THE EFFECT OF URBAN FORM ON TRAVEL BEHAVIOUR – A review of the Literature

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Abstract

This paper analyses the growing body of research on the relationship between urban form and travel behaviour. Continuing urbanization trends along with high car dependency calls for the need to assess the complex inter-relationships between urban form and travel behaviour to strike a balance for sustainable growth. As the existing body of literature on the influence of urban form on travel behaviour is continuously expanding, a major concern is the lack of general consensus in terms of the validity and strength of this relationship. Also the major emphasis in research in this area has been on the quantitative association of this relationship explaining "how" people travel while the qualitative dimension of "why" people travel remains less explored. More recently studies in travel behaviour research are now investigating the realms of qualitative research along with quantitative assessment to provide a deeper insight into understanding and predicting future growth trends; however these studies are still rare in the field of urban form and travel behaviour. Another observation is the complexity of these inter-relationships and the dynamics owing to the multitude of variables involved and their mechanism which result in interesting patterns of inter-dependencies. Variations in results are also found by the studies reflecting their high spatio-temporal dependency and contextual legacy. The socio-demographic composition, attitudes and preferences and above all the complexity of human nature involved lends to this diversity and the variations in the strength of this relationship. Finally research design and analysis techniques play a major role in assessing these inter-relationships as studies have shown diversity in findings owing to the level of analysis, type of data used and the type of analysis used. These observations reinforce the need for a re-assessment of this relationship using a more comprehensive approach including socio-demographic factors, urban form indicators, preference and attitudinal factors, as the existing body of research needs a new dimension. This paper thus concludes that although the vast body of literature does give an in-depth insight into the inter-relationships between the built form and travel behaviour, refinement in terms of data matching at the individual level, life trajectory considerations and extensive qualitative exploration within their contextual settings still require further research in this area. This paper aims to highlight these issues and point out at the key areas where further research can aid in a better understanding for policy information and addressing sustainability targets.

Key Words: Urban form, Travel behaviour, Socio-demographic characteristics, Attitudes and Preferences, Spatial dynamics, Sustainability.

Introduction

The extent of influence of urban form on travel behaviour has been an on-going debate with previous research showing convincing evidence of the influence of urban form on travel behaviour, however the nature and strength of this influence still remains disputed. This may be explained by the multitude of factors involved ranging from the physical context of the built form like density, land-use, network pattern, to socio-economic, demographic factors and further more subtle perception issues like the preferences, attitudes and lifestyle choices. Essentially every urban form is a combination of a set of these parameters within a physical context which jointly impacts on the travel behaviour generated within it. However the physical structure of urban form remains the only area where there is direct scope for

intervention and control by planners and policy makers to achieve sustainability [4, 5]. Thus with over 80% of the UK population now living in urbanized areas and new construction activity adding high volume of traffic to the environment [5], this area is of priority for research for policy decisions. Also the early twenty-first century marked a new agenda of environmental awareness and greener forms of transport usage in the realm of transportation studies [7] and exploring the potential of urban planning in reducing travel related energy is gaining importance to achieve sustainable lifestyles and sustainable travel behaviour patterns which are becoming intractably complex as the urban structure provides the framework for travel generation along with socio-economic and cultural factors. Thus reduction in transport related energy consumption is a key policy imperative and there is a need to clarify the contribution of urban form as a determining factor in shaping travel behaviour.

The dimensions of urban form – a brief introduction

The physical context

The physical structure of urban form has been mainly represented by density, land-use mix, accessibility, network pattern and infrastructure; however essentially density is the main facilitator of all urban function. Almost all studies point out at density as one of the most influential and critical urban form parameter affecting travel behaviour patterns. Although from the literature we find that perceptions and acceptability of high density urban forms vary culturally [16,10], it is universally the most important criteria to determine the feasibility of mass transit systems [32]. Also research shows the association of density and urban form and studies have demonstrated statistically the effectiveness of urban form density in reducing travel expressed in terms of travel energy savings [21]. Also it affects several aspects of travel behaviour such as use of mass transit, modal choice, travel time, trip chaining, travel distance and travel speed. Empirical analysis and studies have suggested the effectiveness of high density living as a more sustainable option [32] as the density increases, automobile ownership decreases and transit use increases. However the effects are varied in terms of contextual perspective [44].

Also travel basically originates from engaging in activities which results in travelling from one location to the other within the urban fabric [31]. Thus spatial context and land-use is of particular interest to researchers to ascertain the influence of the residential locations on travel pattern [28]. Also there is a vast body of research which advocates the idea that by using land use as a planning tool to influence the location of activities and creating diversity, travel related energy can be reduced [31, 20, 27]. Mixed land use settings have resulted in more pedestrian movement and promote public transport [26]. Thus land use is a strong predictor of modal choice as well as a facilitator of active travel opportunities which is vital from the public health viewpoint as well. We can conclude that the spatial dimension of the urban form has direct effects on travel behaviour and manipulation of land use mixes and spatial location can effectively reduce travel distance, travel time, car dependency, encourage mass transit usage and cater for a more sustainable form of travel energy usage [12]. However there is a critical issue of phase lag between the land use and transportation transformation time scale as pointed out in their reciprocal relationship which needs careful planning as the two time scales differ largely in terms of operationalization and implementation [43].

Also the very mention of urban form brings to our mind the urban morphology and while some studies have reported nominal effects of urban structure on travel behaviour where the effect was observed on modal choice and non-motorised travel [37], still others have reported no effect on travel behaviour in the US context considering the effect of street network pattern on non-work travel decisions [15]. However a study in the US based on investigating the effects of new urbanism design principles concluded that the type of neighbourhood (built-form) at the home end exerts a strong influence on non-work trips like shopping and leisure in terms of mode choice [13].

Another major influencing factor is the concept of centrality in the spatial setting of a city which is expressed in terms of distance to the city centre, and has played an important role

in influencing travel behaviour and energy consumption [21, 31, 38]. A study in Surrey, UK, concluded that households situated in rural settings had a 24% higher energy consumption than the households located in the town centres while the households located in other parts of the urban area had a 13% higher energy consumption [21]. In Oslo similar discrepancies in energy consumption was observed depending on the distance from the city centre in a study which states that residents living in the periphery consume two and half times more energy in comparison to the residents living in the central downtown area [31]. Accessibility is another important criterion in determining the success of urban form in encouraging the use of public transport and reducing travel distances. Studies have reported the effectiveness of better accessibility to public transport in potentially reducing car travel [27]. Also the provision of better urban infrastructure such as highways do increase travel but it is a vital element of accessibility and the absence or reduction can have negative impact on the overall growth of an area. Thus looking at the converse of this theory of highway infrastructure provision, we can safely conclude that they are not the sole reasons for sprawl [18] and hampering their growth may not necessarily yield desired results.

The individual (person-centred) context

As the basic unit of measure of travel behaviour is the individual himself or herself, the constituent characteristics of the individual plays a vital role in influencing this relationship. Socio-economic and demographic variables thus play a key role in determining the travel characteristics such as travel distance and choice of mode or modal split [40]. Also affordability plays an important role in car ownership and commute pattern, and with increasing levels of income and car ownership there might be a completely different emerging pattern of travel behaviour [16]. Research has also established that cultural background, lifestyle perception, personal choice and attitude are some inherent traits of human behaviour which affect their travel behaviour [40,41]. Although these are mainly human qualities which cannot be measured empirically, their effect on travel pattern can be explained by their degree of influence. Also studies have successfully established that lifestyle perception, ethnicity and cultural factors, social interactions do exert a strong effect on the modal choice and on travel distance [36]. Again while most studies relating to residential self-selection are based on current travel attitudes, as they are the only standard ones available from general data sets, the travel-related attitudes observed during the residential self-selection are rare. Measuring these attitudes during the actual self-selecting process is more complex and would involve retrospective data whose reliability may be of question. Also considering each residential alternative and its combination of attributes in terms of travel is a complex procedure. Also attitudes, built environment and travel have their own interdependencies and dynamics which is a constant ongoing process. Thus residential self-selection and travel related attitudes change with stages of life creating a complex pattern [9]. Scholars have found that travel mode in particular is more influenced by the life situation factor as compared to lifestyle choices [35]. This creates a very interesting pattern in self-selection as often there will be temporal mismatches in phases of life followed by self-selection to overcome it. Also a reverse pattern is observed in terms of travel as there might be temporal mismatches in terms of travel attitudes and then adoption of available travel opportunities to match their aspirations. Here creating a positive imagery of public transport can lead to more sustainable forms of travel. Thus in the life-cycle process studies have showed that the neighbourhood accessibility and design become important factors for the elderly to relocate so that they can maintain a more active lifestyle [29]. Built environment factors like better accessibility to post-office, shops restaurants etc. along with safety issues and neighbourhood attractiveness were the top priorities for relocation from which we can conclude that the self-selection criteria changes with age and mobility. However the older population is not a homogenous group as the urbanites and sub-urbanites have distinct travel related preferences. Whilst the urbanites have similar accessibility and mode preferences and self-select themselves in environments offering such choices, the sub-urbanites prefer cars and sub-urban locations into which they self-select themselves [11]. However there is a great concern for the current auto-oriented generation which will be ageing in the near future and despite having an auto-oriented preference will face declining mobility. For this built form, travel behaviour and self-selection will have to create to right mix to promote mobility and accessibility in future. Thus we find that there is a link with demographics in explaining for the self-selection process which may be easier to standardize

to create more homogenized solutions to cater to such choices. In the UK context a study using longitudinal data found socio-demographic characteristics and neighbourhood factors like accessibility and safety having greatest effect on car ownership and travel behaviour and can significantly reduce driving. This study also confirmed the role of residential self-selection in adapting to travel habits as those who favoured sustainable modes of travel were more likely to reduce car usage supporting the concept of compact cities with better accessibility and pedestrian-oriented developments [1]. Thus generally speaking self-selection is driven by the human selection criteria which can involve all aspects of life. However this relationship between travel behaviour and self-selection can be bi-directional as both can influence each other [46]. As one self-selects into a neighbourhood which has good transit options, one may become a pro-transit user. Thus this bi-directional relationship can help planners design environments to encourage sustainable travel patterns and attitudes.

Another current area of interest to researchers which play a vital role in altering our lifestyle choices is the intention to travel considering the availability of telecommunication facilities such as mobile phones and internet. A number of studies broadly categorized the potential relationships between travel and telecommuting as; substitution, enhancement or complementarity, modification and neutrality [23, 33, 14]. This adds a new dimension to issues in social exclusion and mobility as telecommunications play an important role in communication and replaces mobility to some extent. In effect the role of information and communication technology is key to achieving sustainability as it can directly influence the demand for transportation and mobility in terms of volume and spatio-temporal distribution [4] which may be observed as the new lifestyle in the IT age.

The societal context (segregation and spatial dynamics)

Another dimension which acts as a backdrop for the inter-relationship between urban form and travel behaviour is the societal context which is of growing interest to scholars researching on travel behaviour and studies have mentioned the need for further research in this area [35]. The issue of segregation today is no longer a citywide concept but a more global phenomenon due to the impact of globalization, de-industrialization, restructuring and increasing income inequalities which have a profound impact on the socio-spatial structure of the modern city [45, 8, 17]. Division or segregation essentially stems from inequality which maybe explained in terms of power, income and status [17]. Such disparities are a result of differences in class, ethnicity, religion etc and on the broader perspective these social divisions in the cities are a result of global economic changes [45, 17], resulting in unequal income and social and spatial polarization. We find examples of this in Britain where the most deprived households in cities are concentrated in the social rented sector while in Netherlands there are designated areas for the social rented dwellings creating concentrations of low-income groups [45]. More unique examples of such spatial segregation which resulted from ethno-national conflicts are still remnant in Belfast. Territorial hardening thus became a feature of the city caused a rigidity in the urban social fabric with very little cross-movement which impacted on the perceived accessibility of spaces within the city. This resulted in decentralization and deconcentration with the inner city further segmented based on ethnic segregation creating disrupted travel patterns within the urban fabric. This socio-political legacy gave rise to the unique urban restructuring which is beyond the scope of generalization for predicting the travel behaviour generated within it. Thus essentially this concept is strongly related to the geographical context and setting as every urban form would have its own spatial dynamics which in turn would reflect on its spatial structure.

Key findings from the literature review

We can thus safely conclude that there is a multitude of factors involved in influencing the relationship between urban form and travel behaviour and most studies have focussed on particular aspects of these complex inter-relationships to analyse the effect. In a chronological manner the studies initially looked into the direct relationship between the physical parameters of urban form influencing travel behaviour followed by using a more individual approach to include the effect of socio-economic and demographic factors on

travel behaviour. This process intensified into investigating more into the role of individual lifestyle preferences and attitudes and their relative influence in affecting travel behaviour as compared to the urban form. Further studies investigated into the role of life situation in predicting travel patterns and the role of societal context. Parallel to this research investigated the influence of technology in effecting this relationship. Another key area of research in the public health domain was the role of urban form in influencing travel behaviour to encourage active travel to battle health epidemics like obesity. However at the core of all issues laid the intent to promote public transport ridership and active travel and reduce car usage but looking at the vast body of existing knowledge we can highlight a few points with examples from the literature which are of concern:

1) The lack of general consensus in terms of the validity and strength of the relationship

The main concern in terms of research findings lies in the lack of general consensus with studies differing in opinion on the strength and the validity of this relationship. To take for example the most influential urban form indicators such as density, land-use, neighbourhood structure, centrality and accessibility, there are studies both supporting and negating their influence on travel behaviour. In the UK context itself while some researchers argue on the effectiveness of urban planning tools such as density, accessibility and land use in managing travel demand [5, 21, 6], still, others argue that the socio-economic factors play a greater role in influencing travel behaviour [16, 40, 1, 2], thus not being able to point out clearly at what influences travel behaviour. Also there is a vast body of research which advocates the idea that by using land use as a planning tool to influence the location of activities and creating diversity, travel related energy can be reduced [20, 27,26] while others report little or no effect of land-use in explaining travel behaviour [15] and attitudes more strongly associated with travel behaviour rather than land-use characteristics [24]. Similar discrepancies in opinion on the validity and influence of neighbourhood structure and accessibility on travel behaviour can be found with studies reporting the effectiveness of better accessibility to public transport potentially reducing car travel [27] while others report little or no effect at all [15, 39]. Similarly there are studies which contend that the concept of centrality in the spatial setting of a city which is expressed in terms of distance to the city centre did plays an important role in influencing travel behaviour and energy consumption [21, 31, 38]. Others argue that the spatial context has no influence on travel behaviour and other indicators such as density and psychological aspects play a greater role in explaining travel patterns [42]. We can thus conclude that there is no consensus on the effect of urban form in influencing travel behaviour as the vast body of literature remains divided in opinion.

2) Spatio-temporal and socio-cultural dependency

Drawing upon the work of Newman and Kenworthy which is a very major contribution to the vast body of literature on the impact of built form on travel behaviour, a study [44] looked at introducing the effect of the socio-economic and demographic variables in a multivariate analysis which was fundamentally left out in the research by Newman and Kenworthy. With the introduction of these variables in an aggregate level perspective, the effect of other built form variables such as density and spatial dynamics seemed to reduce significantly and differences in travel pattern seemed to reflect the contextual background (UK, US and Canada) and the resident composition more than just simple built form variables. Similar geographical variances were reported by another study which found that the effect of land-use on travel behaviour was more significant in Europe as compared to US [2].

Also differing geographic locations have shown complete opposite urban residential location choice which impacts on the travel behaviour. For example in the UK, where the rise in socio-economic factors such as income and affordability, leads to demand for more space, thus creating lesser density and longer commuting patterns and as opposed to this in Europe the rich would be occupying the central hub of the cities where as the lesser capable ones would be forced out [16]. A study in US reports similar findings where the economically disadvantaged occupied the inner city locations and were at a closer proximity to the job market in the physical context. Thus commute trip length was negatively associated with the socio-economically disadvantaged [3]. In Paris this situation is quite acute where the first

time buyers are mainly the low income households who have to move out of inner cities for more affordable properties [30]. These contrasting examples clearly bear upon the socio-cultural and economic impact on travel behaviour in different geographical locations thus showing varying results in terms of validity of the relationship.

3) More quantitative association

Studies have generally shown a stronger association with the quantitative explanation of the relationship between urban form and travel behaviour. As density remains one of the largely agreed influencing factors, a study in the US showed that doubling the built form density will lead to a savings of 25-30% less driving per household [22]. In UK a study in Surrey reported that urban structure can be influenced over time at local levels to reduce travel energy consumption as housing located in higher density urban areas with over 35 persons per hectare developments, had 29% less commute energy consumption than the sample average. Also in rural areas the energy consumption was found to be 24% higher than that of town centre locations and 13% higher than urban locations [21]. Also in terms of the spatial context the study concluded that households situated in rural settings had a 24% higher energy consumption than the households located in the town centres while the households located in other parts of the urban area had a 13% higher energy consumption [21]. In Oslo similar discrepancies in energy consumption was observed depending on the distance from the city centre in a study which states that residents living in the periphery consume two and half times more energy in comparison to the residents living in the central downtown area [31]. Again there are contradictions to these findings as stated in the first observation, as a study using the National Travel Survey at the individual level in UK concluded that distance from the urban centre had no effect on the travel distance [40]. Thus while most studies have successfully established the association in quantitative measures the qualitative dimension remains less explored and can be identified as an important area for further research.

4) Variations due to research design

Various research designs using different methodology has been used to measure the degree of association and the complex inter-dependencies of urban form and travel behaviour and the variations and the differing results are to some extent a result of these different approaches. We can mainly summarize them as the level of analysis (aggregate, disaggregate, multi-level), the type of data (cross-sectional, longitudinal, quasi-longitudinal) and the type of analysis used (regression analysis, SEM, MNL, factor analysis, GIS analysis etc.). Every research design is essentially a combination of these which have their own inherent strength and weaknesses. While most studies showing world comparison [32, 42] used readily available aggregate level data, still others which encompassed a more comprehensive approach of taking into consideration the effect of urban form, socio-economic and attitudes and perception on travel behaviour had to use disaggregate level data to match both spatial and individual data [24]. A study in the US further reflected these research design variations as the multivariate analysis using cross-sectional data showed differences in travel behaviour due to attitudes while the same study using quasi-longitudinal analysis showed strong association between built form and travel behaviour [19]. Again two different studies in San Francisco Bay area showed similar results based on different research designs. Using cross-sectional data in three neighbourhoods in San Francisco Bay area and multinominal logit model, results showed that neighbourhood structure has autonomous influence on travel behaviour (mode choice) as there was not much difference in the consonant and dissonant residents of the urban and sub-urban neighbourhoods [37]. The other study using longitudinal data to analyse the travel behaviour of households in two consecutive years in San Francisco Bay area using regression modelling also found that households change travel behaviour when exposed to different urban forms [25].Thus research design plays a critical role in explaining for variations in observations in different studies and essentially every research design has its own merit and drawbacks to which can explain somewhat for the variations in results.

Conclusions

This review of the vast body of literature on the relationship between urban form and travel behaviour clearly points out that although there is convincing evidence of the influence of urban form on travel behaviour, there is no general consensus on the strength and validity of this relationship. Further research thus needs to test this relationship between urban form and travel behaviour in depth for a robust inference on the validity of this relationship.

Also we can conclude from the literature that the relationship between urban form and travel behaviour involves complex mechanisms and inter-dependencies due to the multitude of factors involved. Scholars have tried to establish these relationships using various theories like the activity theory, choice models such as utility theory and prospect theory to mechanisms like causality. However owing to the diverse range of variables ranging from human factors to physical and contextual factors, encompassing all of these variables in a single study framework becomes next to impossible. Thus although a more comprehensive approach taking into consideration all of these factors is warranted to identify the key levers in achieving sustainable travel behaviour with more confirmative results, the complexity poses a threat to this intent. There is a potential gap in knowledge where owing to the multitude of factors involved in the relationship between urban form and travel behaviour, research has mostly been limited to snap-shot studies analysing the effect of a selected set of variables on travel behaviour. However including for other factors could have steered a complete opposite effect, as studies have shown, thus rendering flaw to the validity of their results. Thus further research could gain from using mixed-method approach, which is still a rarity in this field. With the use of qualitative research to augment quantitative analysis a wider range of variables can be analysed thus minimising error and bias in findings as qualitative analysis can aid in both exploring, with an open mind, the factors influencing the relationship between urban form and travel behaviour and subsequently help identify a smaller set of key variables that are the major influencing factors in the particular context. This not only reduces the complexity of the interacting parameters but also allows for a more detailed analysis of the interdependencies between the variables influencing the relationship between urban form and travel behaviour. Also this would greatly contribute to a theoretically richer understanding of the relationship between of urban form and travel behaviour and identify the underlying reasons for the travel behaviour patterns. This remains a key area where further research can greatly contribute to understand why people travel as although the ‘how’ of this relationship has been extensively researched the ’why’ remains less researched. This is mainly due to the fact that there is an over-representation of studies investigating this relationship in the light of quantitative association rather than qualitative analyses of the inter-dependencies. Thus the already existing vast body of knowledge which tends to be more quantitative measure oriented would benefit from the new knowledge of qualitative exploration.

Another area for further research is the evaluation of this relationship in the societal context which is a fairly new dimension to research in this area. The spatial dynamics and segregation issues of the physical environment is a less researched area and further research could aid in understanding these spatial polarization issues impacting on travel behaviour.

Thus we can finally conclude that there is a need to establish the validity of the relationship between urban form and travel behaviour. Also further research needs to encompass both qualitative and quantitative analyses to deal with the complexity and multitude of factors involved in the inter-relationship between urban form and travel behaviour. Also the relationship needs to be addressed in the societal context as well along with the physical parameters and socio-economic factors to capture the true dynamics as the inter-relationship between urban form and travel behaviour is of a dynamic nature and understanding the dynamics of this inter-relationship is key to achieving sustainability.

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