relationship between link distance and cost.

Appendix 3: ***Correlation between link distance and average driving speed***
Correlation coefficient between link distance (LD) and average driving speed (ADS) is given by:

$$r_{LD.ADS} = \frac{n(\sum LD.ADS) - (\sum LD)(\sum ADS)}{\sqrt{n\sum LD^2 - (LD)^2}\ x\ \sqrt{n\sum ADS^2 - (ADS)^2}}$$

Where: n = 39, LD = 117.7, ADS = 12.0

$$= \frac{39 \times 41.94 - 117.7 \times 12.0}{\sqrt{39 \times 466.43 - 13853.29}\ x\ \sqrt{39 \times 4.2 - 144}}$$

$$= \frac{223.26}{293.08}$$

Hence r = 0.76.

In testing for the significance of the correlation we use the student's 't' test which is given by

$$t = \frac{r\sqrt{n-2}}{\sqrt{1-r^2}}$$

Where r = 0.76, n = 39

Hence

$$t = \frac{0.76\sqrt{37}}{\sqrt{1-0.76}}$$

$$t = \frac{4.62}{0.65}$$

Approximately = 7.11

Ho: There is no significant relationship between link distance and average driving speed.
Hi: There is some statistically significant relationship between link distance and average driving speed.

Table value n – 2 degree of freedom
39 – 2 = 37
0.01 = 1 – 0.01 = 0.99 = 2.42
But t cal. > t = 0.01

Hence at 0.01 probability level, we reject Ho and state that there is some statistical significant relationship between link distance and average driving speed.