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AN ANALYSIS OF TRAVEL FREQUENCY USING THE COM-POISSON REGRESSION MODEL – IMPLICATIONS FOR ENVIRONMENTALLY SUSTAINABLE TRANSPORT IN MAURITIUS

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ABSTRACT

The paper analyses the socio-economic determinants of travel behaviour and discusses the implications for an environmentally sustainable transport system. The Com-Poisson regression model is used and the model was applied to Mauritius, a small island state, where size is a constraint to travel demand. A survey was undertaken and the findings imply that age, gender, income, qualification, ownership of car and household size are significant factors influencing travel behaviour. The study concludes that societal dynamics can be incompatible to environmental sustainable transport and hence, these forces are important considerations to design sustainable transport policies.

Keywords: environment, sustainable transport, trips, travel behaviour, Com-Poisson

INTRODUCTION

Evidence from the Intergovernmental Panel on Climate Change (IPCC) clearly shows that changes in climatic conditions are expected as greenhouse gases (GHGs) accumulate (IPCC, 2007). Given the slow atmospheric carbon absorption, GHGs act as a stock pollutant and its concentration is likely to raise the earth average temperatures, influence precipitation, and alter the patterns of extreme weather conditions. There is an overwhelmingly scientific consensus that action is needed to restrict the emission of GHGs (Sterner, 2007).

The transport sector is a major sector which consumes fossil fuels and contributes significantly to GHGs. It accounts for 26% of global CO_2 emissions and represents the fastest growing source of GHGs (Chapman, 2007). It may be concluded that the advantages of car ownership and use have been outweighed by GHGs, air pollution, noise pollution and urban sprawl. A major challenge facing policy makers is how to design policies for an environmentally sustainable transportation system. Various transport strategies have been proposed to be in line with climate policy and one of such strategies is the management of mobility (Abmann and Sieber, 2005). Gudmundsson and Hojer (1996) refer to the concept 'sustainable mobility' to define a transport system within the sphere of sustainable development. The success story of Singapore to manage mobility provides a basis to conduct further research on the link between sustainable transport and mobility (Han, 2010)

To investigate sustainable mobility, transport analysts must understand the link between societal dynamics and mobility (Himanen *et al*., 2005). Referring to Button and Nijkamp (1997), social change involves a complex interaction of existing trends, new trends and trend breaks that interact to bring about changes to the way society develops. Rising incomes, higher

demand for leisure time, changing demographic patterns, better education, technological advances, emerging life styles and new political priorities are among the factors leading to social change and, consequently, affect demand for mobility. Individual households' travel patterns change over the life cycle, are different for different generations and are influenced by spatial and socio-economic characteristics. These forces, in very broad terms, lead to higher flexibility, fragmentation, polarization and differentiation in time and space and have profound impacts on travel behaviour and policies towards sustainable transport.

The link between environmentally sustainable transport, social change and mobility is rather complex. It may be argued that social dynamics may be incompatible to sustainable transport. For instance, Steg and Gifford (2005) outline the inconsistency between sustainable goals and socio-economic forces, and conclude that individuals must adapt their lifestyles in order to reach the sustainability objectives of transport. Improvements in the quality of life as aimed through sustainable transport, may conflict with individual short-term interests. Black (2000) in turn, identifies socio-economic barriers to sustainable transport while Chapman (2007) emphasises behavioural change and argues that such change can be brought about by transport policy.

Many of the important areas of interest which are important to design transport policies, such as the interaction between changing socio-economic behaviour and household characteristics, and travel behaviour, have been examined before but significant areas of ignorance remain especially in the face of climatic change and environmentally sustainable transport. This can be explained by the fact that while transportation science has evolved considerably as a field of scientific inquiry, the measurement and determinants of travel behaviour are still ambiguous. Travel behaviour has initially been examined as a derived demand, at least in an absolute term, and factors affecting demand is related to the activities which occur at the place of destination. However, Mokhtarian and Salomon (2001) argue that a recent innovation is to model travel demand as an end in itself since people enjoy undirected travel. This may motivate people to undertake excess travelling behaviour towards a particular destination. If the size of the country is a constraint to rising demand, then the frequency of travelling rises. Thus, the measurement of travel behaviour should consider both travel behaviour as a derived demand as well as an end in itself. Anas (2007) argue that formulating the travel problem in terms of trips undertaken help to treat the complementariness and substitution between consumption and travel. The frequency of trips and its determinants have received little attention in the empirical literature.

This paper aims to bridge this gap and attempts to analyse the determinants of travelling behaviour and seeks to shed light on whether societal dynamics and travel behaviour are compatible to the concept of environmentally sustainable transport. The determinants of the number of trips which an individual has undertaken over a period of time towards a particular destination are analysed. The basic unit for measuring transportation activities in this study is a trip, generally defined as a one-way move from an origin to a destination, motivated by a main purpose, and involving a public infrastructure (Shafer, 2000). Hence, as the number trips for one activity falls, trips for undirected travel demand may rise if travel demand is a normal product.

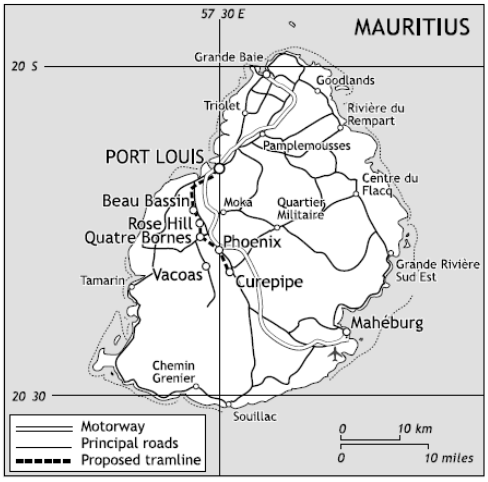
The number of trips is modelled as a count variable and the Com-Poisson regression is applied as a novel approach to modelling travel behaviour within a socio-economic and demographic framework. The model accounts for the integer value

characteristic of the travel frequency variable. The distribution of the frequency variable is right skewed because it comprises a large proportion of zeros and this implies that conventional OLS estimation techniques are inappropriate (Long, 1997). In this context, count data models are a natural starting point for estimating the frequency of travel. The regression model analyses the determinants of the frequency of travel taking into account the fact that it is a discrete variable that can only take nonnegative integer values. This novel approach may be compared to the limited dependent regression which is usually used to model transport behaviour, following the work of McFadden (1973).

The study is conducted for a small, isolated, densely populated, developing Indian Ocean island state called Mauritius. Investigating travel behaviour for Mauritius is even more challenging since over the last decades or so, the island of Mauritius has undergone and continues to undergo a revolution in the way its society lives and works. Mauritius consists of a relatively small main island (58 km north to south by 47 km east to west), and various other scattered atolls. The main island has a high population density of 624 people per square kilometre and this is set to rise further by a steadily growing population. From a transport perspective, the case of Mauritius is interesting because it exhibits many of the transport characteristics facing developing countries with land constraint, such a craze for owning private cars. There is a rise in demand for mobility, especially, towards the city of Port-Louis and this has a negative impact on quality of life and on the economy. In a small island such as Mauritius, the size of island limits the increase in distance travel and hence, people have a tendency to compensate the demand for travelling through higher trips towards a particular destination. Taking into account the characteristics of Mauritius, particularly the level of mobility to the city of Port-Louis where most of the business activities take place, the purpose of this paper is to obtain a better insight into the relative influence of socio-economic and demographic variables on travel behaviour. This is achieved by modelling the number of trips which individuals undertake towards the city of Port-Louis as shown in figure 1, over a reference period.

The paper is organized as follows: in the following section, a brief review on the concept of environmentally sustainable transport and its relationship with travel behaviour is provided; this is followed by a brief review of literature on modelling travel behaviour, with emphasis on travel frequency as an indicator of travel behaviour and the methodology and data modelling; eventually the findings are provided with discussions and conclusions.

Figure 1: The Map of Mauritius



Source: Enocks (2003)

ENVIRONMENTALLY SUSTAINABLE TRANSPORT AND TRAVEL BEHAVIOUR

There is no clear definition of the concept 'sustainable transport'. Perhaps the lack of consensus may be attributed to the fact that sustainability implies different facets and finding a proper balance between (current and future) environmental, social and economic qualities is difficult. Moreover, it is not clear which environmental, social and economic qualities should be ensured and balanced. This has led to various interpretations to the meaning of sustainable transport and hence, the concept has been defined along a spectrum of dimensions. A sustainable transport may be one which leads to livable streets and neighnourhood, protects the environment, guarantees equity and social inclusion, ensures health and safety and supports a vibrant and efficient economy (Castillo & Pitfield, 2010). According to Black (2000), sustainable transport also includes the minimisation of congestion and land use.

A number of studies, including Gudmundsson and Hojer (1996), Greene and Wegener (1997), Black (2000) and Chapman (2007), focus on the environmental impacts of transport to define the sustainability of transport system. Following Gilbert (1999), the OECD uses the term 'environmentally sustainable transport' to distinguish the environmental aspects from other facets of sustainable transport (Black, 2000). The interpretation of environmentally sustainable transport is related to the concept of sustainable development proposed by the World Commission on Environment and Development (WCED, 1987), that "sustainable development meets the needs of the present without compromising the ability of future generations to meet their own needs.'' Daly (1991)'s operationalising of the strong form of sustainable development also has an influence on the interpretation of the concept (Gudmundsson & Hojer, 1996). Daly (1991, pp. 44-45) emphasises four operational principles of sustainability: (1) to limit the human scale (throughput) to a level which, if not optimal, is at least within carrying capacity and therefore sustainable; (2) to make technological progress for sustainable development to be efficiency-increasing rather than throughput-increasing; (3) to exploit renewable resources, in both their source and sink functions, on a profit-maximising

sustained yield basis and in general not driven to extinction and (4) to exploit non-renewable resources at a rate equal to the creation of renewable substitutes (Black, 2000).

Sustainable transport from the perspective of the environment is defined as a system of mobility which limits waste within the planet's ability to absorb them, minimises consumption of non-renewable resources and land use, prevents pollution and all potentially adverse global phenomena such as climate change and stratospheric ozone depletion, and maintains ecosystem health for the benefits of the future generation (OECD, 1997; Greene & Wegener, 1997; Black, 2000; Gilbert & Tanguay, 2000; Shiftan *et al*., 2003; Lautso & Toivanen, 1999). The concept of environmentally sustainable transport also includes the generally accepted objectives for health and environmental quality such as those set forward by the World Health Organisation (Friedl & Steininger, 2002). It also means an avoidance of institutional failures, such as congestion which lead to non-sustainable policies of road building (Greene & Wegener, 1997).

Referring to environmentally sustainable transport, three options are reviewed by Abmann and Sieber (2005): technical improvements of conventional engines; the use of renewable energy, such as the blend of ethanol and gasoline; and managing transport mobility. In fact, mobility is linked to the demand for travelling and modelling travel demand behaviour has always been a challenge to analysts. Initially, the activity-based approach to model travelling demand had a profound implication on transportation research and policy. The approach defines the motives for travelling to be linked to the activities which take place at the destinations and people confound utility for such activities and its relation to the activities which are conducted while travelling. According to this approach, travel has been taken as a derived demand, at least in an absolute term, but as Mokhtarian and Salomon (2001) argue, people may demand travel as an end in itself. Such undirected travel demand may result from a sense of speed, motion, control, enjoyment of beauty. This may lead people to undertake excess travelling. This aspect motivates the next section of the paper.

MODELLING TRAVEL BEHAVIOUR - A BRIEF REVIEW OF LITERATURE

Modelling travel behaviour as a scientific inquiry has a rich literature on both the theoretical dimension as well as on the empirical dimension. Anas (2007) argues that the theoretical dimension was formulated as a response of major criticism of the neo-classical theory of consumer behaviour. Accordingly, the neo-classical theory ignores the spatial nature of consumption and, therefore, fails to consider the fact that most consumption cannot be realized without incurring travel or communication costs. Becker (1965)'s theory of allocation of time assumes that travel is intimately related to both consumption and the allocation of time among discretionary activities, but overlooked explicit treatment of travel itself as an activity. Location theory and urban economics did not help to provide a formulation of the demand for travel (Anas, 2007). For instance, the conventional location theory, assumes that the consumer travels to the nearest store or destination while in urban economics, it is standard to assume that the consumer commutes a rather non-standard manner.

Much of the literature on travel behaviour is dominated by the empirical dimension. This has developed independently of standard microeconomic theory, mainly due to the contribution of McFadden (1973)'s econometric formulation of the

problem in terms of discrete choice modelling. Most of travel demand empirical studies have, thus, its roots in applied econometric techniques and, especially, in binary choice models.

An important element in empirical analysis is the measurement of travel behaviour. Schafer (2000) analyses various indicators such as the travel time budget - defined as the time devoted to travelling - or the travel expenditure budget which is the money spent on travelling. An important indicator of transport behavioural is the number of trips. Gordon and Richardson (2000) use the number of trips as an indicator for travelling and conclude that for the period 1969 to 1995, the average commuting time in the US fell but the total vehicle miles have increased during the same period. The cause of the increase of vehicle miles may be attributed to the demand of people to travel longer distances at higher speeds on their commutes. However, it may also result from a larger number of discretionary trips.

Anas (2007) further adds that the travel demand problem can be and should be defined more generally by how many trips and what kind of trips to make over a period of time and to which destinations. Theoretical foundation of trips as indicator of travel behaviour may be found in Bacon (1995) which constructs a utility-maximizing model of the optimum frequency of shopping at a given centre.

Further evidence of the importance of frequency of travelling is found in the operative traffic model for Copenhagen, called the Orestad traffic model (OTM) (Jovicic & Hansen, 2003). This is a state-of-practice for modelling passenger travel demand and is a trip-based or tour-based modelling approach. A tour is defined in the OTM to be a sequence of only two trips, i.e. a trip from home to the destination and a return trip from the destination to home, without intermediate stops. Schafer (2000)'s cross country analysis provides ample evidence of changing behaviour associated with trips. The transport surveys reviewed by Schafer (2000) show that at low mobility levels, one trip in a day is dedicated to a combination of work (short term survival) and education (longer term well-being), and about half a trip on average is dedicated largely to personal business (essentially, shopping at local markets). Over time, decentralisation of work in many countries leads to lower trips being undertaken for work related purpose but trips for non-work discretionary purposes rise. The reasons for the proliferation of non-work discretionary trips may be attributed to the fact that the decentralisation of jobs and residences reduces the average distance between homes and employment concentrations to which non-work trips are made. With economic development, incomes increases and the demand for product variety grows. Consequently, consumers seek a larger diversity of opportunities to shop, purchase services and engage in recreation or leisure-related activities (Anas, 2007). Car ownership also increases with rise in income and the availability of multiple private vehicles or of more persons with access to a private vehicle stimulates more travel and discretionary mobility and eventually, the number of trips rises (Anas, 2007).

Formulating the travel problem in terms if trips undertaken helps to treat the complementariness and substitution between consumption and travel (Anas, 2007). This closes the gap between the theoretical dimension and empirical dimension of demand travel by recognising that while travel is necessary for consumption, it also competes with consumption for income and time, that there are many alternative "shopping" destinations available to modern consumers, that such destinations are substitutes and that the degree of substitutability varies. Over the past years, there has been considerable research on people's

trip patterns and recent development includes the analysis of trip chaining patterns (Anas, 2007; Jovicic & Hansen, 2003; Ye *et al*., 2007].

MATERIALS AND METHODS

In this paper, the Com-Poisson GLM is used to examine the determinants of the number of trips an individual undertakes to the Port-Louis, city of Mauritius. The following section provides a brief explanation of the factors which are taken into account in the regression analysis of travel behaviour.

Determinants of travel behaviour

The determinants of travel behaviour involve different dimensions such as the spatial dimension and the socio-economic dimension (van Acker *et al*., 2007). The spatial dimension is an important part in the activity system approach in which daily activity and travel behaviour can be analyzed. Living, working, shopping, and recreation are spatially separated activities which motivate the need to travel. Consequently, travel demand does not derive its utility from the trip itself, but rather from the need to reach locations where activities take place. For that reason, the configuration of activities, in terms of the land use pattern, characterized by density, diversity, and design among others, is likely to influence travel behaviour.

The spatial component is, our analysis, is accounted by modelling the number of trips towards one reference destination which is the city of Mauritius, Port-Louis. Taking one destination into consideration, the individuals in our study faces the same set of location characteristics, and constraints, such as weather conditions, business, shopping and recreation activities which exist in the place and this permit the investigation to focus on the socio-economic factors which influence the frequency trips towards this destination.

The focus of the study is on individual households and relationship between their socio-economic characteristics and travel behaviour. The socio-economic dimensions influencing travel behaviour include age, gender, household size, income, level of education, employment status, and mobility constraints (van Acker *et al.*, 2007). Basically we aim to analyse these factors on the number of trips. Age has a rather ambiguous effect on frequency of trips since as people get older, they may travel less. However, if travelling has a socialising effect, then age will have a positive effect on travel demand. We also analyse the role of gender on travel behaviour. For instance, women remain responsible for most household maintenance tasks, and hence, non-work trips may be higher. However, the status of women and their occupation as well as the low ownership of car may lead to less trips than men.

There is also a close relationship between household size and trips. Intra-household decisions are related to the activities of several household members and it may be appropriate to own more cars in large household size. Consequently, car ownership and use is higher, and the use of public transport and walking are lower within large households. As such households are more car dependent, they wish to travel longer distances. But if size is a constraint, then, the number of trips will increase. The effect of household size is accounted through the number of children in the household. Yet, the number of children may have direct relationship with trips. Households with children less than 18 (adult) are more involved with recreational activities and a positive relationship between number of children below 18 and trips is expected.

Educational level, employment status, and income may be interrelated. Highly educated workers are more involved in jobs with a higher occupational status, which results in higher incomes. Consequently, studies of the effects of educational level, employment status or income on travel behaviour can result in comparable findings (van Acker *et al*., 2007). For example, higher car use, longer travel distances and travel times can be found across highly educated people, employed people, and high income groups. These people often obtain jobs with a high occupation status that are concentrated in high-density office parks. As a result, highly-educated people and high-income groups are more involved in higher number trips. High educated individuals may have personal preferences for higher number of trips. Our empirical analysis takes into account only income and education level to avoid any simultaneity bias but we bear in mind the bias which may be induced in the analysis through the correlation of education and income.

To account for social dynamics, the study analyses the interactive effects of age with qualification, income and ownership of car. Age reflects the change in the society structure, especially the generational effect on travel behaviour.

Table 1: Variables descriptions

Variables	**Characteristics**
Age	Continuous
Sex	Binary: Male =1; Female =0
Income	Binary: High=1; Low=0
Model of Transport	Binary: Car = 1; Bus=0
Number of children less than 18	Continuous
Qualification	Primary =1; secondary = 2; and tertiary =3
Interaction effects:	
Age/Qualification:	
Age/Income	
Age/Transport	

Com-Poisson Regression model (CPRM) and the quasi-likelihood estimation technique

The Com-Poisson GLM is used to set up a regression model between the number of trips an individual undertakes to Port-Louis in relation with his age, sex, level of income, his mode of transport, the number of children and his qualification level. More specifically, the covariate sex will be coded as 1 for Male and 0 for female. His level of income will be classified into two categories: high income (> Rs 15,000) coded as 1 and low income (< Rs 15,000) coded as 0. To capture the effect of car ownership in Mauritius, the variable is coded as follows: car-usage coded as 1 and non-car usage as 0. As for household size effect, the number of children is taken into account. Specifically, we focus on school children less than 18 years old. Finally, the level of qualification is split into three types: primary coded as 1, secondary coded as 2 and tertiary coded as 3. The interaction effects of age of the respondent in the household with his qualification, income level and his mode of transport are

accounted by introducing their multiplicative form in the regression. To estimate these regression parameters, the joint quasi-likelihood estimation approach (JQL) developed by Jowaheer and Mamode Khan (2009) is referred. In the next section, we present the Com-Poisson regression model and the JQL approach.

Based on the theoretical explanatory variables, a survey of 250 respondents was undertaken where respondents in the person sample were asked to report the number of trips undertaken during particular reference week. The survey was undertaken in the month of June to August to avoid the excess travel behaviour in other periods such as at the end of year due to end of year shopping activities. The destination was the city of Port-Louis and the origin involves various points around the island. Mauritius is divided into nine districts and the sample has been stratified according to the population of the districts, excluding Port-Louis. The points were chosen at random using the random street approach and involves equal number of male and female.

From the data collected, it is noted that the mean of the response variable is greater than the variance, indicating under-dispersion. In fact, the mean of the response variable was 8.333 while the variance was 3.211. By carrying out a likelihood ratio test based on the assumption that $H_0 : \nu = 1$, the dispersion parameter is found to be significant at 5% level of significance and thus the under-dispersion index cannot be ignored in the analysis. In statistical literature, under-dispersion is handled through various generalized forms of the Poisson distribution such as the Generalized Poisson distribution [Consul and Jain, 1973, Famoye *et al.,* 2004) and the class of weighted Poisson distributions (Castillo & Perez-Cassamy, 2005). However, modelling of under-dispersion by the Generalized Poisson distribution may not always be efficient (Famoye *et al*., 2004). In this paper, we emphasize on one of the weighted Poisson distributions that have become increasingly popular in the recent years known as the Conway Maxwell Poisson or Com-Poisson distribution (CMP) (Shmueli *et al.,* 2005). This distribution has elegant statistical properties such as its flexibility to model both over-,equi- and under-dispersed data. Moreover, it forms part of the family of exponential dispersion models and is a generalization of some popular discrete distributions such as the Geometric, Poisson and Negative-Binomial distributions.

In fact, Shmueli *et a*l. (2005) have shown that CMP yields fits with almost equal efficiency as the negative-binomial model and other discrete distributions. Besides, its generalized linear model (GLM) has also been established. In the regression set-up, Jowaheer and Mamode Khan (2009) and Mamode Khan and Jowaheer (2013) have developed the Com-Poisson (GLM) and studied its application to set up a regression model for analyzing car breakdowns in Mauritius (2010)]. The following provides a description of the Com-Poisson Regression model (CPRM) and the quasi-likelihood estimation technique.

Let y_i be the number of trips for the i^{th} individual $(y_i > 0, i = 1,2,3,...,250)$ and x_i be the 11-dimensional vector of covariates corresponding to y_i. Let β be the 10-dimensional vector of covariates such that β_j $(j = 1,2,3,...,10)$ is the regression effect of the j^{th} covariate on the number of trips. The Com-Poisson regression model is given by

$$P(Y = y_i) = \frac{\lambda_i^{y_i}}{(y_i!)^{\upsilon}} \frac{1}{Z(\lambda_i, \upsilon)} \quad (1)$$

where

$$Z(\lambda_i, \upsilon) = \sum_{j=0}^{\infty} \frac{\lambda_i^j}{(j!)^{\upsilon}}, \lambda_i > 0, \upsilon > 0 \quad (2)$$

and

$$\ln(\lambda_i) = x_i^T \beta \quad (3)$$

Note that $\upsilon < 1$ indicates over-dispersion, $\upsilon = 1$ indicates equi-dispersion and $\upsilon > 1$ indicates under-dispersion. Following Shmueli et al. [16] , equation (2) can also be approximated by

$$Z(\lambda_i, \upsilon) = \frac{\exp(\upsilon \lambda_i^{\frac{1}{\upsilon}})}{\lambda_i^{\frac{\upsilon-1}{2\upsilon}} (2\pi)^{\frac{\upsilon-1}{2}} \sqrt{\upsilon}} \quad (4)$$

To estimate the parameters β and υ, we solve the joint quasi-likelihood equation $\sum_{i=1}^{250} D_i^T V_i^{-1} (f_i - \mu_i) = 0$ (5)

where $f_i = (y_i, y_i^2)$ and $\mu_i = (\theta_i, m_i)$. Note $\theta_i = E(Y_i) = \frac{\lambda_i^{\frac{1}{\upsilon}}}{\upsilon} - \frac{\upsilon - 1}{2\upsilon}$ and $m_i = \theta_i^2 + Var(Y_i)$, where $Var(Y_i) = \frac{\lambda_i^{\frac{1}{\upsilon}}}{\upsilon}$. The components of D_i and V_i are derived following the approach of Jowaheer and Mamode Khan [17]. The JQL equation (5) is solved iteratively using the Newton-Raphson technique, i.e,

$$\begin{pmatrix} \hat{\beta}_{r+1} \\ \hat{\upsilon}_{r+1} \end{pmatrix} = \begin{pmatrix} \hat{\beta}_r \\ \hat{\upsilon}_r \end{pmatrix} + \left[\sum_{i=1}^{250} D_i^T V_i^{-1} D_i \right]^{-1} \left[\sum_{i=1}^{250} D_i^T V_i^{-1} (f_i - \mu_i) \right] \quad (6)$$

Under mild regularity conditions, for large sample size, $[(\hat{\beta}_r - \beta), (\hat{\upsilon}_r - \upsilon)]$ follow the normal distribution with mean 0 and variance $[D_i^T V_i^{-1} D_i]^{-1}$.

RESULTS AND DISCUSSION

In this section, we apply the JQL equation (6) to obtain estimates of the regression parameters. The following table shows the regression estimates for the various covariates. The covariate of age is negative and significant. This implies that older people have a tendency to undertake less trips towards Port-Louis, that is a unit decrease of 1.115 in the number of trips taken. One major reason may be because of the spatial characteristics of the place in terms of its high temperature and population density, among others. The finding also implies that the frequency of travelling towards our reference destination is higher

for younger people. More evidence of the effect of age representing societal dynamics is provided through its interactive effects with other variables.

Table 2.Regression estimates

	Estimates	Standard Error
Intercept	1.567	(0.155)
Age	-1.115	(0.162)
Sex	2.892	(0.210)
Income	5.231	(0.292)
Mode of transport	8.011	(0.252)
Number of children	-1.762	(0.162)
Qualification Level	4.517	(0.286)
INTA:		
Age/qualification	0.3415	(0.265)
Age/Income	0.2512	(0.112)
Age/Transport	0.1111	(0.012)

The positive covariate associated with sex implies a unit increase of 2.892 in the number of trips taken which further implies that gender plays a significant role in travel behaviour. The number of trips is less for women than men. The finding is consistent with van Acker *et al*. (2007). This can be explained by the fact that car ownership is generally lower among Mauritian women. Women travel more often by public transport, or on foot. As women are more reliant on slow modes, they cannot travel such long distances as their male counterparts. Hence, number of trips is expected to be lower for women than for men. The difference may also be explained by women's lower wages and the fact that women obtain different types of jobs to man. The cultural aspect also plays an important role in determining travel behaviour of women. Travel tends to be less in conservative religious setting.

Car ownership can be analyzed as an endogenous variable which is explained by various socio-economic variables. Highly educated people are found to own more cars. Due to relationships between education and income, car ownership is higher across high-income groups as well. On the other hand, car ownership can be considered as an exogenous variable, explaining travel behaviour and Ownership of car may lead to higher number of trips. The result provides evidence that ownership of car enhance the frequency of travelling by a unit increase of 8 trips. The covariate is positive and highly significant. Such results may have major implication for environmentally sustainable transport policy. Due to the recent economic progress in Mauritius, the population have a craze for purchasing car and our analysis suggests that the number of trips is likely to

increase to Port-Louis and the problem of congestion will further rise. This answers partly the question of whether socio-economic progress is a barrier to sustainable transport.

The covariate with household size proxied by the number of children is, however, negative by 1.762 unit decrease. This differs from our theoretical expectation that higher household size leads to higher trips. A possible explanation is that household with children may choose other destinations for travelling purposes, especially if the purpose is for recreational purposes.

The relationship between age and travel frequency depends on other factors such as the mode of transport. Age in our analysis reflects societal dynamics and evidence suggests that car ownership is lower among young and older people. Thus, older people walk more often and public transport usage is greater. Moreover, if older persons travel by car, they travel shorter distances. This implies that frequency of travelling is lower as people get older. However, as noted by van Acker *et al*. (2007), travel itself may have socializing opportunities for older people. Thus, non-work trips have, therefore, been found to be highest among older people. Our conclusion shows that the impact of age on the number of trips taking into account car ownership is positive and is highly significant.

As expected, high income and high qualification enhance the demand for travelling and lead to higher trips. Both covariates are positive and significant. The interactive effects provide interesting results. As mentioned earlier, as people get older, the number of trips decreases. However, the interactive effect between age and qualification has a positive and statistically significant effect on the number of trips. Thus, we conclude from the study that a more educated society is likely to travel more. Again, the interactive effect between age and income, is positively related to the number of trips – the covariate is positive and significant. As the Mauritian society moves up the ladder of economic development, people earn higher income and over time, as they get older, they are likely to travel more. Societal dynamics can therefore be a barrier to environmentally sustainable transport. The findings confirm conclusions of early studies that demand for travelling may rise as society progresses, leading to higher environmental impacts and traffic congestion.

CONCLUSION

The study provides an analysis of travel behaviour using major socio-economic determinants at individual household level using a novel regression model – the Com-Poisson model. The analysis considers the number of trips, which is undertaken towards particular destination, as a count variable. The use of a reference destination provides a close examination of the socio-economic determinants for the motive to travel to that particular destination and we seek to investigate whether societal dynamics are consistent with environmentally sustainable transport.

We conclude that socio-economic determinants such as qualification, income and ownership of car and their interactive effects with age play a significant role in determining travel demand. Economic progress may be incompatible to environmentally sustainable transport. Planning policies based on the activity approach attempt to reduce travel by bringing destinations closer to origins. However, our study shows that the frequency of travelling may rise and such conclusion should be accounted in

transport policies. Transport system design may have to take into account societal dynamics and public mode of transportation may be among the solutions to curb the craze for private car ownership.

Such analysis may be used for projecting future mobility in our reference area. The Com-Poisson regression uses the number of trips as a count variable and such model may be distinguished to binary models which analyses the determinants of the decision whether or not to travel. Com-Poisson accounts for the skewness of the data as well as for the dispersion of the number of trips.

One of the major limitations of the current study is the number of explanatory variables which are used in the regression model. This provides opportunities for further research. Using the number of trips as a count variable and the Com-Poisson regression model, the analysis may be extended to account for more socio-economic characteristics such as family types, purpose of travelling and personal preferences of individuals and different locations.

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