



Modelling Household Travel Behaviour to Promote Educational Values of Sustainability

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Abstract

The emergence of concern about global sustainability raises questions about the nature of travel behaviour and its potential effect on the sustainability of households. This potential, generated through an understanding of what is meant by travel behaviour sustainability, must be addressed by way of education. The paper attempts to characterise this type of sustainability using a coarse multiattribute model that reduces the concept to five measurable attributes. These can be readily integrated with a public educational programme designed to enable households to assess and reflect on their behaviour as a result of a household sustainability index of travel behaviour. Results from a large survey of households in the Belfast City Region are presented to illustrate the tangibility of the modelling methodology (Belfast is the capital city of Northern Ireland).

Keywords: Travel behaviour, Sustainability, Multi-criteria analysis, Expert opinion, Agenda 21

1. Introduction

Universal government policy is sensitive to the problems attached to global warming and the desire to control and minimise the present high levels of adverse transport activity on the environment is one of the most important demands facing policy makers in their efforts to secure sustainable development. In light of the many definitions of sustainable development [Pezzey (1989) lists some sixty definitions and Pearse et al. (1989) exhibit thirty in their Gallery of Definitions] the notion put forward by the Brundtland Commission is adopted herein – namely:

Sustainable development meets the needs of the present without compromising the ability of future generations to meet their own needs.

The paper argues the potential for enhancing public response to governmental policies (e.g. Agenda 21) by enabling householders to learn how sustainability relates to their ecological identity. The United Nations Conference on Environment and Development Education (1992) established the Agenda 21 policy on promoting sustainability and stated that (ibid:36.1), “Education is critical for promoting sustainable development and improving the capacity of the people to address environment and development issues”. It was emphasised that “Both formal and non-formal education are indispensable to changing people’s attitudes so that they have the capacity to assess and address their sustainable development concerns. It [education] is also critical for achieving environmental and ethical awareness, values and attitudes, skills and behaviour consistent with sustainable development and for effective public participation in decision-making”.

Local Agenda 21 (LA21) is the local version of the U.N. policy both internationally and within the U.K. In line with this policy, District Councils have been tasked with establishing partnerships with Non-Governmental Organisations

(NGOs), both in pursuit of sustainable enterprise development and the “implementation of participatory democracy (Section 27.1)”. In the U.K. “all local authorities signed up to the deal, and through the use of LA21 Officers, aimed to make an impact on their local community’s attitudes to recycling and many other actions related to the environment”. (DEFRA, 2005, 1.3). It was, also, required that all schools should have links with the local authority concerning environmental issues, specifically through an LA21 Officer. DEFRA research (ibid) found that not all schools did link with a local authority but those that did were “more likely than average to say that the issues featured do affect what they teach” (ibid). The findings suggest the need for holistic and ‘joined-up’ policies if the concept of sustainability is to be embedded across communities and the rising generation of children.

The introduction of such policies will entail a new and radical approach to public education both in terms of the role of schools and the different arms of government, including local authorities. DEFRA (2003:3) through the ‘Learning to Last’ strategy has emphasised that “all parts of the education system” and “all organisations involved in local and regional governance” should apply their respective capacities to addressing sustainability. It has been suggested (Blewitt, 2005), however, that a paradigmatic shift in government thinking is required, informed by the metaphor of natural capital (Daly and Cobb, 1994) which provides a different mode of ecosystem analysis. Clearly this is a major project and will, ultimately, be dependent on the capacity of government to influence public behaviour. A starting point, however, for the enhancement of public education would be to identify clearly the individual behaviours that are detrimental to sustainable living and to utilise this data to support the development of effective public health policies and practices. The outcome of this study is intended to inform public education by providing findings that can assist in informing decision-making through examination of household behaviour. It has already been shown through publicly funded project studies that behavioural changes are possible, albeit incremental at their stage of enquiry. See for example, Haq *et al* (2004), Cairns *et al* (2004) and the Community Survey and Marketing Campaign for the South Perth Travel Smart Pilot Project Third Evaluation Report (September 2000).

By taking the household as a focus in terms of its occupant travel behaviour, this article presents the reader with the outline of a simple model designed to link expert knowledge of travel behaviour with corresponding household data abstracted from a large household survey, see Donegan *et al* (2007). The outcome is an index of travel behaviour sustainability - referred to as the household sustainability index (HSI). This gives the household an indication, measured on a percentage basis, of how well it is performing with respect to its travel behaviour. Such an indicator has the potential from an educational perspective to motivate a household’s consideration of a more sustainable approach to its travel behaviour habits. This could be achieved via a profile of performance across the range of fixed and variable travel behaviour attributes that are an integral part of the model. The points-scheme used to abstract the household attribute data will be described in some detail.

Policy makers can also benefit from the indexing concept. For example, the aggregation of individual household indices over a range of developments within settlements across the urban-rural spectrum would offer policymakers an opportunity to compare the travel behaviour performance of settlements when judged against corresponding sustainability benchmarks. Such judgements could be used to enhance any particular transport initiative or potential innovations related to an educational provision whether formal or informal. There may be a concern that, currently, education in sustainability is too broadly directed and this information can contribute to a more focused approach which takes account of recent settlement patterns and, moreover, contributes to an understanding of how the process of persuading individuals to consider alternative choices regarding place of abode.

The results arising from the model’s application to the survey data raises a question concerning suburbanisation. Does household travel behaviour result from a residual culture of behaviour? For example in Northern Ireland, does the popular trend for the provision of homes in suburbanised settlements mean that many of the occupants of these settlements continue to use former amenities, which could result in unnecessary and greater travel distances associated with private transport modes and journey frequencies? Put another way: do people in selecting their locations fail to reconcile their lifestyle and travel patterns with sustainability? Public education, to date, has been largely concerned with how individuals address sustainability in their current abodes. By providing the public with empirical evidence concerning their decisions regarding settlement, individuals will be better informed in terms of making a transition to a more sustainable mode of living. If the public do not have this knowledge they may not be able to capitalise on values they may have espoused regarding sustainability.

2. The Modelling Perspective

2.1 The Model Concept

The model was derived from a primary hypothesis derived from the above question – namely “*people in selecting their living environment fail to harmonise their lifestyle and travel patterns with appropriate sustainability indicators*”. To this end a large survey comprising almost 1000 households was conducted along a key commuter corridor of greater Belfast to yield a picture of relative *travel behaviour sustainability* (TBS) across a selection of settlements. Taking any single settlement, it would be naive to claim that its global TBS is related solely to, for example, the minimisation of car

ownership. There are other related attributes linked to higher levels of social, economic and environmental criteria - see for example, SDS (1998) and Newman and Kenworthy (1999). The attributes are identified and measured using a range of expert opinion and then integrated into the decision making process - hence the need to employ a multi-attribute methodology that can accommodate both qualitative and quantitative input.

There is a vast literature on methods of multi criteria evaluation, see for example Zietsman and Rilett, (2002), Goodwin and Wright, (1998); Taha, (1997); Saaty, (1995); French, (1988); Bunn, (1984); Edwards and Newman (1982); Keeney and Raiffa, (1976). It assists decision-makers in the task of prioritising or selecting from a finite set of alternatives with respect to multiple and usually conflicting criteria. The mechanisation of multi-criteria evaluation, interpreted from the above literature listing, is characterised in Figure 1, adapted from Donegan (2003), which shows how the *expert opinion weights* are linked to selected *attribute values*. (These are numerical scores abstracted from household survey data using a *points scheme* that will be described in Section 3).

The *alternatives* in this investigation are identified with households sampled in the settlements of Moira, Knockmore, Fourwinds and Brownfield Sites within Belfast's CBD, all from the key southern approach route into Belfast and ordered respectively by distance from the CBD.

2.2 The Meaning of Attributes

Attributes are the key elements in the eventual ranking of alternatives (households in this study). Together with any higher level criteria they form the baseline of a decision or analytic hierarchy (Saaty, 1980), sometimes referred to as a *value-tree* to facilitate the judgement process.

In a more formal sense, attributes are the dimensions along which alternatives are represented (French, 1988). For example, if alternatives are to be judged against three attributes, picture these as the three axes X , Y and Z shown in Figure 2. An alternative \mathbf{a} (in this study, a particular household) with attribute preference valuations - a_1 , a_2 , a_3 , is effectively an attribute preference vector (a_1, a_2, a_3) with a_1 in the X - dimension, a_2 in the Y - dimension and a_3 in the Z - dimension. Another alternative household \mathbf{b} could have value co-ordinates b_1 , b_2 , and b_3 and so on. This research draws on five key attributes, which for each household, yields a 5-dimensional preference vector $(a_1, a_2, a_3, a_4, a_5)$.

The attribute values of each household are determined by means of a *points-scheme* applied to *activity* data retrieved from a household survey. Attribute preference vectors, however, do not readily assist the direct comparison of households. It is necessary to take a weighted sum of the respective attribute values using expertly determined weights of importance. This (the basis of multi-attribute utility theory) is necessary because attributes, although chosen by experts for their direct relevance, do not have equal merit in their representation of households. The resulting weighted-sums for each household are used to rank the households. That is if w_i ($0 \leq w_i \leq 1$) is the level of importance of attribute i and v_i ($0 \leq v_i \leq 100$) represents its resultant survey value in points awarded, then $\sum w_i v_i$ is the weighted or composite score in the range 0 to 100, for that particular household. (Since the weights w_i sum to 1, there is no need to divide this expression by $\sum w_i$).

Normally a formal process is used to arrive at a credible consensus in the levels of importance identified by experts – the process may be as informal as the Delphi (See End Note 1) procedure (Schiebe *et al.*, 1975) or as formal as Saaty's (1980) Analytic Hierarchy Process (AHP). These are tried and tested methods, which can readily be adapted to any particular form of enquiry - it is not the purpose of this paper to dwell on their respective technical merits or methodologies.

2.3 Selecting and Using the Attributes

Since policy makers have targeted travel behaviour in recent years, the public has been subjected to a host of exhortations regarding how citizens might consider changing their travel behaviour. The precise impact of the different decisions that might be made has not, however, always been clear, hence the construction of a set of appropriate travel behaviour indicators that can be embedded within a hierarchy of attributes and significant criteria, can make an important contribution to public debate and understanding. In pursuit of key words that could assist with travel behaviour questionnaire design, Donegan (2003) produced a typology of key words, distilled from a vast selection of literature linking *travel behaviour* and *sustainability*. This list, reproduced in Table 1, was used as an *aide memoire* in the selection of attributes and criteria to be identified with the proposed model of household travel behaviour sustainability. In line with Parker's (1972) recommendation, a panel of experts drawn from both the public and private sectors, together with academics having key research skills, ratified the final choice and hierarchy illustrated in Figure 3.

Dalkey's (1969) work for the RAND Corporation shows that there is only a marginal difference in the average group error between an expert group of size 10 and a group of size 29. This is important in the management of a Delphi enquiry since it is much more convenient to administer 10 responses than 29. In this study it was convenient to use the consensus opinion of twelve experts with a cross-section of experiences from the fields of sustainability, planning and

transport. Each expert had at least ten years experience in his/her field of knowledge and, moreover, retaining their anonymity enabled their participation as a Delphi group in the weighting of the attributes.

The decision hierarchy shown in Figure 3 was discussed and agreed with the experts to assist them with attribute comparison evaluations. Although the process is labour intensive, the use of a hierarchy enables quantitative base-line attribute comparisons to be made relative to each of the criteria in the next highest level and so on, up the chain of criteria. A relevant discussion on consensus and decision hierarchies, along with example calculations, can be found in Donegan *et al.* (1998). The end result is a set of *attribute weights* relative to the top element of the hierarchy – *sustainable development*. This procedure reduces the remoteness of decision-making when seeking attribute comparisons (Shields, 1991) and it leads to greater precision in the decision-making process.

The baseline attributes along with a household's knowledge of its travel behaviour sustainability can readily advance an educational opportunity for any household to upgrade the sustainability of its travel behaviour. This suggests that government, at central or local levels, should review and reconsider policies, as it would appear that a new model of public education is required. This model would be informed by knowledge of the degree of flexibility pertaining to the different attitudes to be addressed; consequently, policies designed to support education for change could incorporate drivers directed towards the targeted attitudes.

Assuming that a household is aware of its Index of Sustainability, the baseline attributes:

- a. *mode* [of transport used for travelling to/from activities]
- b. *frequency* [of activity participation] and
- c. *location* [of activities]

facilitate the opportunity for a household to make positive changes to its occupant lifestyle as policy is reviewed. For example, choosing a more sustainable mode of transport, reducing the frequency associated with certain activities and choosing localised activities where possible.

The attributes:

- d. *proximity* [to public transport] and
- e. the *numbers* of vehicles and/or licence holders [associated with a household]

are less flexible to change, requiring much more radical intervention.

When the expert consensus weights are logged for each attribute, the set of baseline attributes also defines a basis for obtaining the household *values*, which when appropriately weighted by the logged expert-opinion, provides the household comparison indices. The household's resultant *value* for each baseline attribute is obtained through an averaging process carried out over an agreed set of activities – namely: *bulk shopping, occasional shopping, leisure, entertainment, health/medical, business, worship, education and employment*. Each household activity rates a score determined from the survey database and a well-defined *points scheme*. The points scheme used in the present study is outlined in Section 3.

Using this information, and recalling the weighted sum $\sum w_i v_i$ mentioned previously, gives the formula for a household's index of travel behaviour sustainability, namely:

Household Sustainability Index (HSI) = $\sum w_i v_i$ (bounded by $0 \leq \text{HSI} \leq 100$), where w_i is the consensus of the expert weightings for each baseline attribute i and v_i is the corresponding harmonic mean of a specific household's *activity* values.

[One hundred is the maximum sustainability score for a household – this is explained at the end of Section 3]. Table 2 illustrates a typical calculation for a household's index of travel behaviour sustainability. Later in Table 7, the calculation of the latter is illustrated in detail for two sample households.

3. Household Travel Behaviour Sustainability Valuations

3.1 The Points Scheme and Evaluation of the HSI

The household questionnaire and points-scheme were designed around sets of sub-attributes associated with *mode, frequency, location, proximity* and *vehicle/licences*. It is well known that setting points against sub-attributes is a subjective exercise and in order to minimise subjective shortcomings a number of experts from the Delphi panel offered assistance in reaching a points scoring consensus. The sets of sub-attributes are bulleted as follows:

MODE (method of commuting):

- a. travelling by car
- b. travelling by motorcycle
- c. travelling by taxi

- d. travelling by bus
- e. travelling by train
- f. travelling by bicycle
- g. walking
- h. immobile (non participation)

FREQUENCY (of trips):

- a. daily
- b. weekly
- c. fortnightly
- d. monthly
- e. zero frequency (non participation)

LOCATION (of activity relative to household):

actual distances (d) provided by respondents

PROXIMITY (of a public transport halt to the household estimated in minutes (t)):

- a. a nil response
- b. time t (mins) such that $t \geq 20$
- c. time t (mins) such that $15 \leq t < 20$
- d. time t (mins) such that $10 \leq t < 15$
- e. time t (mins) such that $5 \leq t < 10$
- f. time t (mins) such that $0 \leq t < 5$

NUMBER OF VEHICLES AND OR LICENCES

- a. number of licences/household and number of motor vehicles/household.

Points-schemes have an extensive literature in decision-theory, see for example Watts (2002), Cole (1997), Doxsey (1994), Prior (1993) and Stollard (1984). Fundamentally, the value or utility that can be attributed to an attribute can be mapped on to a common numerical scale designed to accommodate the admissible range of expected values (Edwards and Newman, 1982). The HSI scale ranges from zero (no value) to one hundred (maximum value within the confines of the model) – the higher the score the greater the travel behaviour sustainability relative to the measured attribute. The points scoring strategy for each of the baseline attributes is summarised below, starting with the transport *mode* used in getting to and from activities. A fuller discussion takes place in Donegan (2003). Although 0 (the least score) and 100 (the maximum score) identify with particular sub-attributes in this study, there is no reason to restrict the sub-attributes in a future project. For example it could well be that in the future there would be something more sustainable than zero travel such as a future mode that produces power, improves air quality etc. Indeed it would be possible to think of a mode less sustainable than the private car if sub-classifications of emissions were to be taken into consideration. However, the reader should not lose sight of the fact that this is a coarse model designed to assist with household education and over-precision could swamp any benefit that would emerge from a future policy on travel behaviour sustainability.

3.1.1 Mode of Transport

In terms of this model, expert opinion ranked the modes from 1 ['most' sustainable], to 8 ['least' sustainable], as shown in Table 3. The absolute maximum points score of 100 identifies with non-participation and the remaining modes are weighted by a method suggested in Edwards and Newman (1982), namely: according to their inverse rank position where *Car* = 1 through to *Non-participant Mode* = 8. Here, each rank is divided by the sum of the ranks and then a multiplier is chosen (450 in this case) to make the most sustainable mode identify with a score of 100. Such a strategy provides for the inclusion of additional modes. For example, had this project been carried out in the USA then it is probable that the 'SKATE-Board' would have been identified as a self-propelled mode, perhaps ranking between *walking* and *cycling*. The scores would then be adjusted accordingly.

3.1.2 Location of Activities

This refers to the distance of activities from the household. The zero distance caters for the category of household occupancy that does not participate in certain activities outside the confines of the home. Distances to activities were deduced using a combination of mapping and location addresses. As the distance d increases, the points awarded reduce

according to the relationship $p = (100 - 2d)$. Here d represents the one-way *actual distance* as given by the respondent and p represents the points score. This formula is based on the assumption that an activity located ≥ 50 miles from the home would rate zero in terms of sustainability. The data revealed some participants with a journey to work in excess of 50 miles.

3.1.3 Trip Frequency

Table 4 shows the corresponding points that are identified with each frequency. Clearly the fewer the number of trips to an activity the greater the influence on sustainability. Five points were allocated for a daily frequency and on a *pro rata* basis thereafter.

3.1.4 Proximity to Public Transport

In this instance, the householder provides an estimate of the time for an able-bodied occupant to walk to the nearest public transport halt/stop - see Table 5. The closer a household is to a public transport halt the greater is the sustainability potential - this is an area where education can play a key role. For example, the DfES action plan (2003: 2.5) recommends the use of public transport as part of the education strategy but does not take this issue further by suggesting that availability of public transport should be a factor in choosing a domicile. Since the Department has the opportunity to educate young people who will, in the near future be selecting a location for adult life, this would appear to be a significant omission.

3.1.5 Household Motor Vehicles / Licence Holders

The scoring strategy for numbers of household vehicles and licence holders is based on the law of diminishing returns. The simplest formulation of this association is given by the twin hyperbolic relationships: $(k + 1) \times p = 100$ and $(n + 1) \times p = 100$, where k is the number of cars, n is the number of licence holders and in either case, p represents the points awarded. Either *no cars* or *no licence holders* identify with the 'most' sustainable score, namely, 100 points. Table 6 illustrates the corresponding points awarded for the various permutations of licence holders and car ownership.

3.1.6 Sample Output

A significant feature of the modelling process is the interpretation of *non-participation* in an activity. A household failing to participate in a particular activity would obviously not engage in any associated travel behaviour. Hence, that activity would register a top mark of 100 in terms of travel behaviour. It is important to recognise that the scoring profiles are related to travel behaviour only and not to generic household sustainability. It is for this reason that a score of 100 identifies with non-participation in an activity. The data shows that only a few activities within the range would rate a score of 100 - for example, households that do not have children in education, see household B129 in Table 7. Also, although the present sample did not reveal such cases, there are arguable exceptions that need to be accommodated within any scoring system - situations where there is no travel involved, for example, householders suffering from immobility or those with agoraphobia. In such cases, the model could be adapted to mirror '*travel behaviour to*' rather than '*travel behaviour from within*' the household.

In terms of the journey to work, there is evidence in the data that some individuals reside in their place of work or use an internet/electronic office - so they obviously work, but are *non-participants* in relation to 'travel to work'. Others are currently unemployed and some are currently housewives/husbands (the latter is treated as an occupation). The data also shows occupants who are retired and have jobs. The potential exists for all these types to 'travel to work'. Consequently, for the purpose of developing a travel behaviour sustainability index, such occupants are allocated a 'non-participant status'. These individuals have greater sustainability. Hence it is evident that:

- a. Working at home - yields a higher HSI (a positive consequence of new technology)
- b. Being unemployed - results in a higher HSI (interesting consequences for full employment)
- c. Housewives/husbands - contribute to a higher HSI (negative consequences for working wives/husbands)
- d. Being retired - yields a higher HSI (positive consequence of an ageing population).

The reader will appreciate that being classified as *non-participant* in 'the journey to work' may be offset by other activities - for example, a retired occupant might do more shopping or get involved in more entertainment etc.

Sample outputs, which illustrate activity scoring for two households are given in Table 7. Namely, B129 from a Brownfield site location in Belfast and M037 from the suburbanised village of Moira. The specified activities down the left-hand side show that both *education* and *employment* are evaluated using the number of participants associated with each. Notice that for B129, the household does not attend a place of worship and correspondingly rates a score of 100 for non-participation across *mode*, *frequency* and *location*, similarly since there are no children in the home it rates a score of 100 for its non-participation in education.

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The household in Belfast with its HSI of 63.6 is clearly more sustainable from a travel behaviour perspective than the household sample from Moira with its score of 48.2 where none of the attribute scores exceed the urban household scores. This significant difference is essentially due to the respective occupancy profiles – the home with no children attending school has a major impact on the final score. The distinctions in other activities are effectively smoothed out in the *harmonic mean* averaging process.

4. Educational Factors

Although each household has an implicit Household Sustainability Index of travel behaviour it is of no real significance unless it becomes explicit and is accompanied by the necessary education linking its travel behaviour to the meaning of generic sustainability. Essentially the educational processes that underpin sustainability need to be embedded within the common practices adopted throughout communities for significant change in behaviour to take place. It has been shown explicitly in a number of projects that education has a part to play, for example The York Intelligent Travel Project (Haq *et al*, 2004) and the Individualised Marketing Project in Perth Western Australia (Sept. 2000). Clearly there is a role for schooling and the Department for Education and Science in the UK has proposed a strategy for learning about sustainable development (DfES, 2005). It may well be, however, that the impact of institutional policies may impact less on sustainability than the development of local initiatives and the growth of social consciousness in relation to the impact of community activities on the environment.

It has been suggested (eg Kelly, 2004) that peer education effectiveness derives from the fact that, as individuals interact more frequently and with more emotional impact with peers (than non-peers) and consider peers to be a credible source of information, they are therefore more likely to be persuaded by peers. The data shows an interesting consequence of this phenomena when the duration of occupancy is partitioned into ESTABLISHED RESIDENTS and NEWCOMER RESIDENTS (An occupant is a Newcomer if the length of residency is less than 5 years.). Figure 4 shows that for the village of Moira the modal distributions are similar for both Newcomers and Established Residents, which is not the case for central Belfast.

The close community spirit associated with a rural village could offer an explanation where newcomers have a greater opportunity to absorb and imitate peer behaviour, unlike the newcomer in an urban environment removed from a community spirit of involvement.

Peer education programmes to date, however, have, generally been concerned with the dissemination of health information and attempts to change health practices. Peer influence, though, is a valuable resource for changing habits, as the health programmes have shown, and it may be timely to commence the implementation of similar programmes in relation to embedding concepts of sustainability within the everyday living habits of communities.

This process is likely to be dependent on the recognition and valuing of the validity of implicit forms of knowing (Polanyi, 1966) and drawing on the shared understanding of communities. These understandings may be conceived of as a form of shared cognition initiated and continued through the formation of communities of practice (Wenger, 1998) where interactions between individuals based on their joint purpose and their endeavours lead towards agreed common goals. Creating such communities may entail a comprehension of Habermas's view that people are embedded within their "lifeworld" which consists of the cultural and linguistic traditions in which they participate (Habermas, 1987). The lifeworld is a storehouse of unquestioned cultural givens from which those participating in communication draw agreed-upon patterns of interpretation for use in their efforts to address the everyday choices perceived to be available to them. The current pattern of settlement may suggest that movement to Greenfield suburban destinations has come to be viewed as a routine life choice. The provision of evidence that challenges this perception has the potential to encourage communities to reconsider choices that may, by now, have become embedded and intergenerational.

Habermas (1987) places a high premium on the use of rational discourse in encounters among learners and argues that, in a democracy, such encounters can only lead to understanding if there is a level playing field for all the participants. From the work of Habermas, Bourdieu and Passeron (1990) has emerged the notion of 'habitus'. This is the view that while there are many alternatives for action in particular situations for individuals, they are not usually considered in everyday life. Individuals, drawing on community norms are dependent on a resource of scripts and bodies of knowledge, which govern daily choices. In order to challenge common modes of understanding, it will be necessary for communities to develop a greater consciousness of the nature and implications of choice. In fact this is not an impossible aspiration and is already taking place as instanced by the considerable growth in the purchase of goods offered at higher cost, marketed as being 'fair trade' or 'organic'.

Since the Agenda 21 policy is predicated on the devolution of demographic powers to local communities as the UK Government and other EU States are committed to implementing the policy across regions and local councils there is now, therefore, a statutory basis for a community policy to address educational change within communities. Within

communities there is also an infrastructure for change in terms of pressure groups, voluntary organisations and the social economy bodies.

The time may have come to examine the potential for synergy between local councils, local organisations and community educational initiatives. Discussing and negotiating change on the basis of respect for participatory and democratic modes of working within communities, as required by the Agenda 21 rubric, has the potential to lead to real changes in behaviours. These changes could lead to more sustainable household occupancies and household groupings in respect of their travel behaviour.

5. Relevant Outcomes

5.1 Summary of HSI Results

The summary of HSI results for the complete spectrum of 958 household responses is given in Table 8. The corresponding distribution of HSIs is illustrated in Figure 5.

The profile exhibits a quasi normal distribution with a slight negative skew. This would accord with expectation - in the sense that current transport strategies are perhaps just beginning to have an overall positive effect on sustainability, with environmental policies such as Agenda 21 and LA21 now beginning to have impact. Perhaps, in a resulting climate of TBS education, if this study were to be repeated five years hence, the distribution would exhibit a significant negative skew with many more households moving towards a higher sustainability index. As it stands, the normality in the distribution identifies with a state of equilibrium based on years of indifference towards environmental awareness.

Table 9 is of particular interest as it disaggregates the mean HSIs for each settlement class by residential classification for each of the five base-line attributes.

5.2 Interpretation of Results

In every case the HSI global totals for Established Residents exceeds the total for Newcomers and moreover, this is generally true when reading across the table for each attribute. Analysis of the data shows that the residential classification (Established Resident -V- Newcomer) has a statistically significant bearing on HSI; [$F(1, 984) = 7.914, p < 0.5$]. By considering only dominant cases of the difference: [HSI for Established Residents – HSI for Newcomers], the following observations can be made.

- a. Belfast - *mode, distance* and *car/licence availability* are key distinguishing attributes
- b. Fourwinds - *distance* is the strongest distinguishing attribute, but there is a large negative anomaly for *proximity*
- c. Knockmore - *proximity* is the key distinguishing attribute
- d. Moira - there are no significant distinguishing attributes.

Some of these could have a bearing on educational policy formulation. For example, why would Fourwinds have a large negative anomaly for *proximity*? The data shows that this edge of city settlement is the least sustainable settlement class along the surveyed corridor and comprises mainly of newcomer residents (*sustainability* here means travel behaviour sustainability). Perhaps the anomaly can be attributed to the possibility that the newcomers were motivated to become aware of a recent CityBus-service upgrade. Also of educational interest is the fact that for Fourwinds the mean walk time to a public transport halt is 13 minutes. This is significantly greater than 5 to 9 minutes, which, across all settlements, was deemed to be an acceptable walk time from home to a public halt. Clearly, the notion that 13 minutes does not identify with an acceptable walking distance is a socially and historically constructed attitude, a consequence of familiarity with modern modes of transport and the growth of a habitus of restricted personal effort in relation to mobility. There is much current concern in the media regarding public health and lack of exercise. Linking health education to sustainability may make the public more aware of the multiple benefits to be gained through greater use of public transport. A more holistic approach to public education in these areas may enable citizens to begin to consider breaking their current routines and exploring new ways of living that may benefit health as well as enhance sustainability.

Another interesting feature deducible from Table 9 is the fact that Fourwinds records the least overall HSI value and yet it exhibits the largest HSI value for the *frequency* of activity. This result displays a generic behaviour pattern for both Newcomers and Established Residents consistent with remoteness from readily accessible activities and the corresponding low HSI score for proximity to public transport would support this.

Turning to Belfast, which is the most sustainable settlement from a travel behaviour perspective it is easy to see why *mode, distance* and *car/licence* attributes each constitute significantly greater HSI means for the Established Residents. Generally, the data shows that they rely more on public transport, travel shorter distances and have fewer vehicles and licences at their disposal. Although the Newcomers lag the Established Residents on HSI scoring, it is illuminating to note that their global HSI of 60.209 is much greater than any other settlement's Established Resident total. This promotes the argument that if Established Residents from other settlements can be persuaded to move to a brownfield

site it follows that their brownfield newcomer status will enhance sustainability in general. This is a fundamental key to educational policy.

With *proximity* dominating the HSI difference in favour of Established Residents in Knockmore it follows that as a dormitory settlement close to the large town of Lisburn (now with City status), the travel-behaviour benefits from the close proximity of established public transport halts to numerous developments. If an educational promotion were put in place directed at newcomer residents by the bus and train service providers it is possible that the newcomers would start to behave more in line with their brownfield counterparts.

The data for Moira showing that there are no distinguishing attributes of travel behaviour illustrates the earlier arguments put forward in terms of peer education.

While the results of this investigation point to a clear and unambiguous result in respect of the Belfast City Region, it is worth reflecting on the work of De Weerd *et al.* (1996). They observe that the way people live their daily lives is determined to a large extent by the planning and design of settlements. For example, someone living in a city within southern California is more likely to use the car for going to work, for shopping and for recreation activities because local planning in California promotes mono-functional areas, low-density housing and very limited public transport. On the other hand, someone living in inner city Paris or New York is likely to travel by public transport because of the compactness of these cities, the mix of residential and other functions and their extensive metro system coupled with the difficulty of finding a parking space. In Amsterdam and Beijing many people use self propelled transport, a mode that would be totally unacceptable in LA, where distances to be covered are long. Hence in designing educational programmes based on HSI comparisons to promote more efficient travel behaviour, it is essential to seek expert opinion profiles appropriate to the city being investigated.

6. Conclusion

The study points to the need to consider the impact of demographic mobility on sustainable behaviour and the role that learning may play in enabling incomers to communities to become aware of existing sustainable lifestyles within the communities they have gravitated towards. It was also pointed out in Cairns *et al.* (2005) that travellers do not adjust their behaviour instantaneously. Governments, on a global scale, are now committed to supporting local partnerships between local councils and schools to promote sustainable practices across communities. This entails a recognition that the development of more sustainable policies requires a profound reconsideration of the ways in which people can become involved in local decision-making and contribute to the creation of cultures of sustainability in their communities. The study suggests that, where incomers have demonstrated a broad acceptance of the local culture, they are more likely to adopt sustainable policies. The finding that brownfield developments may have greater potential for developing awareness of sustainable polices and practices emphasise the need to value existing community culture residues of positive knowledge and social capital regarding sustainability.

In a climate where schools are often under pressure to produce continually improving examination results, there must be a concern that a focus on narrow academic achievement may impede schools from fully participating in the process of liaising with local councils to improve consciousness of sustainability. Smith (2004: 73) has asserted that “educators concerned about moving our society in these directions [towards ecological sustainability and social justice] must find ways to engender a sense of connectedness and responsibility in their students”. Equally, Jucker (2004:10) has argued that “it is impossible to look at educational issues before we develop a clear understanding of the dominant ideologies that currently perpetuate unsustainability”.

The creation and durability of a form of education that will support sustainability is, clearly, a formidable challenge. A challenge that will involve policymakers and practitioners in both local councils and education adopting a critical approach to the analysis of current ideologies underpinning educational, social and educational policies in order to identify both barriers to sustainability and opportunities for a more closely connected approach to improving sustainability.

It is clear that travel behaviour plays a significant role in the sustainability debate - supported by the value of opportunity offered by planning and transport policies. This paper seeks to promote consideration of educational policies as an essential pathway to the further enhancement of sustainability, but it leaves open one of the most obvious questions emanating from this research, namely: '*can the behaviour of the individual be altered and can individual hedonism be reduced?*' For individual behaviour to change without outside direction, or for individuals to accept and even support political and other action that could result in change, there has to be individual awareness of the need to change. For example an individual can learn about the impact of a motor car on global warming but the car in pursuit of pleasure is likely to outweigh any potential concern. Here lies the crux that needs to be examined by a programme of research on the psychology of educational influence where an individual can be persuaded to trade-off hedonism for the future good of mankind. OECD (2002) has identified the following barriers to the attainment of environmentally sustainable transport:

- a. Lack of awareness of the need for change
- b. Lack of concern for future generations
- c. Fear of change, and thus resistance to change
- d. Attractiveness of present transport modes
- e. Absence of transport alternatives
- f. Resistance to collective alternatives
- g. Car ownership and
- h. Lack of adequate professional advice

These if coupled with the model and findings described herein could provide the elements of a contextual framework designed to underpin an educational programme devoted to improving travel behaviour sustainability. However, if human behaviour and individual hedonism are to be altered and transportation sustainability plans are to be effective, there is a need to employ a combination of strategies aimed at improving *travel choices*, *pricing* and *road design incentives*. These have the potential to encourage more efficient travel choices, land use patterns that minimise the need to travel and encourage use of alternative modes.

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Notes

Note 1. A method ideally controlled by a co-ordinator who solicits collective specialist and mutually exclusive opinions from a number of previously appointed remote experts, called the Delphi panel. The co-ordinator summarises the various opinions as to the global consensus or otherwise and feeds this information back to the Delphi panel so that members can revise or sustain their previous opinions. The process is repeated until the co-ordinator is satisfied that the opinion has stabilised. See Linstone and Turoff (1975) for a detailed description of the Delphi Process.

Table 1. Key Words in Travel Behaviour

Global Key Word	Parametric Key Word	
Mobility	Journey Mode Income Goods/Services Social Economic Distance	Car Ownership Public Transport Locations Visited Accessibility Occupational Status Demography Motivation
Activity	Health Leisure Low/High Order Shopping Entertainment Commerce	Opportunities Constraints Family Make-up Occupational Status Travel Pattern
Lifestyle	Household Individual Dependants Age Profile	Time Allocation Life Cycle Travel Frequency Destination Choice
Car Ownership	Level of Ownership Impact on Other Modes Car Availability Licence Holders	Car-pools Utility Convenience
People Factor	Suburbanisation Established Residents Newcomers Environment Community Attractiveness Security	Recreation Employment Education Development Transport Facilities Housing
Public Transport	Infrastructure Convenience Reliability Fare Structure	Cleanliness Scheduling User Friendliness Comfort Factor

Used as an *aide memoire* in the selection of attributes and criteria to be identified with the proposed model of household travel behaviour sustainability.

Table 2. Typical Household Sustainability Index (HSI) Calculation

Baseline Attributes →	Mode	Frequency	Location	Proximity	Vehicles & Licences
Mean Points Value v_i	18.1	16.1	96.8	1.00	50.0
Expert Weight (w_j)	0.216	0.155	0.322	0.193	0.114
Product $w_i v_i$	3.91	2.50	31.2	0.19	5.70
HSI = $\sum w_i v_i$ = 43.5					

This table shows how a typical household’s mean points scores for each attribute are combined with the generic expert weightings for each attribute to produce an index of travel behaviour sustainability.

Table 3. Points Scores for Each Mode

Mode	Rank	Calc	Score
Non Participant	1 'most' sustainable	$450 \times 8/36$	100.0
Walk	2	$450 \times 7/36$	87.5
Cycle	3	$450 \times 6/36$	75.0
Train	4	$450 \times 5/36$	62.5
Bus	5	$450 \times 4/36$	50.0
Taxi	6	$450 \times 3/36$	37.5
Motorcycle	7	$450 \times 2/36$	25.0
Car	8 'least' sustainable	$450 \times 1/36$	12.5
$\Sigma = 36$			

In this table the absolute maximum points score of 100 identifies with non-participation. The remaining modes are weighted by a method suggested in Edwards and Newman (1982), namely: according to their inverse rank position where Car = 1 through to Non-participant Mode = 8.

Table 4. Points Scores for Trip Frequency

Frequency of Activity/Trips	Rank	Score
Daily	5	5
Weekly	4	25
Fortnightly	3	50
Monthly	2	75
Zero Frequency (Non-participant)	1	100

This shows the point scores that are identified with each frequency.

Table 5. Points Scores for Proximity to Public Transport

Proximity Time Intervals (Mins)	Rank	Score
Non-Response	6	1*
$t \geq 20$	5	20
$15 \leq t < 20$	4	40
$10 \leq t < 15$	3	60
$5 \leq t < 10$	2	80
$0 \leq t < 5$	1	100

*Logically the score for 'non-response' should be zero, but to facilitate the calculation of harmonic means, changing 0 to 1 eliminates the zero divisor problem.

Table 6. Points for Household Motor Vehicle/Licence Holder Combinations

No. of Licence Holders n	Number of Cars k					
	0	1	2	3	4	5
0	100	100	100	100	100	100
1	100	50	50	50	50	50
2	100	50	33	33	33	33
3	100	50	33	25	25	25
4	100	50	33	25	20	20
5	100	50	33	25	20	17

In this table the scoring strategy for numbers of household vehicles and licence holders is based on the law of diminishing returns.

Table 7. Two Cases of HSI Software Output - B129 (Belfast household - no children) and M037 (Moira household – with children)

ACTIVITY	B129					M037						
	M	F	L	P	V/L	M	F	L	P	V/L		
Bulk Shopping	37.5	50	97			12.5	25	74				
Occasional Shopping	12.5	25	97			12.5	5	82				
Leisure	50.0	25	97			12.5	25	60				
Entertainment	50.0	75	97			12.5	25	60				
Health/Medical	62.5	75	97			87.5	25	99				
Business	87.5	50	97			12.5	75	82				
Place of Worship	100	100	100			12.5	25	92				
0 Children	100	100	100			-	-	-				
Child 1	-	-	-			37.5	5	80				
Child 2	-	-	-	80	50	37.5	5	84	60	50		
Child 3	-	-	-			50	5	99				
Child 4	-	-	-			50	5	-				
Child 5	-	-	-			50	5	99				
0 Wage Earners	-	-	-			-	-	-				
Wage Earner 1	25.0	5	84			25	25	66				
Wage Earner 2	75.0	5	98			12.5	5	80				
Wage Earner 3	-	-	-			-	-	-				
Wage Earner 4	-	-	-			-	-	-				
Wage Earner 5	-	-	-			-	-	-				
Valid responses <i>N</i>	10	10	10	1	1	14	14	13	1	1		
Inv $\Sigma(\text{Inv Pts}) = p$	4.05	1.77	9.62	80	50	1.38	0.60	6.08	60	50		
Product $N \times p$	40.5	17.7	96.2	80	50	19.3	8.5	79.0	60	50		
Experts' Weights	.216	.155	.322	.193	.114	.216	.155	.322	.193	.114		
HSI	8.75	2.74	31.0	15.44	5.70	63.6	4.17	1.31	25.4	11.6	5.70	48.2

M = Mode of Transport; F = Frequency; L = Location (Distance); P = Proximity and V/L = Vehicles & licences

The HSI for B129 is given by $\sum_{i=1}^5 w_i v_i = 8.75 + 2.74 + 31.0 + 15.44 + 5.7 = \mathbf{63.6}$ and the HSI for M037 is given by

$$\sum_{i=1}^5 w_i v_i = 4.17 + 1.31 + 25.4 + 11.6 + 5.7 = \mathbf{48.2}.$$

Table 8. Descriptive Statistics: Overall HSI

Statistic	HSI
Mean	52.2600
Median	52.3227
Std. Deviation	9.345
Minimum	12.60
Maximum	84.37
Interquartile Range	8.6985

This table shows the summary of HSI results for the complete spectrum of 958 household responses.

Table 9. Mean HSI Values by Location and Residential Classification

ATTRIBUTE	LOCATION							
	BELFAST (Inner-city)		FOURWINDS (Edge of City)		KNOCKMORE (Dormitory Area)		MOIRA (Suburbanised)	
	New	Est	New	Est	New	Est	New	Est
Mode	6.586	8.453	3.635	3.927	3.403	4.028	3.705	3.869
Frequency	2.590	2.792	3.020	3.306	2.622	2.616	2.842	3.079
Distance	28.632	30.297	28.426	31.334	28.562	29.507	24.862	25.612
Proximity	16.735	17.724	9.586	6.834	12.688	14.424	14.019	14.168
Car/Licence Avail	5.667	6.867	4.656	5.198	4.606	4.776	4.560	4.491
Total	60.209	66.134	49.322	50.598	51.882	55.351	49.987	51.219

New = Newcomer, Est = Established Resident

It is clear from this table that for every location the HSI global totals for Established Residents exceeds the total for Newcomers and moreover, in most cases this is true when reading across the table for each attribute.

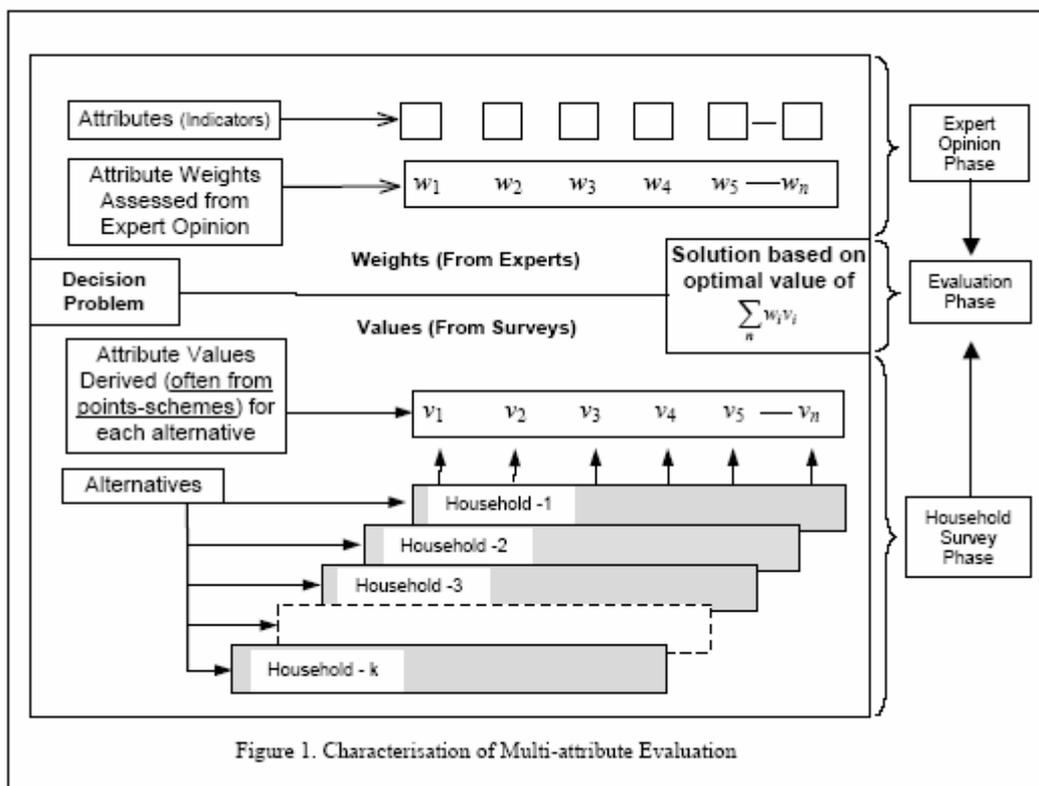
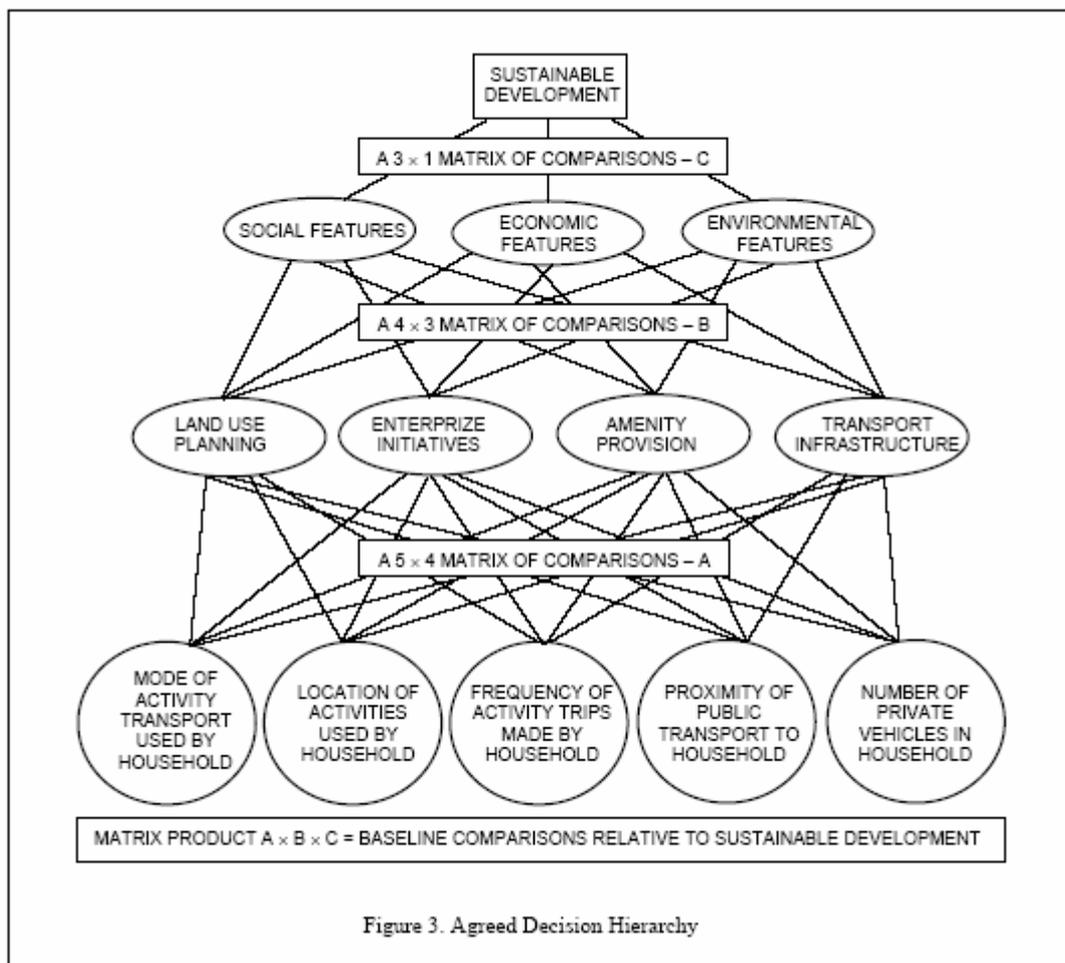
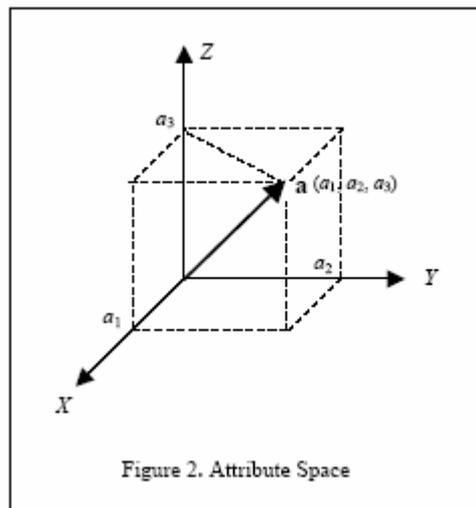


Figure 1. Characterisation of Multi-attribute Evaluation



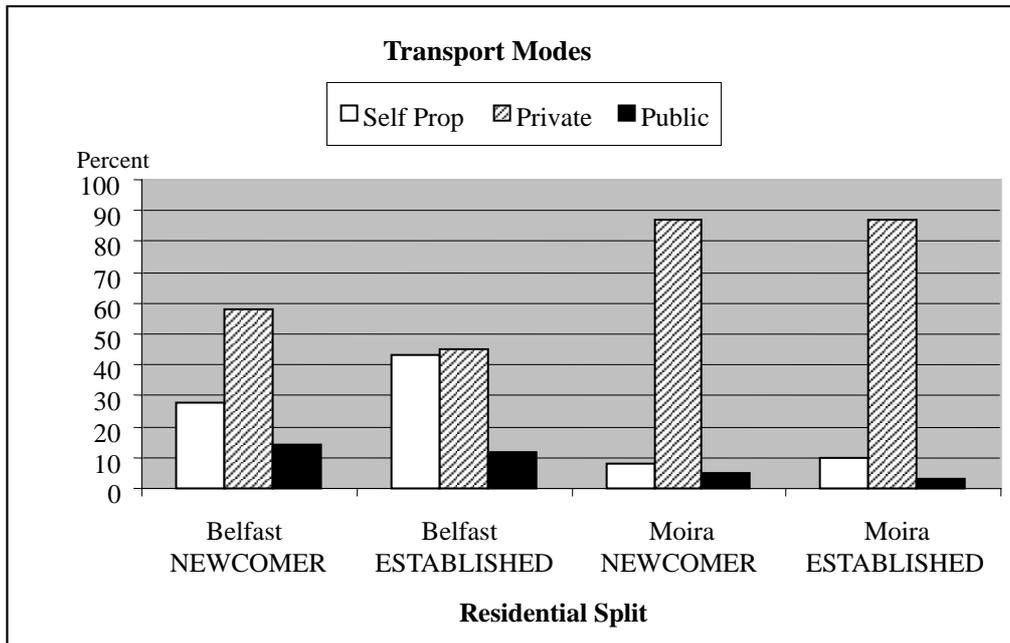


Figure 4. Modal Distributions for Newcomers -V- Established Residents

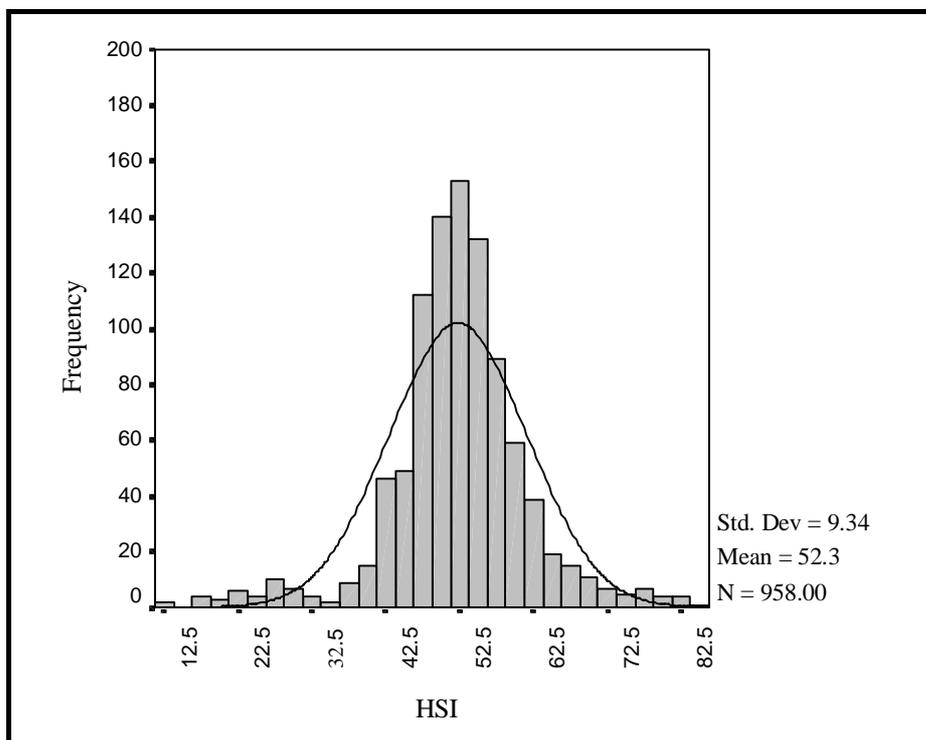


Figure 5. Household Sustainability Index: Overall Distribution